ENVIRONMENTAL IMPACT STATEMENT
NEW NUCLEAR - DARLINGTON
ENVIRONMENTAL ASSESSMENT

NK054-REP-07730-00029

Submitted To:

Ontario Power Generation Inc.

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In Association With:

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EIS FOR THE NND EA

EA Consulting Team

SENES Consultants Limited	SENES Consultants Limited	Atmospheric Environment Aquatic Environment Ecological Risk Assessment Emergency Planning and Preparedness Environmental Impact Statement Human Health Malfunctions, Accidents and Malevolent Acts Project Management Radiation and Radioactivity Environment Scope of Project
MMM GROUP	MMM Group Limited	Environmental Impact Statement Land Use Project Management Traffic & Transportation
Golder Associates	Golder Associates Limited	Aquatic Environment Surface Water Environment
AECOM	AECOM	Socio-Economic Environment Sustainability
CH2MHILL	CH2M HILL Canada Limited	Geological and Hydrogeological Environment
NSS Enhancing performance through partnering	Nuclear Safety Solutions Incorporated	Radiation and Radioactivity Environment
BEACON ENVIRONMENTAL	Beacon Environmental	Terrestrial Environment
ARES CORPORATION	ARES Corporation	Seismicity
ARCHAEOLOGICAL SERVICES INC.	Archaeological Services Incorporated	Physical and Cultural Heritage Resources
KINECTRICS	Kinectrics Incorporated	Sample Analyses
KLD ASSOCIATES, INC.	KLD Associates Incorporated	Emergency Planning and Preparedness

EXECUTIVE SUMMARY

ES.1 Introduction

This Executive Summary is based on the Environmental Impact Statement (EIS) prepared for the New Nuclear – Darlington (NND) Project proposed by Ontario Power Generation Inc. (OPG). The site selected by the provincial government for development of the NND Project is the existing Darlington Nuclear (DN) site located on the shore of Lake Ontario in the Municipality of Clarington, within the Regional Municipality of Durham, about 70 km east of Toronto. The portion of the DN site proposed for development of the Project is primarily the eastern one-third of the overall DN site. OPG is the owner of the DN site, the operator of the existing Darlington Nuclear Generating Station on the site (DNGS) and the proponent for the NND Project.

In accordance with direction from the Province of Ontario, and consistent with the Ontario Power Authority's (OPA) Integrated Power System Plan (IPSP), the NND Project will involve the construction and operation of up to four nuclear reactor units supplying up to 4,800 MW of electrical capacity to meet the baseload electrical requirements of Ontario. While the initial need is for only two new nuclear units, it was assumed for environmental assessment (EA) and subsequent site preparation planning purposes that the nuclear generation capacity of the DN site would be maximized in future. In addition to fulfilling the need for new units, the NND Project will contribute to the Province's requirement that a baseload nuclear generation capacity of 14,000 MW be maintained.

A range of reactor designs for the Project is being considered by the Province of Ontario, which is responsible for procuring the reactors and associated construction and installation services (OPG will operate the reactors). It is anticipated that each new reactor constructed would have an operating life of approximately 60 years, possibly including mid-life refurbishment.

The regulatory process for the NND Project began on September 21, 2006 when OPG submitted to the Canadian Nuclear Safety Commission (CNSC) an "Application for Approval to Prepare a Site" for the Project. That application initiated the licensing process under the *Nuclear Safety and Control Act (NSCA)*. For new nuclear power projects, the following licences under the *NSCA* are required over the life of a project: (i) a licence to prepare a site; (ii) a licence to construct; (iii) a licence to operate; (iv) a licence to decommission; and (v) a licence to abandon.

The September 2006 application to the CNSC triggered the *Canadian Environmental Assessment Act (CEAA)*. The proposed construction of a nuclear power plant is identified in *CEAA* regulations as a project for which comprehensive EA studies are mandatory. On March 20, 2008, the federal Minister of Environment announced referral of the NND Project to a review panel pursuant to the *CEAA* and indicated that the CNSC and the Canadian Environmental

Assessment Agency (CEA Agency) should pursue a joint EA review process. Accordingly, a Joint Review Panel (JRP) under the *CEAA* and the *NSCA* was established to undertake EA and regulatory review of the Project. Because of the joint nature of the EA process, the CEA Agency has assumed an overall coordination role for the conduct of the EA and the activities of the JRP. The Project is excluded from a provincial EA because it is not a designated undertaking pursuant to the Ontario *Electricity Projects Regulations* which identify the electricity projects that are subject to the Ontario *Environmental Assessment Act (EAA)*. The Province has, however, indicated its desire to remain informed about the progress of the federal EA.

OPG has prepared and submits this EIS in accordance with EIS Guidelines prepared by the CEA Agency and the CNSC in consultation with other Federal Authorities and issued in January 2009, following public review.

ES.2 The Project for EA Purposes (Chapter 2)

The proposed Project is the "Site Preparation, Construction and Operation of New Nuclear - Darlington". The NND Project will include as many as four nuclear reactor units supplying up to 4,800 MW of electrical capacity. For EA purposes, the key elements and activities of the NND Project will include:

- Preparation of the DN site for construction of the new nuclear facility;
- Construction of the NND nuclear reactors and associated facilities;
- Construction of the appropriate nuclear waste management facilities for storage and volume reduction of waste;
- Operation and maintenance of the NND nuclear reactors and associated facilities for approximately 60 years of power production (i.e., for each reactor);
- Operation of the appropriate nuclear waste management facilities; and
- Development planning for decommissioning of the nuclear reactors and associated facilities, and eventual turn-over of the site to other uses.

Three vendors, each with different reactor designs, are currently being considered by the Province of Ontario:

- Atomic Energy of Canada Limited (AECL) – Advanced CANDU Reactor (ACR-1000), a pressurized heavy and light water hybrid reactor (Hybrid),with 1085 MW(e) net output per unit;
- AREVA NP – US EPR (EPR), a pressurized water reactor (PWR) with 1580 MW(e) net output per unit; and
- Westinghouse Electric Company LLC – AP1000, a PWR with 1037 MW(e) net output per unit.

All of the considered reactors use low-enriched uranium fuel (<5% enrichment). The PWRs use light water for both moderator and fuel cooling purposes; the ACR-1000 Hybrid uses heavy water for moderator purposes and light water for fuel cooling.

The vendor and specific reactor type were not yet selected by the Province at the time of submission of this EIS, nor was the design of the overall site development complete (since development requirements will be unique for each reactor). Therefore, the "Project for EA Purposes" is defined within a bounding framework that incorporates the Plant Parameter Envelope (PPE) that effectively brackets the range of variables to be assessed. The use of the PPE method is consistent with CNSC licensing guidance for new nuclear power plants which recognizes that an application for a Licence to Prepare a Site may be submitted in advance of selection of a specific technology. Should the design that is ultimately selected by the Province be other than those considered in this EIS, any necessary adjustments would be made to the EIS to take into account any substantial changes in the environment, the circumstances of the Project, and new information of relevance to the assessment of effects of the Project.

Alternative Means

The EIS considers the following alternative means of carrying out specific elements of the Project.

Alternative Reactor Designs and Number of Units	Although only one of the three reactor options will ultimately be implemented (ACR-1000, EPR or AP1000), all three are evaluated in the EIS. The EIS also considers the number of reactor units that would be required to achieve the power production objective of 4,800 MW, without exceeding it (four ACR-1000s, three EPRs, four AP1000s).
Alternatives for Condenser Cooling	Four options for plant condenser cooling (once-through lake water cooling; natural draft cooling towers; fan-assisted natural draft cooling towers; and mechanical draft cooling towers) are considered in the EIS.
Alternatives for Management of Low and Intermediate Level Waste (L&ILW)	Two alternatives are evaluated in the EIS for management of L&ILW (new facilities developed on-site for this purpose; and transportation of L&ILW off-site to an appropriate licensed facility).
Alternatives for Storage of Used Fuel	The alternatives for storage of used fuel are directly related to the reactor options being considered, specifically: OPG's existing Dry Storage Containers (DSCs) and AECL's MACSTOR system for the ACR-1000 option; metal casks, concrete canisters and concrete modules (widely used internationally) for the EPR and AP1000 options. In all cases, after a period of initial decay in used fuel bays, storage will be onsite in a purpose-built used fuel storage facility
Alternatives for Excavated Material Management	Three separate plant layouts were conceptualized and aggregated to create the bounding site development layout that was used as the basis for assessment of effects associated with site preparation and construction activities. The individual model plant layouts represented a range alternatives in terms of the quantities of material to be excavated and the means for management of this material.

The Project Description for EA Purposes incorporated the individual features and characteristics of each alternative means such that the bounding framework being assessed as the NND Project was fully inclusive (i.e., bracketed) all the conditions represented by the alternative means.

Conceptual Project Timeline

For EA purposes, the following Project conceptual timeline was adopted.

Project Phase	Start	Finish
Site Preparation and Construction	2010	2025
Operation and Maintenance	2016	2100
Decommissioning	2100	2150

Site Preparation and Construction Phase

The NND Project development scenario adopted for purposes of the EA anticipates that the site will be prepared at the outset for the maximum number of reactor units and associated support facilities. Two reactors will initially be constructed generally in parallel, although the first reactor will become operational as the second reactor is being constructed. Construction of some Project facilities may take place concurrently with site preparation works. Construction of the last one or two reactors (up to four in total) is assumed to begin after the first two are in service. The principal works and activities associated with the Site Preparation and Construction phase are:

- Mobilization and Preparatory works (e.g., clearing and grubbing, services and utilities, and on-site roads and related infrastructure);
- Excavation and Grading (e.g., on-land earthmoving and grading, rock excavation, and development of construction laydown areas);
- Marine and Shoreline Works (e.g., lake infilling, shoreline protection, wharf construction, and some minor lake bottom dredging);
- Development of Administration and Physical Support Facilities (e.g., offices, workshops, maintenance, storage and perimeter security buildings and utilities operating centres);
- Construction of the Power Block (e.g., reactor buildings, turbine-generator buildings, and related structures);
- Construction of Intake and Discharge Structures (e.g., offshore submerged intake and discharge structures similar to those of DNGS for the once-through lakewater cooling option; or alternatively, smaller but generally similar structures for the cooling tower options);

- Construction of Ancillary Facilities (e.g., including cooling towers and blow-down ponds, if applicable, and expansion of the existing switchyard);
- Construction of Radioactive Waste Storage Facilities (e.g., facilities for dry storage of used fuel, following initial wet storage in bays within the Power Block, and facilities for storage of L&ILW);
- Management of Stormwater (e.g., ditches, swales and ponds);
- Supply of Construction Equipment, Material and Operating Plant Components (e.g., to the work site);
- Management of Construction Waste, Hazardous Materials, Fuels and Lubricants; and
- Workforce, Payroll and Purchasing (e.g., including approximately 100 workers during Site Preparation and up to 3,800 workers during Construction).

Operation and Maintenance Phase

The Operation and Maintenance phase will begin with the receipt of the first load of fuel for the first reactor and will end when the last reactor has been defueled in preparation for decommissioning. The principal works and activities associated with the Operation and Maintenance phase are:

- Operation of the Reactor Core (e.g., startup, reactivity control/operation and shutdown activities);
- Operation of the Primary Heat Transport System (e.g., including management of heavy water with the ACR-1000 reactor option only);
- Operation of Active Ventilation and Radioactive Liquid Waste Management Systems;
- Operation of Safety and Related Systems (e.g., such that fundamental safety functions are ensured);
- Operation of Fuel and Fuel Handling Systems (e.g., receipt and storage of new fuel, fuelling/refuelling the reactors and transfer of used fuel from the reactors to wet storage);
- Operation of Secondary Heat Transport Systems and Turbine-generators (e.g., comprising the secondary side of steam generators, main steam system, turbines, condensers and generators);
- Operation of Condenser and Condenser Circulating Water, Service Water and Cooling Systems (e.g., once-through lakewater cooling system; similar to the DNGS system; or natural draft, mechanical or fan-assisted natural draft cooling tower alternatives);
- Operation of Electrical Power Systems (e.g., main transformers and emergency/standby power facilities);
- Operation of site services and utilities (e.g., sewage, stormwater, domestic water);

- Management of operational low and intermediate-level waste (e.g., including off-site transportation if applicable);
- Dry storage of Used Fuel (e.g., at an on-site facility pending eventual transfer to a long-term management facility);
- Management of Conventional Waste (e.g., including reuse and recycling);
- Replacement/Maintenance of Major Components and Systems (e.g., including possible mid-life refurbishment of major components such as reactor components and steam generators);
- Physical Presence of the Station (e.g., as an operating nuclear facility); and
- Administration, Purchasing and Payroll (e.g., involving a workforce estimated at 1,400 for the first two units and up to 2,800 for four units).

Decommissioning Phase

Toward the end of its planned operating life, each NND unit will be defuelled and dewatered in preparation for eventual decommissioning. For EA purposes, it is assumed that NND decommissioning will begin in 2100 after a decision has been made to permanently end the operation of one or more NND units. A preliminary decommissioning plan is provided in Section 12 (see also Section ES.12).

Existing Security, Safety and Environmental Programs

As a Class 1 Nuclear Facility, NND will include appropriate security systems to comply with CNSC's security requirements. OPG already has extensive protection and emergency response plans and capability in place at the DN site. In addition, other programs already established by OPG, such as Radiation Protection, Occupational Health and Safety, and Environmental programs, will be applied similarly to the NND Project. OPG Nuclear has developed an Environmental Management System (EMS) to manage environmental aspects consistent with elements of the ISO 14001 EMS Standard. As a company committed to sustainable development, OPG will continue to strive to minimize the environmental footprint of its operations while bringing social and economic value to the communities in which it operates.

ES.3 Methodologies Used in the EIS (Chapter 3)

The over-arching methodology applied in the assessment of environmental effects is consistent with the requirements of the *CEAA,* related guidance, and the EIS Guidelines. Fundamentally, it revolves on a detailed understanding of the Project (i.e., as reflected in its individual works and activities) and a systematic consideration of how each may interact with, and consequentially affect the environment, with a focus on valued ecosystem components (VECs) as features of the environment deemed important and relevant.

The spatial boundaries, representing the general geographic framework within which the Project-related effects are assessed, comprise a Regional Study Area (RSA), a Local Study Area (LSA) and a Site Study Area (SSA) generically described as:

- RSA - extends approximately 40 km east and west of the DN site. Its western limit is the Region of Durham boundary and it extends east to the Town of Cobourg (thereby including both the Pickering NGS and the Town of Port Hope historic low level radioactive waste sites which are relevant from a cumulative effects perspective). In the north, the RSA includes the Oak Ridges Moraine and the provincially-designated greenbelt area south of it;

- LSA - expanded substantially beyond the area suggested in the EIS Guidelines, the LSA includes all of the Municipality of Clarington and the easterly urbanized portion of the City of Oshawa. The LSA coincides generally with the Primary Zone for emergency response identified by Emergency Measures Ontario; and

- SSA - comprises the entire DN site and extends into Lake Ontario a distance of approximately 1 km.

The generic study areas were adjusted as appropriate for individual EA studies conducted for each environmental component to ensure that the unique nature of the spatial requirements for each were considered.

ES.4 Description of the Existing Environment (Chapter 4)

Consistent with typical EA practice, characterization of the existing environment relevant to the NND Project as the baseline upon which to consider potential environmental effects focused on those aspects of the environment (environmental components), within the three study areas, that were most likely to interact with and be affected by the Project.

Since environmental studies have been conducted on and around the DN site since 1972, a large body of information on the physical, biological and social environments relative to the site and vicinity was available for characterizing the existing environment. Nevertheless, a program of field studies and data collection was undertaken to supplement the existing information based on needs identified through a gap analysis.

Environmental Components and Valued Ecosystem Components (VECs)

For each environmental component the baseline characterization included identification of the VECs considered relevant for that environmental component. VECs are features of the environment selected to be the focus of the EA because of their ecological, social, cultural or economic value and their potential vulnerability to effects of the Project. The selected VECs and their corresponding environmental components are summarized in Table ES-1. Selection of the VECs included input from the public and other stakeholders.

TABLE ES-1
Environmental Components and Selected VECs

Environmental Components	Relevant VECs	
Atmospheric Environment	• Pathway to human health • Pathway to non-human biota health • Pathway to VECs in other environmental components	
Surface Water Environment	• Pathway to human health • Pathway to non-human biota health • Pathway to VECs in other environmental components	
Aquatic Environment	• Darlington Creek and intermittent tributary to Darlington Creek • Lake Ontario nearshore	• Forage species • Benthivorous fish • Predatory fish
Terrestrial Environment	• Cultural Meadow and Thicket Ecosystem • Shrub Bluff Ecosystem • Wetland Ecosystem • Woodland Ecosystem • Dragonflies and damselflies • Migrant butterfly stopover area • Breeding birds • Migrant songbirds and their habitat	• Waterfowl staging areas and winter habitat • Migrant songbirds and their habitat • Winter raptor feeding and roosting areas • Breeding and key summer habitat (amphibians and reptiles) • Breeding mammals • Wildlife corridors
Geological & Hydrogeological Environment	• Pathway to human health • Pathway to non-human biota health • Pathway to VECs in other environmental components	
Radiation & Radioactivity	• Pathway to human health • Pathway to non-human biota health	
Land Use Environment	• Land use planning regime in local study area • Visual aesthetics	
Traffic and Transportation	• Transportation system operations (road, rail, marine) • Transportation system safety (road, rail, marine)	
Physical & Cultural Heritage Resources	• Aboriginal archaeological resources • Euro-Canadian archaeological resources • Euro-Canadian built heritage resources • Euro-Canadian cultural landscape resources	

TABLE ES-1 (Cont'd)
Environmental Components and Selected VECs

Environmental Components	Relevant VECs	
Socio-Economic Environment	• Local and regional population • Education • Health and safety services • Local and regional economic development • Agriculture • Residential property values • Municipal revenues and financial status	• Housing • Community character and image • Municipal infrastructure and services • Community and recreational facilities and services • Ability to use and enjoy property • Community cohesion
Aboriginal Interests	• Community characteristics • Hunting and fishing for subsistence • Fishing, trapping and traditional harvesting and collecting for sustenance, recreational and economic purposes	
Health - Humans	• Members of the public • Workers on the NND Project	
Health – Non-Human Biota	• Terrestrial vegetation • Insects and invertebrates • Birds and waterfowl • Mammals • Amphibians and reptiles • Benthic invertebrates • Aquatic vegetation • Fish	

ES.5 Assessment and Mitigation of Likely Environmental Effects (Chapter 5)

Each Project work and activity was screened to determine if it was likely to interact with the environment and, if so, if it was likely to result in a measurable change in the environment. If a measureable change was considered likely, the change was evaluated to determine the associated likely environmental effect. Design features incorporated into the Project planning to pre-empt or preclude environmental effects (i.e., in-design mitigation measures) were considered in the evaluation for change and effect.

Opportunities to further mitigate the likely environmental effects were identified, assumed to be implemented and the residual effect (i.e., after all mitigation) determined. Where effects were deemed beneficial, no further assessment was carried out. Residual adverse effects were further considered for their significance. This methodical assessment process identified a number of residual adverse effects on the environment as summarized in Table ES-2.

TABLE ES-2
Summary of Residual Adverse Effects and Relevant VECs

Environment Component	Likely Residual Adverse Effects	Relevant VECs
Atmospheric Environment	None	N/A
Surface Water Environment	None	N/A
Aquatic Environment	Loss of some aquatic biota (i.e., benthic invertebrates, fish) during the construction of the lake infill and the cooling water intake and discharge structures.	Benthic invertebrates and VEC fish species
	Impingement and entrainment losses associated with the operation of the once-through lakewater cooling option and, to a far lesser degree, the cooling tower option.	
Terrestrial Environment	Loss within the DN site of approximately 40 to 50 ha of mostly Cultural Meadow Ecosystem.	Cultural Meadow and Thicket Ecosystem
	The net loss of approximately 24 to 34 ha of on-site habitat currently used as butterfly stopover area migration.	Migrant butterfly stopover areas
	Decrease in populations of breeding birds on the DN site.	Breeding birds
	Loss of nesting habitat for up to 1,000 Bank Swallow burrows; however, some mitigation not directly comparable to effect, will result in advances for the species elsewhere.	Breeding birds
	Bird strike mortalities associated with natural draft cooling towers (estimated at <110 in the spring and <300 in the fall, assuming four natural draft cooling towers).	Breeding birds Migrant song birds and their habitat
	Periodic and short-term disruption to wildlife travel along the east-west wildlife corridor during the Site Preparation and Construction phase of the Project.	Landscape connectivity
Geological & Hydrogeological Environment	None	N/A
Radiation & Radioactivity Environment	None	N/A
Land Use	Changes in the quality of existing views of the DN site throughout the operating life of the Project from viewing locations in the LSA and RSA as a result of the presence of natural draft cooling tower structures and the associated plumes released from either natural draft or mechanical draft cooling towers.	Visual aesthetics
Traffic & Transportation	None	N/A

TABLE ES-2 (Cont'd)
Summary of Residual Adverse Effects and Relevant VECs

Environment Component	Likely Residual Adverse Effects	Relevant VECs
Physical & Cultural Heritage Resources	None	N/A
Socio-Economic Environment	Change in the character of communities in the RSA and LSA as a result of the presence of the natural draft cooling tower structures, and the associated plumes released from either natural draft or mechanical draft cooling towers (if the NND Project were to be implemented with cooling towers).	Community character
	Reduced use and enjoyment of the recreational features on the DN site during the Site Preparation and Construction phase.	Community and recreational facilities
	Disruption to use and enjoyment of property because of nuisance-related effects (e.g., dust, noise, traffic) during the Site Preparation and Construction phase for some residents living along the truck haul routes.	Use and enjoyment of property
	Reduced enjoyment of private property in the RSA and LSA as a result of the visual dominance of the natural draft cooling tower structures and the associated vapour plumes released from either the natural draft or mechanical draft cooling towers (if the NND Project were to be implemented with cooling towers).	Use and enjoyment of property
Aboriginal Interests	None	N/A
Health - Human	Reduced enjoyment of private property in the RSA and LSA as a result of the visual dominance of the natural draft cooling tower structures and the associated vapour plumes released from either the natural draft or mechanical draft cooling towers.	Members of the public
	Disruption to use and enjoyment of property because of nuisance-related effects (e.g., dust, noise, traffic) during the Site Preparation and Construction phase for some residents living along the truck haul routes.	Members of the public
	Reduced use and enjoyment of community and recreational features on the DN site during the Site Preparation and Construction phase	Members of the public
Health - Non-Human Biota	None	N/A

Note: N/A = not applicable

The number of residual adverse Project effects identified through this assessment is relatively small due to the comprehensive scope of OPG's proposed environmental and safety design features, procedures; in-design mitigation measures; and additional mitigation measures identified through the assessment process. It should be noted, in particular, that no residual health effects on humans or non-human biota, resulting from NND radiation or radioactivity or other emissions, were found to be likely. The maximum radiation dose to members of the public from normal NND operation was conservatively estimated to be only approximately 4 μSv/y, a very small fraction of the regulatory dose limit, and an even smaller fraction of the dose from natural background radiation.

In addition, the assessment indicated that the Project is likely to result in a number of beneficial effects, all related to the Socio-Economic Environment, including (but not limited to):

- New direct, indirect and induced employment opportunities in the RSA and LSA;
- New business activity and opportunities due to (i) increased spending associated with households directly or indirectly associated with Project employment and (ii) increased Project expenditures for goods and services; and
- Stimulation of increased local and regional economic development during all phases of the Project.

ES.6 Assessments of Other Likely Effects (Chapter 6)

The EIS also addressed a number of other factors including sustainability, likely effects of the environment on the Project, and climate change considerations.

Sustainability

The concept of sustainability has become generally accepted *"development that meets the needs of the present without compromising the ability of future generations to meet their own needs"*. The assessment of sustainability considered, in an integrated manner, the net ecological, economic and social benefits to society and the extent to which the NND Project, as a whole, would be supportive of sustainable development. The assessment concluded that the Project can enhance regional progress towards sustainability largely through economic and social means, while not diminishing overall progress from an ecological perspective. Nevertheless, the NND Project is likely to have a greater adverse effect on progress towards sustainability if implemented with natural draft cooling towers as this may adversely affect the perceived character of the neighbourhoods in the vicinity of the DN site where the towers would be dominant features on the landscape. It is also to be recognized, however, that this adverse effect would be expected to diminish over time as the presence of cooling towers and associated vapour plumes became familiar features and OPG as continued to maintain or improve its positive environmental and safety record.

Likely Effects of the Environment on the Project

The EIS has considered a number of natural hazards and environmental conditions that might affect the Project and, in turn, cause adverse effects on workers, the public or the environment, including:

- Flooding (including coastal, on-site or nearby watercourses, surface runoff and other flooding hazards);
- Severe weather (including tornadoes, hurricanes, thunder & hail storms, and freezing rain);
- Seismicity (including earthquakes and earthquake-related phenomena such as tsunamis); and
- Biophysical environment (including zebra & quagga mussels, attached algae, and fish).

Taking into account the reasonable expectations of the Project design including in-design mitigation measures and additional and mitigation measures proposed, the evaluation of these natural hazards concluded that the environment is not likely to cause significant effects on the Project.

Climate Change Considerations

Studies reported by Environment Canada and others indicate that predicted increases in global mean temperatures could result in climate changes in Ontario over the next 100 years. Because the planned life of the Project extends to approximately 2100, and the Project may therefore be subject to measurable changes in climate, an evaluation of risks to the Project as a possible consequence of climate change was carried out. The evaluation concluded that climate conditions into the foreseeable future are not likely to affect Project physical structures or systems and result in a risk to workers, the public or the environment.

Potential climate change interactions were also considered in terms of their likelihood to contribute to uncertainty of the predicted environmental effects of the Project for those environmental components susceptible to climate change. It was concluded that uncertainty of the predicted environmental effects associated with climate change is not of concern.

ES.7 Malfunctions, Accidents and Malevolent Acts (Chapter 7)

The following six categories of malfunctions and accidents relevant to the NND Project were evaluated:

- Conventional (Non-Radiological): involving only non-radiological substances or other events that could result in injury to workers;

- Radiological: involving radioactive substances and components within NND facilities, other than the reactors and their auxiliaries, such as the radioactive waste and used fuel storage facilities;

- Transportation**:** related to off-site transportation of L&ILW;

- Nuclear (Reactor System): involving the operation of the reactors and associated systems, possibly involving damage to the fuel bundles and/or the reactor core, which could result in an acute release of radioactivity to the environment;

- Out-of-Core Criticality: involving potential criticality events outside of the reactor core, due to improper spacing or moderation of enriched nuclear fuel, which could result in an acute release of radioactivity to the environment; and

- Malevolent Acts: involving a deliberate attempt to cause damage to the facility.

A summary of the evaluation in each category is provided below.

Conventional Malfunction and Accidents

A range of potential conventional malfunction and accident scenarios was identified for each phase of the Project. The scenarios were screened to focus the assessment on those that were considered to be credible and had the potential to affect workers, the public or the environment. Scenarios that were found to be similar were grouped and compared to identify a bounding scenario (having the greatest potential environmental effect) within each group or category for assessment purposes. Five credible bounding scenarios were assessed: i) spill of oil on land; ii) spill of fuel into Lake Ontario; iii) spill of chemicals; iv) fire or explosion incident; and v) personnel injury.

The assessment concluded that conventional malfunctions and accidents are unlikely to cause long-term or residual effects both to humans and non-human biota, taking into account the proposed mitigation measures including preventive measures and emergency response capability.

Radiological Malfunction and Accidents

A range of potential on-site radiological malfunction and accident scenarios was identified related to waste processing, storage and on-site transfer. The scenarios were screened for potential to affect workers, the public or the environment and bounding scenarios were selected for assessment purposes. The assessment results indicate that the estimated doses to workers and the public in the event of an on-site radiological malfunction or accident would be below the applicable regulatory dose limit. Similarly, the estimated dose to non-human biota would be well below the level where observable effects are considered likely.

Transportation Accidents

For off-site transportation of L&ILW, based on OPG's extensive operational experience and considering the robustness of the waste packaging and precautions taken, any accident that may occur would be very unlikely to result in a release of radioactivity. Consequently, no residual health effects in humans or non-human biota would be expected in the event of a radiological or transportation malfunction or accident.

Nuclear Accidents

All three of the reactor designs being considered for NND are enhancements of designs currently operating and have a variety of characteristics that make them safer to operate (e.g., they incorporate a number of passive safety features that are reliant on natural forces such as gravity or convection).

Whatever the nature of an accident that might occur inside the reactor containment structure, such an event could only pose a threat to the environment if radioactivity were to escape from the station in an uncontrolled manner. This would require an accident causing major damage to fuel in the reactor core, an opening in the containment structure and an internal driving force sufficient to expel the radioactivity into the environment.

The selected reactor technology for NND will undergo a thorough review of its design and safety analyses by the CNSC during later licensing phases. It will be demonstrated during that time that Canadian regulatory requirements, particularly those relating to nuclear safety, are met. CNSC Regulatory Document RD-337, Design of New Nuclear Power Plants, identifies qualitative and quantitative safety goals for the new reactors. These safety goals were specified by the CNSC to ensure that the risk posed by a nuclear power plant to members of the public living near the plant is acceptable. Review of the preliminary safety analyses for the reactor technologies under consideration provides confidence that the RD-337 safety goals will be met.

For EA purposes, a nuclear accident scenario is considered credible only if it has a one in one million (1×10^{-6}) or greater chance of occurring in any year. Review of the preliminary safety analyses for the reactor technologies under consideration provides confidence that postulated accidents near this frequency will not have substantial off-site radiation releases. Nevertheless, an assessment was done, evaluating release scenarios corresponding to RD-337 safety goal radionuclide release thresholds, which demonstrated that the reactor designs under consideration meet the intent of the RD-337 safety goals with respect to the impact of protective measures (i.e., temporary evacuation, long-term relocation) on the local population. For this assessment, doses to the whole body and to the thyroid gland of potentially affected members of the public were calculated for various distances from the plant, over various time frames. The predicted doses at various distances were compared to the Protective Action Levels in the Nuclear Emergency Plan for evacuation and relocation and it was confirmed that the effects meet the intent of RD-337.

The assessment also involved calculation of the predicted collective doses to the present and future population (forecast out to 2084) living within 100 km of NND, to identify any potential human health effects. It was determined that the increase in cancer risk to this population is very small and would not be measurable in the overall population. In addition, the assessment included estimation of the doses to non-human biota within 1 km of NND. The results showed that the doses were well below levels where observable effects on populations of non-human biota would be expected. Social and mental well-being and economic effects of a nuclear accident were also considered, consistent with the WHO definition of health.

Out-of-Core Criticality Events

To meet the intent of the EIS Guidelines, a discussion of the potential consequences of an inadvertent criticality event (sustained nuclear chain reaction) outside of the reactor core is included in the overall assessment of malfunctions and accidents even though, with appropriate preventive controls in place, an inadvertent out-of-core criticality event is considered not credible.

Natural uranium fuel, such as is used in OPG's existing reactors, only contains approximately 0.7% U-235 (the fissionable component of uranium) and requires very precise conditions in the reactor to sustain a chain reaction. As the concentration of U-235 in the uranium is increased ("enriched") relative to the other isotopes of uranium, conditions for nuclear criticality outside of the reactor core (e.g. new or used fuel storage areas) become possible unless special measures are taken to prevent them. The fuel for the proposed NND reactors will be enriched to between 1% and 5% U-235. Therefore, a criticality safety program, involving a number of design/engineering measures and administrative controls will be implemented to prevent an inadvertent criticality event involving new or used nuclear fuel, outside of the core of the NND reactors. It is important to note that the lowest enrichment level identified for a historical criticality accident was an enrichment of 6.5% U-235 (as uranium oxide slurry which can more readily achieve a critical geometry), for an accident that occurred in the former Soviet Union in 1965. A review of past criticality incidents in other countries showed that no such accident has ever resulted in significant radiation dose to humans or the environment beyond the facility site.

Although an inadvertent out-of-core criticality event is considered not credible, an assessment of such a hypothetical event was conducted to illustrate the potential dose consequences of workers and the public. It was shown that workers in the immediate vicinity of such an event would be subject to substantial risk. However, the potential radiation effects on the public beyond the site would be greatly reduced due to the mitigative effects of shielding and distance. This analysis indicates that the potential consequences of an out-of-core criticality event (considered to be not credible) would not trigger a public evacuation, thus satisfying the requirement of the EIS Guidelines.

Malevolent Acts

Since the events of September 11, 2001, increased attention has been focused in Canada and world-wide on ensuring the safety and security of nuclear facilities against deliberate attempts (malevolent acts) to damage them and cause harm to people and/or the environment.

OPG has completed a comprehensive review of the safety of its existing nuclear facilities against credible threats and accidents, including the potential consequence of aircraft striking each facility. This review determined that, considering the robust nature of the facilities, the "defence-in-depth" protection provided by various safety systems, and the difficulty of perpetrating a damaging malevolent act, a substantial release of radioactivity to the public in such an event would be unlikely. Given the broad range of credible malfunction and accident scenarios considered in this EA, it is reasonable to conclude that the potential consequences of a malevolent act would be encompassed within the range of consequences identified for the malfunction and accident scenarios.

ES.8 Assessment of Cumulative Environmental Effects (Chapter 8)

The NND Project-related residual environmental effects identified were considered to determine if there was potential for them to act cumulatively (i.e., overlap in type, space and time) with the effects of other projects and activities within the study areas around the Project. The cumulative effects assessment did not include the potential effects of the malfunction or accident scenarios already examined because these scenarios have a very low probability of occurrence and

Canadian EA guidance indicates that such events should be assessed as "unique scenarios", not together with the more likely effects of normal operational activities.

A total of 34 other projects and activities within the RSA was selected for consideration of their potential to contribute to cumulative environmental effects. These included the following seven projects and activities existing or planned within a decade or so in the host municipality (Clarington):

- St. Marys Cement operations;
- Durham-York Energy from Waste (EFW) Facility;
- Clarington Energy Business Park (CEBP);
- Highway 407-401 East Link;
- Highway 401-Holt Road interchange improvements;
- GO Transit rail service extension – Oshawa to Bowmanville; and
- Growth and development in regional communities

All were screened to identify those expected to have effects similar to, and likely to overlap geographically and temporally with, the residual effects of the NND Project. As summarized in Table ES-2, Project-related residual adverse effects were identified as likely within the following four environmental components: Aquatic Environment, Terrestrial Environment, Land Use (visual landscape), and Socio-Economic Environment. Each Project-related residual adverse effect was assessed in combination with the overlapping effects of other projects and activities advanced through the screening step. In all cases, it was determined that no further mitigation measures were considered to be necessary to address potential cumulative effects.

Although the assessment determined that the Project is not expected to result in residual adverse effects as a result of radiation dose, the concern for dose to the general public was examined further based on concerns expressed by some members of the public. The cumulative doses to members of the public and workers, including contributions from other on-site and off-site sources (including the Pickering NGS and the Port Hope area low-level radioactive wastes) were found to be well below regulatory limits.

In addition, although no residual adverse effects on local traffic, air quality, noise, labour market or community infrastructure was determined likely to result from the NND Project, these aspects of the environment were also examined further in response to stakeholder feedback which suggested some concern that the concentration of other projects and activities in the Municipality of Clarington over the next decade in combination with the NND Project could result in adverse effects on these particular areas of the environment.

Recognizing that all Project-related residual adverse effects would be carried forward to the determination of significance, only one potential cumulative effect was forwarded for determination of significance:

- Combined visual and related community effects (concerns about a negative change in community character and reduced enjoyment of private property) resulting from the possible NND Project cooling towers and other tall structures existing and foreseeable in the vicinity of the DN site.

ES.9 Significance of Residual Adverse Effects (Chapter 9)

All residual adverse environmental effects of the Project, including the potential cumulative effect noted above, were advanced for a determination of their significance. As well, although it was not determined as a residual adverse effect because of proposed mitigation measures, the loss of approximately 40 ha of aquatic habitat as a result of lake infilling and construction of intake and discharge structures was also carried forward to a consideration of significance because of the possible perception that this loss was, in fact, a residual effect.

A methodical, traceable procedure was applied for the assessment of significance of residual adverse effects. Each residual effect was systematically evaluated using criteria derived from standard EA practice (i.e., magnitude, spatial extent, duration/timing, frequency or probability, reversibility, physical human health, psycho-social human health, ecological importance of the affected VEC, societal value of the VEC, and sustainability). The assessment of significance concluded that all residual adverse effects are likely to be minor and not significant.

ES.10 Communications and Consultation Program (Chapter 10)

A comprehensive communications and consultation program was developed at the outset of the NND Project and will continue throughout the regulatory process and beyond. As is normal practice, the EIS Guidelines require notification of, and consultation with, the potentially affected public and other stakeholders. The Guidelines also require that the EIS summarize the public and stakeholder comments received and indicate how any related issues are considered in the completion of the EA studies, or how they may be addressed at any subsequent stage in the regulatory process.

A wide range of stakeholders was identified from, but not limited to, the following categories:

- Federal government departments and agencies (including the CNSC and the CEA Agency);

- Aboriginal communities (including Métis organizations);
- Provincial government ministries and agencies;
- Regional and local Municipal government agencies;
- Conservation Authorities;
- Elected officials (including MPs, MPPs, regional and local municipal councils);
- Local, regional and national non-governmental organizations;
- Residents/general public;
- OPG employees; and
- Print and broadcast media.

In addition to pre-submission meetings with federal, provincial and municipal government departments, ministries and agencies, various passive and active methods were also used to communicate and consult with the public and other stakeholders. The more passive methods included an initial notification letter and regular update letters; a series of Project EA newsletters circulated to approximately 95,000 households and businesses in the local communities; information placed in community libraries; a Project website and toll-free phone line; and a "Community (drop-in information) Kiosk" in Bowmanville. More active methods included regular meetings with existing and new stakeholder committees; periodic briefing sessions and workshops with key stakeholders; five rounds of community information sessions; OPG participation at community events; and a special program for engaging Aboriginal stakeholders.

Existing committees involved in the Communication and Consultation Program included the Durham Nuclear Health Committee (DNHC), the Darlington Site Planning Committee and the Pickering Community Advisory Council (CAC). In addition, OPG established a new committee in late 2007, the Darlington Planning and Infrastructure Information Sharing Committee (DPIISC), to share information and advice regarding planning, infrastructure and transportation matters related to lands and projects in south Clarington.

Input from DPIISC has been particularly useful for cumulative effects assessment purposes. All five rounds of community information sessions (from spring 2006 to spring 2009) included sessions in the urban areas of the Municipality of Clarington (the host community) and the City of Oshawa. In addition, one or more sessions were held in urban areas beyond Clarington-Oshawa, including Toronto/Scarborough, Markham, Pickering, Ajax, Whitby, Port Perry, Kawartha Lakes, Peterborough, Cobourg and Port Hope. For each round of community information sessions, the local community was informed through local media advertisements and mailed invitation cards.

While a number of general areas of interest beyond the scope of the EA were identified through the communication and consultation program (such as Ontario's electricity system, long-term energy plan, and long-term nuclear waste management), key areas of interest related to the NND Project included potential effects on air quality; lake/drinking water and human health; reactor/condenser cooling alternatives; rationale for selection of the DN site; traffic and transportation system issues; waste heat utilization; and economic benefits. In addition, the following areas of interest or concern were repeatedly raised by certain stakeholder groups: assessment of the full life-cycle of uranium fuel; perceived over-reliance on nuclear generation in Ontario's power system plan and the risk of not reaching the Province's greenhouse gas reduction targets; and a variety of concerns expressed through public comments on the draft EIS Guidelines (including disposal of high-level radioactive waste, carbon emissions from construction, protection against terrorism, provincial participation in the EA review, need for epidemiological and gamma radiation health studies, and need to evaluate the complete uranium fuel cycle). Results of the Aboriginal Engagement Program to date do not indicate any effect of the Project on interests held by the Aboriginal communities or organizations involved. All comments and issues received from or raised by stakeholders, and the responses provided by OPG, are tracked in a database. All relevant issues, to the extent feasible, have been addressed in the EIS.

ES.11 Preliminary Plan for EA Follow-up Program (Chapter 11)

A plan and preliminary scope for an EA follow-up and monitoring program is included in the EIS (Chapter 11) as required by the EIS Guidelines. The objective of the follow-up and monitoring program is two-fold: (i) to verify that the environmental effects of the Project are as predicted; and (ii) to confirm that the proposed mitigation measures are effective (and thus determine if additional or new mitigation measures are required).

As the follow-up program is intended to focus on issues of relevance to the EA, it will be designed to incorporate pre-Project information such as applicable EA baseline data. In addition, the program will be coordinated with other Project monitoring programs carried out for other related purposes, including licence and regulatory compliance and operational performance monitoring. Furthermore, OPG will continue to consider the results of independent monitoring and studies such as Health Canada's Canadian Radiological Monitoring Network, the Ontario Ministry of Labour's Radiation Protection Monitoring Service and the Durham Region Health Department's periodic studies on radiation and health in the region.

Details of the follow-up program will be developed in consultation with the CNSC and other stakeholders as appropriate. The scope and details of the program will be reviewed and adjusted on an ongoing basis to incorporate evolving Project/site conditions and monitoring data as acquired. It will remain dynamic throughout its full implementation period and continue to be responsive to the evolving nature of its purpose, objectives and ongoing input from stakeholders. In addition, the program will contribute to continuous improvement (through adaptive management measures) of the effectiveness of EA methods and procedures.

All monitoring data will be provided to the CNSC and other government authorities involved. While the final distribution of monitoring data will be determined in conjunction with finalization of the program itself, it is likely that some of the information will be provided to other stakeholders also, as appropriate. It is anticipated that the data will be assembled into formal monitoring reports and submitted on a regular basis.

ES.12 Preliminary Decommissioning Plan (Chapter 12)

The EIS includes a preliminary decommissioning plan for NND. It addresses identification of the preferred decommissioning strategy; end-state objectives; major decontamination, disassembly and remediation steps; the approximate quantities and types of waste generated; and an overview of the principal hazards, environmental effects and protection strategies envisioned for eventual decommissioning.

The preferred decommissioning strategy for NND is one of deferred dismantling in order to minimize radiation exposure to workers, the public and the environment. OPG’s end-state objective for the NND site following decommissioning, is that all radioactive contamination and other hazardous materials will have been reduced to established clearance levels or removed from the site, all station systems will have been dismantled and all buildings demolished, and subsurface structures will have been drained, de-energized, decontaminated, removed to a nominal depth and capped. Furthermore, the objective is that the site will be remediated and restored to a state suitable for other OPG use and it will meet the criteria established by the CNSC for a Licence to Abandon. There is considerable decommissioning experience available from the U.S. and other countries where a number of nuclear power reactors have been completely decommissioned and the sites released for other uses. This experience demonstrates the feasibility of OPG’s end-state objective for decommissioning of the NND station.

The potential hazards and environmental effects of eventual NND decommissioning are presented in Chapter 12 at a conceptual level. The assessment concludes that, based on the protection strategies and the growing international decommissioning experience outlined in the PDP, it is reasonable to anticipate that effective and practical mitigation options will be available, when required in future, so that NND decommissioning is not likely to cause significant adverse effects on humans or their environment.

ES.13 Conclusions of the Assessment (Chapter 13)

The EIS concludes that the NND Project, taking into account the mitigation measures identified, will not result in any significant adverse environmental effects, including effects from accidents, malfunctions and malevolent acts, effects of the environment on the Project, and cumulative effects. Accordingly, OPG recommends that the JRP accept these conclusions as the basis for recommending to the Minister of the Environment that this EIS be accepted as is within his or her authority under the *Canadian Environmental Assessment Act*.

The EIS has considered the potential environmental effects of the Project as it is defined in a bounding framework because the vendor and reactor type have not yet been selected. The bounding framework incorporates the limiting values for salient elements of the different design options being considered while also recognizing the unique features of each design. A number of alternative means of implementing key aspects of the Project are represented within the bounding framework. All were determined through the assessment to be acceptable (i.e., will not result in significant adverse effects). However, this EIS does conclude with statements of OPG's preference concerning the alternative means, where appropriate, as follows:

- **Alternative Reactor Designs and Numbers of Units:** the reactor procurement process is the responsibility of the Province of Ontario. OPG does not express a preference concerning reactor types or the number of units to be constructed;

- **Alternatives for Condenser Cooling:** OPG's preferred option for condenser cooling is once-through lakewater cooling;

- **Alternatives for Management of L&ILW:** OPG's preference is to transport L&ILW resulting from NND operation to OPG's operating Western Waste Management Facility (acknowledging that some larger components (e.g., steam generators resulting from mid-life refurbishment) will likely require on-site storage and management);

- **Alternatives for Storage of Used Fuel:** OPG's only expression of preference for used fuel storage is that the on-site dry storage facility, which will be required for all reactor types, be located at least 150 m from the perimeter fence, and in the area south of the CN railroad tracks; and

- **Alternatives for Excavated Material Management:** OPG's preference is that the quantity of excavation be minimized (considering overall Project objectives) and that this material be managed to the extent possible, on the DN site, including an amount placed as lake infill to benefit both the NND Project and the ongoing physical security of DNGS.

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1. INTRODUCTION

On September 21, 2006, OPG submitted to the Canadian Nuclear Safety Commission (CNSC), an "Application for Approval to Prepare a Site for the Future Construction of a Nuclear Power Generating Facility in the Province of Ontario, Regional Municipality of Durham, Municipality of Clarington".

On November 22, 2006, the CNSC acknowledged receipt of the application and informed OPG that "Staff has also determined that the application is for a Project of a type for which an Environmental Assessment (EA) will be required pursuant to the *Canadian Environmental Assessment Act* and related regulations before any license may be granted".

This document is the Environmental Impact Statement (EIS) for the New Nuclear – Darlington (NND) Project proposed to be developed at the existing Darlington Nuclear (DN) site in the Municipality of Clarington, Ontario. This EIS and the Technical Support Documents (TSDs) that are referenced throughout it were prepared by Ontario Power Generation Inc. (OPG), which is the owner of the DN site, the operator of the existing Darlington Nuclear Generating Station on the site (DNGS), and the proponent of the NND Project.

An EIS is a document prepared by a proponent to allow a Joint Review Panel (JRP), regulators, members of the public and Aboriginal Groups to understand the Project, the existing environment, and the potential environmental effects of the Project. This EIS documents the environmental assessment (EA) that was conducted for the Project pursuant to the requirements of the *Canadian Environmental Assessment Act (CEAA).* This EIS also includes information of relevance to the application for a Licence to Prepare Site (LTPS) under the *Nuclear Safety and Control Act (NSCA)* and where noted in the licence application material, the information provided in the EIS or TSDs will be relied upon by OPG for licence application review purposes. Where there may be differences in the information presented in the EIS and the LTPS documents, the LTPS will take precedence.

1.1 The Project and Proponent

1.1.1 The Project

The proposed Project is the "Site Preparation, Construction and Operation of New Nuclear - Darlington" hereafter called the "NND Project" or "Project".

The NND Project will involve the construction and operation of up to four nuclear reactor units supplying up to 4,800 MW of electrical capacity to meet the baseload electrical requirements of Ontario. On April 12, 2007, OPG submitted to the CNSC, a "Project Description for Site

Preparation, Construction and Operation of the Darlington B Nuclear Generating Station" (OPG 2007a). In that document and for EA planning purposes, the Project was described as:

- Preparation of the DN site for construction of the new nuclear facility;
- Construction of the NND nuclear reactors and associated facilities;
- Construction of the appropriate nuclear waste management facilities for storage and volume reduction of waste;
- Operation and maintenance of the NND nuclear reactors and associated facilities for approximately 60 years of power production (i.e., for each reactor);
- Operation of the appropriate nuclear waste management facilities; and
- Development planning for decommissioning of the nuclear reactors and associated facilities, and eventual turn-over of the site to other uses.

Since that submission, the description of the NND Project has been updated during the preparation of this EIS. The updated description is presented in the *Scope of the Project for EA Purposes Technical Support Document* and it is summarized in Chapter 2 of this EIS.

1.1.2 Location of the Project

The DN site is located in the Municipality of Clarington, in the Regional Municipality of Durham, about 70 km east of Toronto on the north shore of Lake Ontario (see Figure 1.1-1). The DN site is approximately 485 ha in size. As illustrated on Figure 1.1-2, it is bounded to the north by the South Service Road of Highway 401 and to the south by Lake Ontario. To the west, the site is bounded by Solina Road and agricultural lands. Immediately to the east of the DN site is the large industrial complex associated with St. Marys Cement limestone quarry and processing plant. An operating Canadian National (CN) railway extends east-west across the site. Darlington Provincial Park, a campground and day-use park is located approximately 2 km west of the DN site. The Lake Ontario Waterfront Trail, a multi-use recreation trail extending from Niagara-on-the-Lake to the Quebec border on the north shore of Lake Ontario and the St. Lawrence River, traverses the DN site in the Controlled Area north of the CN Railway tracks.

The existing DNGS is located generally in the southwest quadrant of the DN site, south of the CN railway tracks. The soil stockpile and construction landfill created at the time of original construction and the Hydro One switchyard linking the power plant to the bulk transmission system are located north of the CN railway tracks, generally in the northwest quadrant of the site. DNGS includes four operating nuclear reactors with a total output of 3,524 MW which were commissioned between 1990 and 1993; a Tritium Removal Facility (TRF) that serves all of Ontario's current nuclear reactors; and the separately-licensed Darlington Waste Management Facility (DWMF) which stores used nuclear fuel from DNGS.

The portion of the DN site proposed for development as NND is primarily the easterly one-third (approximately) of the overall DN site. It is bounded by the DN site property limits on the east and north boundaries, by Lake Ontario to the south, and by Holt Road (including its southerly projection to Lake Ontario) on the west. It may be that other areas of the DN site will also be used during the construction-related activities (e.g., excavated soil disposal in the Northwest Landfill Area) however, following construction of NND, its operational activities will be maintained within the area described above.

1.1.3 Purpose of and Need for the Project

On June 16, 2006, the Province of Ontario, as represented by the Minister of Energy, issued a directive to OPG to implement the nuclear component of its 20-year energy plan. The relevant portion of that directive stated:

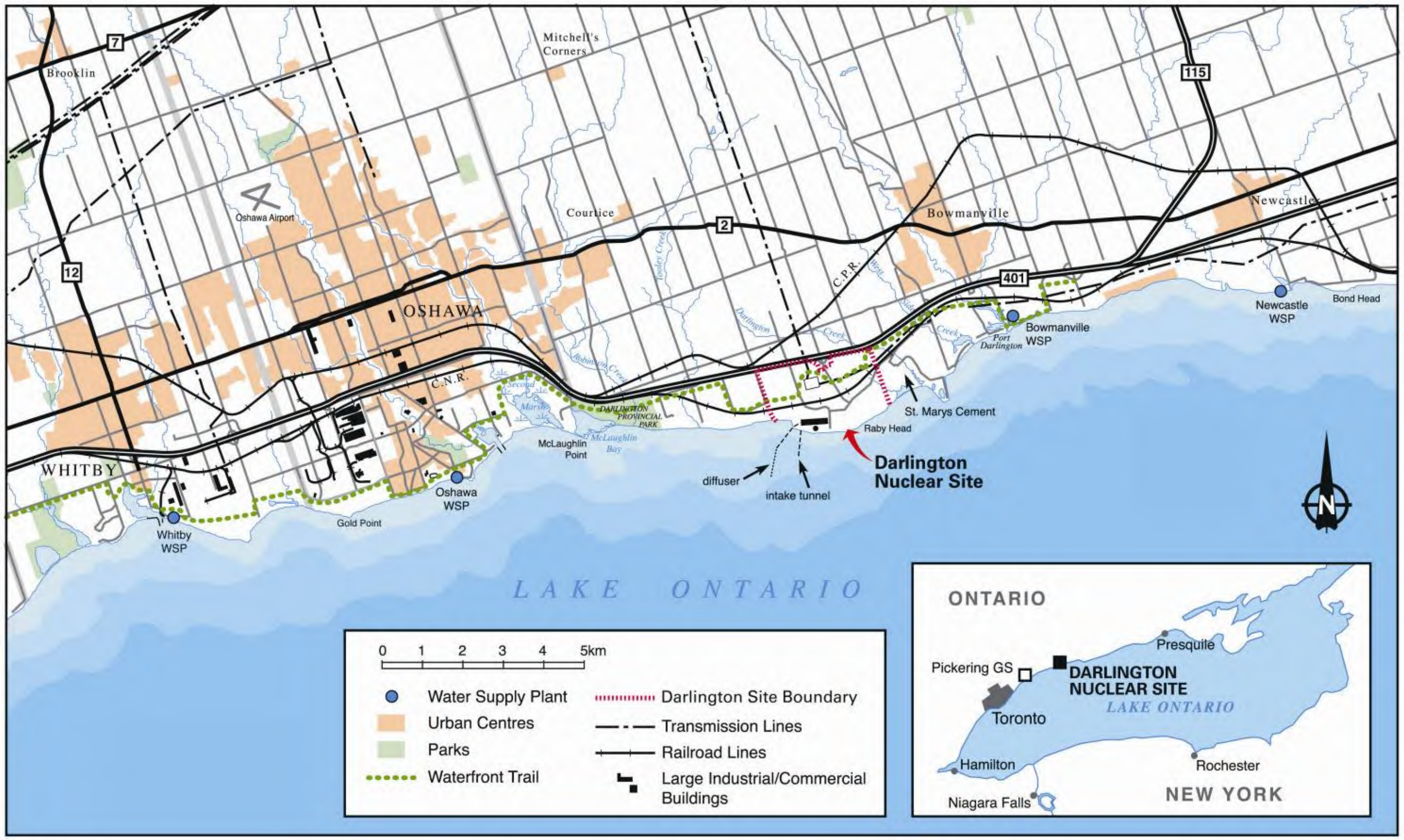
> *"The Ontario Government announcement directed the OPA to ensure adequate baseload electricity supply, while maintaining the nuclear generation component of that baseload at today's level of 14,000 MW of installed capacity.*
>
> *Recognizing that maintaining the current level of nuclear baseload through 2025 would require a combination of refurbishment of existing units and construction of replacement units, and given the long lead times required for licensing approvals of these activities, I am directing OPG to:*
>
> *a) begin feasibility studies on refurbishing its existing nuclear units. As part of this initiative, OPG is directed to also begin an environmental assessment on the refurbishment of the four existing units at Pickering B, and*
> *b) begin a federal approvals process, including an environmental assessment, for new nuclear units at an existing site.*

From OPG's perspective, the purpose of the Project is to fulfill its responsibilities flowing from part b) of the provincial directive (i.e., to begin a federal approvals process, including an environmental assessment, for new nuclear units) and this EIS for new nuclear units at the DN site has been prepared accordingly. OPG has also been undertaking studies and obtaining approvals relating to the refurbishment of existing units in response to part a) of the directive.

In parallel with OPG's program to implement its responsibilities under the directive, on behalf of the Province, Infrastructure Ontario (IO) is managing the procurement process to select a nuclear reactor vendor through an RFP and negotiation process that is outside of the scope of the NND Project EA. Proposals were received by IO in late February 2009 from three prospective vendors: AREVA NP, Atomic Energy of Canada Limited (AECL) and Westinghouse Electric Company.

Figure 1.1-1

DN Site Location



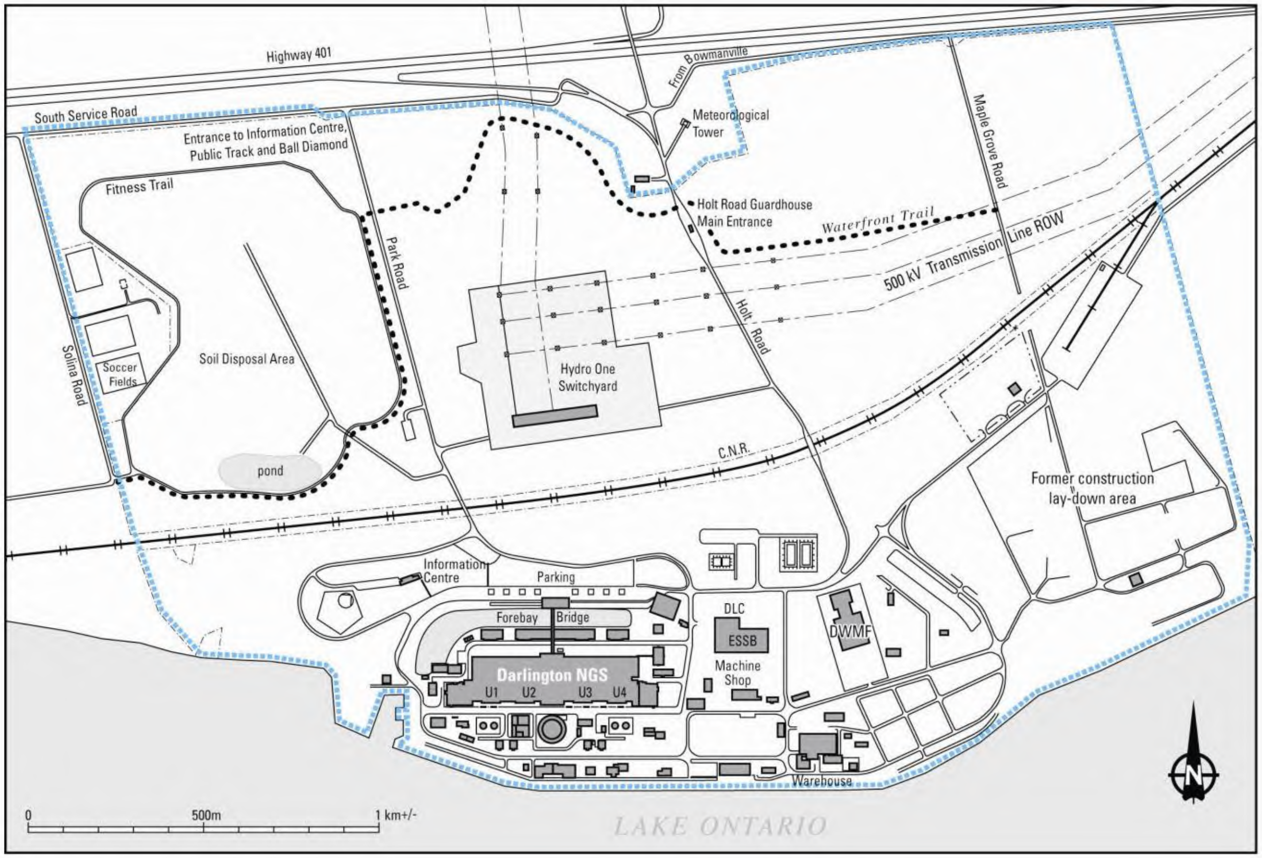
Date: September 2009

Project: 34500

ONTARIO POWER GENERATION

Figure 1.1-2

DN Site Plan



Date: September 2009

Project: 34500

On June 29, 2009, the Minister of Energy and Infrastructure announced that the Province had suspended the competitive process to procure two nuclear reactors for the DN site. The announcement also, however, reiterated that the government remains committed to the modernization of Ontario's nuclear fleet. Further, the suspension of the procurement process did not affect the government’s directive to OPG to proceed with the federal approvals process for the NND Project because the EA studies were being carried out in a manner that was not specific to a particular nuclear reactor type.

OPG’s responsibilities pursuant to the directive have been clarified on two occasions by the Province. Firstly, on April 16, 2007, the Minister of Energy wrote to OPG to confirm that the Province supported OPG’s proposal, as contained in the Project Description, to specify an upper bound of 4,800 MW for the new build nuclear plant at the DN site. In that letter, the Minister referenced the provincial government’s acknowledgement of the EA process as a planning tool and explicitly identified that the upper bound of 4,800 MW for this Project would provide the provincial government with flexibility in its long-term planning to determine the mix of refurbishment and/or new build that would be implemented by the Province, depending on respective feasibility, to maintain the nuclear component of its plan.

Secondly, on June 16, 2008, the Province further clarified OPG’s responsibilities under this directive by announcing the selection of the DN site as the location for Ontario’s new nuclear plant. In that announcement, the Province also clarified that as part of Ontario’s planned nuclear component of 14,000 MW, the Bruce Power site would continue to contribute approximately 6,300 MW, either through refurbishment of existing units or the construction of new units.

The need for the NND Project has been determined by the Province of Ontario and its energy policy, and OPG has been assigned responsibility for obtaining the necessary approvals for it. Specifically, this Project will fulfill OPG’s responsibilities under the “new unit” component of the Province’s directive (item b) and, if approved, the Project will be available to the Province to be implemented to assist in maintaining the baseload nuclear generation capacity of 14,000 MW. The Project also reflects the Province’s selection of the DN site as the location for the new nuclear facility and the selection of OPG as the operator.

Ontario’s installed nuclear capacity of approximately14,000 MW is as follows:

- Pickering NGS A: 4 units of 540 MW each totaling 2,160 MW (two units currently shut down);
- Pickering NGS B: 4 units of 540 MW each totaling 2,160 MW (refurbishment under consideration);

- Darlington: 4 units of 881 MW each totaling 3,524 MW;
- Bruce A: 4 units of 770 MW each totaling 3,080 MW (two currently being refurbished); and
- Bruce B: 4 units of 785 MW each totaling 3,140 MW.

With the shut-down of Pickering NGS A Units 2 and 3, the operational nuclear baseload capacity in Ontario has been reduced to approximately 12,900 MW. The anticipated end of life of the remaining nuclear units in Ontario ranges from 2010 to 2020, without refurbishment. OPG has already decided that it will not further refurbish the reactors at Pickering NGS A; it has not yet made its decision concerning the combination of refurbishment of other reactors and new build that will be implemented to maintain the 14,000 MW baseload component of its plan. Approximately 2,400 MW of new build capacity will be required to replace the capacity of Pickering NGS A. The additional capacity up to four units and 4,800 MW for which approval is sought in this EIS will provide the Province with flexibility to determine the mix of new build and refurbishment that will be implemented to maintain the 14,000 MW nuclear baseload.

In addition to this need for flexibility, the approval of up to 4 units and 4,800 MW is sought in this EIS to ensure that the remaining physical capacity of the DN site is utilized efficiently. The Project which is the subject of this EIS represents the ultimate build-out of the DN site and approval for this Project will allow OPG to undertake the site preparation process with maximum efficiency, to accommodate the staged implementation of either two, three of four reactors, as and when determined by the Province. Similarly, the application for the Licence to Prepare the Site seeks approval to complete the activities necessary for an initial installation of two reactors and up to 3,200 MW of installed nuclear generation capacity.

1.1.4 Alternatives to the Project

As noted in Section 1.1.3, the purpose of the NND Project is to fulfill OPG's responsibilities under paragraph b) of the provincial directive dated June 16, 2006, as clarified by the Minister of Energy. Similarly, the need for this Project has been determined by the provincial directive and clarifications since issued. The clarifications of the provincial directive have established that new nuclear units are to be built at the DN site and that the Province supports OPG seeking approval for up to 4,800 MW, to provide the Province with flexibility in determining the mix of refurbishment and new build that will be implemented to maintain 14,000 MW of installed nuclear capacity.

As indicated in the EIS Guidelines (Section 7.2), alternatives to the Project are the functionally different ways of achieving the Project's purpose and need that are within the control and/or interests of OPG. Such alternatives need not, however, include those that are contrary to

Ontario's formal plans or directives. Possible alternatives to this Project that are within the control of OPG that could be considered are:

1. Do Nothing;
2. Seek approval for a modified Project with a generation capacity less than 4,800 MW;
3. Seek approval for the Project at a different location; and
4. Seek approval for a non-nuclear generation option.

All of these possible alternatives to the Project are deemed unacceptable for the following reasons:

- OPG's responsibility is to comply with the provincial directive. Alternatives 1 and 4 would be clear breaches of the directive; and Alternatives 2 and 3 would be inconsistent with the clarifications of that directive that have subsequently by the provincial government;

- Alternative 2 would be inconsistent with the Province's expressed objective of having flexibility in its long term planning decisions. The Province will consider the feasibility of both refurbishment of existing nuclear units and the construction of new units in determining the appropriate generation mix. Maximizing the new capacity that can be installed at the DN site will provide the Province with the greatest flexibility in determining the most appropriate mix of these to maintain the 14,000 MW nuclear baseload component of its energy plan. Planning for the maximum build-out of the DN site also maximizes efficiencies associated with site planning and preparation; and

- Alternative 3 would be inconsistent with the Province's announcement that the new nuclear plant would be built at the DN site. Further, from OPG's perspective, the DN site is the only existing nuclear site that is exclusively within OPG's control with potential for additional reactors. There is insufficient area available at the Pickering NGS for new nuclear generating facilities; and any new construction at the Bruce site would be beyond OPG's exclusive control because of its long-term lease agreement with Bruce Power concerning that site.

Accordingly, OPG has concluded that there are no reasonable alternatives to the Project that are within the control of OPG, within the interests of OPG and consistent with the directive and clarifications that have been given by the Province.

1.1.5 The Project Timeframe

The NND Project will be implemented in three distinct phases as described below. For EA planning purposes, the following temporal framework has been adopted:

Project Phase	Start	Finish
Site Preparation and Construction	2010	2025
Operation and Maintenance	2016	2100
Decommissioning and Abandonment	2100	2150

Also for EA planning purposes, it is assumed that two reactors will initially be constructed and commissioned, followed by an additional one or two reactors (depending on the reactors selected; see Section 1.4.1). The Site Preparation and Construction phase will extend over approximately 16 years with the first two units commissioned in the 2016-2018 time period and the subsequent two units commissioned in the 2025-2027 time period. The Operation and Maintenance phase will extend to approximately 2100 considering approximately 60 years of power production for each reactor (the equivalent of about 70 calendar years considering planned outages). The Decommissioning and Abandonment phase will extend to approximately 2150. A conceptualized timeline for the NND Project phases is presented as Figure 2.4-1. A more detailed timeline indicating key Project works and activities is presented as Figure 2.4-2.

1.1.6 The Proponent

OPG is the proponent for the Project. OPG, one of the successor corporations to the former Ontario Hydro, is incorporated pursuant to the *Ontario Business Corporations Act* and its shares are wholly owned by the Province of Ontario. In addition to hydroelectric and fossil-fuelled power generating stations, OPG operates the Pickering A, Pickering B, and Darlington nuclear generating stations, and the Darlington, Pickering and Western Waste Management Facilities. OPG is also the owner of the nuclear generating stations located in Ontario's Bruce County which are currently operated by Bruce Power under a lease arrangement. Details of OPG's management structure and organization accountability concerning the NND Project are provided in Section 2.7.

1.2 Regulatory Requirements

An EA is typically only one of several elements in an approval process and in many cases, the EA is triggered by the need for the project to comply with other regulatory requirements. The planning context for the EA and the regulatory environment within which it and the NND Project will be implemented are summarized in the following sections.

1.2.1 Environmental Assessment in a Planning Context

As described above, the NND Project was initiated in response to provincial directives to OPG to, among other actions, begin the approvals process including an EA, for the development of new nuclear units at an existing facility. Initiation of the EA concurrently with the evaluation of the feasibility of the Project is consistent with planning principles for major projects especially in the public sector wherein environmental assessments are undertaken as an aspect of early planning for the undertaking. It is also consistent with *CEAA* policies and procedural guidance documents which suggest that the environmental implications of an undertaking be understood early and before irrevocable decisions are made.

1.2.2 Nuclear Safety and Control Act

Nuclear power plants are defined as Class 1 nuclear facilities under the CNSC regulatory regime and the licensing requirements are prescribed in the *NSCA* and the Class 1 Nuclear Facilities Regulations. The regulations require separate licences for each of five phases in the life-cycle of a nuclear power plant:

1. Licence to prepare a site;
2. Licence to construct;
3. Licence to operate;
4. Licence to decommission; and,
5. Licence to abandon.

As noted above, on September 21, 2006, OPG submitted to the CNSC an "Application for Approval to Prepare a Site for the Future Construction of a Nuclear Power Generating Facility in the Province of Ontario, Regional Municipality of Durham, Municipality of Clarington". That application initiated the licensing process under the *NSCA*.

1.2.3 Fisheries Act

The NND Project will require authorization by the Department of Fisheries and Oceans (DFO) under subsection 35(2) of the *Fisheries Act* since it may result in harmful alteration, disruption or destruction of fish habitat (HADD). The Project must also comply with other related sections of the *Fisheries Act* including, but not limited to: subsection 30 which requires water intakes to be provided with guards or screens; subsection 32 which prohibits the destruction of fish except as authorized by the Minister; and subsection 36(3) which prohibits the deposit of deleterious substances in water frequented by fish.

1.2.4 Canada Transportation Act

If the Project involves construction of a railway line (e.g., spur into the DN site), approval by the Canadian Transportation Agency under subsection 98(2) of the *Canada Transportation Act* may be required. It is noted that the Act provides for exceptions to approval requirements for construction of railway lines in the vicinity of existing railway lines. Because the Project is likely to involve construction of road and utility crossings of a railway line, subsection 101(3) of the *Canada Transportation Act* may also apply. This subsection provides for an authorization of a rail or utility crossing where negotiated agreement with the parties has not been successful, and a determination by the Agency of which party is responsible for the crossing.

1.2.5 Navigable Waters Protection Act

The Project will require authorization by the Department of Transport (Transport Canada) under paragraph 5(1)(a) of the *Navigable Waters Protection Act* (1985) which prescribes that any works built or placed in, on, over, under, through or across any navigable water be approved by the Minister.

1.2.6 Provincial Approvals

The Project is excluded from a provincial EA because it is not a designated undertaking pursuant to the Ontario *Electricity Projects Regulations* which identifies the electricity projects that are subject to the Ontario *Environmental Assessment Act (EAA).* Further, the construction and operation of nuclear facilities are regulated as a federal responsibility and outside the jurisdiction of the provinces. The Province has indicated that it does not have a mandate to make nuclear facilities subject to the Ontario *EAA.* The Province has, however, indicated its desire to remain informed about the progress of the federal EA.

1.2.7 International Agreements

1.2.7.1 Great Lakes Water Quality Agreement

In 1972, Canada and the United States signed the Great Lakes Water Quality Agreement (GLWQA) (JIC 1972) in recognition of the urgent need to improve environmental conditions in the Great Lakes. The 1972 GLWQA established the commitment to restore and enhance water quality in the Great Lakes system. Objectives were specified that would reduce nuisance conditions and the discharge of substances toxic to human, animal or aquatic life. In addition, specific numerical targets were included in the Agreement for the reduction of loadings of phosphorus to Lakes Erie and Ontario. The Agreement re-affirms the rights and obligations of

Canada and the United States under the International Boundary Waters Treaty which was signed in 1910, and the *International Boundary Waters Treaty Act* which was enacted to implement it.

The Agreement was amended in 1978 and again in 1987. The amendments included the introduction of the concept of the ecosystem approach which recognizes the interconnectedness of all components of the environment and the need for an integrated perspective in addressing issues of concern; and the identification of local Areas of Concern where beneficial uses of the ecosystem had been significantly degraded, and committed Canada and the United States to the remediation of these sites.

In Canada, Environment Canada leads delivery on the Agreement and federal-provincial commitments are coordinated through the *Canada-Ontario Agreement Respecting the Great Lakes Basin Ecosystem* (EC 2002, 2007). Obligations of each signatory to the Agreement include the enactment of legislation necessary to implement the programs and measures provided for. Those programs include, among others abatement, control and prevention of pollution from industrial sources entering the Great Lakes System; abatement and control of pollution from all dredging activities; abatement and control of pollution from onshore and offshore facilities; abatement and control of pollution from all contaminated sediments; and assessment and control of contaminated groundwater and subsurface sources entering the boundary waters of the Great Lakes System. The NND Project will comply with all applicable Canadian regulatory requirements, including those that may have resulted from Canada's actions under the Agreement.

1.2.7.2 Canada-U.S Air Quality Agreement

Under the 1991 *Canada-United States Air Quality Agreement* (EC 1991), Canada and the U.S. committed to notify each other concerning proposals that could cause significant trans-boundary air pollution. The Parties have been notifying each other of sources of pollution within 100 km of the border since 1994. The agreement addresses trans-boundary air pollution that contributes to acid rain; it does not address radionuclides or emissions of radioactivity.

Notification is required for any new air pollution source located within 100 km of the border that is expected to emit greater than 90 tonnes per year of any one of the common air pollutants: sulphur dioxide (SO_2), nitrogen oxides (NO_x), carbon monoxide (CO), total suspended particulates (TSP) and volatile organic compounds (VOC), where VOCs are defined as compounds containing at least one carbon atom, excluding carbon monoxide, carbon dioxide, methane and chlorofluorocarbons. Notification is also required for major modifications of existing facilities which would result in an increase of 40 or more tonnes per year of one or more common pollutants. With respect to hazardous air pollutants, notification is required if a new source, or a modification of an existing source, results in a release of greater than 1 tonne per year of any one hazardous air pollutant. Emissions of pollutants subject to the Agreement associated with the NND Project are expected to be well below the notification thresholds in the Agreement.

1.2.7.3 Nuclear Non-Proliferation

The *Treaty on the Non-Proliferation of Nuclear Weapons* (IAEA 1970), established in 1970 and ratified by 188 countries, is fundamental to Canada's nuclear disarmament and non-proliferation policy. The Treaty has three main pillars: non-proliferation, disarmament and peaceful uses of nuclear energy.

All signatories to the Treaty agree to full exchanges of equipment, materials and scientific and technological information for peaceful uses of nuclear energy; and to accept and comply with International Atomic Energy Agency (IAEA) safeguards as a condition for peaceful nuclear co-operation. The IAEA uses safeguard activities to verify that States honour their commitments not to use nuclear programs for nuclear weapons. IAEA safeguards are "based on an assessment of the correctness and completeness of the State's declarations [to the Agency] concerning nuclear material and nuclear-related activities." The Treaty encourages international co-operation for peaceful uses of nuclear energy, from medical diagnostics and treatments to power production.

OPG complies with the licence conditions imposed by the CNSC with respect to meeting Canada’s obligations under the treaty. Its existing facilities are operated in full compliance with IAEA standards and requirements in this respect, and NND will be as well.

1.3 Application of the Canadian Environmental Assessment Act

The NND Project triggers the *CEAA* because in order for the Project to proceed, authorizations under a number of federal Acts must be granted, as described above. For those authorizations to be granted, an EA must be carried out.

The proposed construction of a nuclear power plant is identified in the Comprehensive Study List Regulations (under the *CEAA)* which identifies the projects for which comprehensive studies are mandatory. On March 20, 2008, the Minister of the Environment announced his referral of the NND Project to a review panel pursuant to the *CEAA* and indicated that the CNSC and the Canadian Environmental Assessment Agency (CEA Agency) should pursue a joint EA process. A JRP under the *CEAA* and the *NSCA* is being established to undertake an EA and regulatory review of the Project. The JRP for the Project will evaluate information that relates to the EA and it will also consider information submitted by OPG in support of its application for a Licence to Prepare Site for a Class 1 Nuclear Facility, in accordance with the requirements of the *NSCA* and its regulations.

1.3.1 Federal Roles and Responsibilities

As described above, the Project will require that approvals be granted under the *NSCA,* the *Fisheries Act,* the *Navigable Waters Protection Act* and possibly the *Canada Transportation Act.* Accordingly, the CNSC, DFO, TC and the Canadian Transportation Agency, as the federal departments and agencies responsible for administering those Acts, are Responsible Authorities (RAs) under the *CEAA.*

Pursuant to the *Federal Co-ordination Regulations* under the *CEAA*, Health Canada (HC), Environment Canada (EC), Natural Resources Canada (NRCan) and Indian and Northern Affairs Canada (INAC) have been notified of the NND Project and their roles have been determined to be as expert Federal Authorities (FA).

Because the EA is being conducted as an assessment by a JRP, within its mandate of advising and assisting the Minister in performing his or her duties required under the *CEAA*, the CEA Agency has assumed an overall coordination role for the conduct of the EA and the activities of the JRP.

The Major Projects Management Office (MPMO) is a Government of Canada organization whose role is to provide overarching project management and accountability for major resource projects in the federal regulatory review process, and to facilitate improvements to the regulatory system for major resource projects. Within this mandate, the MPMO will coordinate the development and approval of Project Agreements; monitor and report on the progress of the EA and regulatory review process; and take actions to proactively streamline the EA and regulatory process.

1.3.2 Public Registry

The CEA Agency has established a public registry for the EA, as required by section 55 of the *CEAA*. This includes listing the EA in the Canadian Environmental Assessment Registry (CEAR), which can be accessed on the CEA Agency's website (www.ceaa-acee.gc.ca). The CEAR reference number for this project is 07-05-29525.

As part of the registry, the CEA Agency maintains a list of documents pertaining to the EA. Interested parties may obtain copies of specific documents on the list by accessing the above-noted website or by contacting the CEA Agency as noted below:

Canadian Environmental Assessment Agency
Darlington Panel Secretariat
160 Elgin Street
Ottawa, ON
K1A 0H3
Telephone: 1-866-582-1884
Fax: 613-957-0941
email: darlington.review@ceaa-acee.gc.ca

1.3.3 Environmental Impact Statement (EIS) and EIS Preparation

An EIS is a document prepared by the proponent to facilitate an understanding of the Project, the existing environment and the potential environmental effects of the Project, by the JRP, regulators, members of the public and Aboriginal groups.

In advance of the appointment of the JRP, Draft Guidelines were prepared by the CEA Agency and the CNSC in consultation with DFO, TC and the Canadian Transportation Agency and issued for public comment. Based on comments received from the public and internal agency review, the EIS Guidelines were finalized in January 2009 and issued to the proponent. The EIS Guidelines are included in Appendix A.
As the proponent for the NND Project, OPG has prepared this EIS.

1.4 Scope of the Project and Scope of the Assessment

1.4.1 Scope of the Project

As indicated in the Guidelines (see Appendix A), its authors determined the scope of the NND Project to be site preparation, construction, operation, decommissioning and abandonment of the project components and activities identified in the *Project Description for the Site Preparation, Construction and Operation of the Darlington B Nuclear Generating Station* (OPG 2007a).

The scope of the NND Project includes up to four new nuclear power reactors for the production of up to 4,800 megawatts of electrical generating capacity for supply to the Ontario grid. Operations would involve activities required to operate and maintain the NND including management of all conventional and radioactive wastes. A range of reactor designs is being considered for the Project with the ultimate selection of a vendor and reactor type being the responsibility of the Province of Ontario (see below). It is anticipated that each new reactor constructed would have an approximate 60-year operating life which will include refurbishment or major maintenance at its approximate mid-life stage.

The successful vendor, and thus the reactor design, will be selected by the Province of Ontario through a competitive process. Vendor selection (i.e., the Nuclear Procurement Project) is being managed on behalf of the Province by Infrastructure Ontario, an arm's length crown corporation established in 2006 with a mandate to expand and renew public assets through the delivery of provincial infrastructure projects. Phase 2 of the procurement process was initiated in June 2008 when the Nuclear Procurement Project request for proposals (RFP) was issued to a short-list of three qualified vendors selected during the Phase 1 vendor qualification process.

Submissions were received from the qualified vendors in February 2009 and are being evaluated in three key areas:

- Lifetime cost of power;
- Ability to meet Ontario's timeline to bring new electricity supply on line; and
- Level of investment in Ontario.

In June 2009, the Province announced that it had suspended the competitive process to procure two new nuclear reactors planned for the DN site. The announcement also, however, reiterated that the government remains committed to the modernization of Ontario's nuclear fleet.

For the purposes of this EIS, the Project is not based on a specific reactor type. Rather, the Project is defined by reference to a set of bounding parameters that, when considered together, form the scope of the Project. The description of the Project is addressed further in Chapter 2.

Until the procurement process has been completed and a contract signed, a dollar value cannot be assigned to the NND Project. However, it is widely acknowledged that the capital cost for an undertaking involving the construction and commissioning of up to four nuclear reactors would be in the order-of magnitude range of several billions of dollars.

1.4.2 Scope of the Assessment

As indicated in the Guidelines (see Appendix A), the following factors are required to be considered in the EIS in order to adequately understand and assess the potential effects of the Project.

a. *"the environmental effects of the project, including the environmental effects of malfunctions, accidents or malevolent acts that may occur in connection with the project and any cumulative environmental effects that are likely to result from the project in combination with other projects or activities that have been or will be carried out;*
b. *the significance of the effects referred to in (a);*
c. *comments that are received during the environmental assessment;*
d. *measures that are technically and economically feasible and that would mitigate any significant adverse environmental effects of the project;*
e. *purpose of the project;*
f. *need for the project;*
g. *alternatives to the project;*
h. *alternative means of carrying out the project that are technically and economically feasible and the environmental effects of any such alternative means;*
i. *measures to enhance any beneficial environmental effects;*
j. *the requirements of a follow-up program in respect of the project;*
k. *the capacity of renewable resources that are likely to be significantly affected by the project to meet the needs of the present and those of the future; and*
l. *consideration of community knowledge and Aboriginal traditional knowledge."*

The EIS and the TSDs that support it provide all information pertaining to the environmental assessment of the Project as required of the above scope. These documents present a comprehensive evaluation of the effects associated with the Site Preparation and Construction, and the Operation and Maintenance phases of the Project. Because of the preliminary nature of the decommissioning plan for the Project at its pre-implementation stage, however, the information available for assessing effects of the Decommissioning and Abandonment phase is less detailed than that available for the implementation phases and the assessment of effects associated with these activities is necessarily presented at a conceptual level. This is accepted practice and recognizes that as the Decommissioning and Abandonment phase is further detailed in the future, it will be subject to a separate licensing action, including a more focused consideration of environmental effects. In the meantime, the assessment of effects associated with decommissioning is based on the preliminary decommissioning plan required by the Guidelines to be included in the EIS. Both the plan and the conceptual level assessment of effects are presented in Chapter 12.

1.5 Environmental Assessment Documentation

The EA is documented in this EIS and a series of Technical Support Documents (TSDs) that were prepared to report on the findings of specific studies conducted in support of the EA. The contents of the EIS and of the various TSDs are summarized in the following sections. Where there may be differences in the information presented in the documents, the EIS will take precedence.

1.5.1 EIS Contents and Organization

The EIS consolidates and summarizes all aspects of the EA. As a consolidated summary, the EIS draws heavily from, and references, the technical studies performed in support of the EA and documented in the TSDs, as well as other reference material.

The EIS is organized to present relevant information in a logical sequence that systematically describes the assessment of effects associated with the Project, and other relevant aspects of the EA. It is also generally consistent with the format of the Guidelines. The report is organized into 15 chapters as follows:

1. An introduction to the Project, the EA and the EIS;
2. A description of the Project;
3. Descriptions of the methodologies used in developing the EIS;
4. A description of the existing environment throughout the study areas relevant to the EIS;
5. An assessment of likely environmental effects associated with the Project and mitigation measures identified to reduce or ameliorate them;
6. An assessment of other potential effects associated with the Project including sustainability of resources, effects of climate change and of the environment on the Project;
7. An assessment of possible effects associated with credible malfunctions, accidents and malevolent acts;
8. An assessment of potential cumulative environmental effects and the means to mitigate them;
9. An evaluation of the significance of residual (i.e., after mitigation) adverse effects;
10. A description of the community and stakeholder consultation program associated with the EIS;
11. A discussion of the preliminary EA follow-up program;
12. A description of the preliminary decommissioning plan for the facility;
13. Conclusions of the EIS;
14. References; and
15. Special Terms.

The EIS has been prepared in accordance with the requirements of the Guidelines issued for it. Correlation of the Guidelines and the contents of the EIS is illustrated in Table 1.5-1. The requirements of the Guidelines are indicated in the left-hand column of the table and the location within the EIS wherein the requirement is addressed is indicated in the right-hand column.

TABLE 1.5-1
EIS Correlation with EIS Guidelines

EIS Guidelines Requirements	EIS Section
Part 1 Introduction	
1.0 Context	
1.1 Purpose of the Guidelines	Not Applicable
1.2 Environmental Assessment and Regulatory Process	1.2.1 – 1.2.6; 1.3
1.3 Preparation and Review of the EIS	1.3.3
2.0 Guiding Principles	Various (as below)
2.1 Environmental Assessment as a Planning Tool Identify possible environmental effects; propose measures to mitigate adverse effects; and, predict whether there will be likely significant adverse environmental effects after mitigation measures are implemented.	1.2.1
2.2 Public Participation and Aboriginal Engagement Engage residents and organizations in all affected communities, other interested organizations, and relevant government agencies.	10.0
2.3 Traditional Knowledge Incorporate into the EIS, the local knowledge to which (the proponent) has access or that it may reasonably be expected to acquire through appropriate due diligence.	10.6.2
2.4 Sustainable Development Include in the EIS, consideration of the extent to which the Project contributes to sustainable development. Consider, in particular: (a) the extent to which biological diversity may be affected by the Project; and (b) the capacity of renewable resources that are likely to be significantly affected by the Project to meet the needs of present and future generations.	2.10 2.9.4 6.1
2.5 Precautionary Approach Indicate how the precautionary principle was considered in the design of the Project.	3.2.7
2.6 Study Strategy and Methodology Explain and justify methods used to predict impacts of the Project on each valued ecosystem component (VEC).	3.0
2.7 Use of Existing Information The proponent is encouraged to make use of existing information relevant to the Project.	3.2.3

TABLE 1.5-1 (Cont'd)
EIS Correlation with EIS Guidelines

EIS Guidelines Requirements	EIS Section
Part 1 Introduction	
3.0 Presentation of the EIS • Guide that cross-references the EIS Guidelines with the EIS. • Key subject index. • Proponent's key personnel and/or contractors and subcontractors responsible for preparing the EIS. • Glossary of technical terms and acronyms.	Table 1.5-1 Table of Contents Flysheet 15.0
3.1 Environmental Impact Statement Summary Prepare a plain language summary of the EIS that provides the reader with a concise but complete overview of the EIS.	Executive Summary
4.0 Scope	Various (as below)
4.1 Scope of the Project • Preparation phase. • Construction. • Operation and Maintenance Phase. • Decommissioning and Abandonment Phase.	1.4.1 2.5 2.5 2.6 12.0
4.2 Factors to be considered in the EIS: a) the environmental effects of the Project, including the environmental effects of malfunctions, accidents or malevolent acts that may occur in connection with the Project and any cumulative environmental effects that are likely to result from the Project in combination with other projects or activities that have been or will be carried out; b) the significance of the effects referred to in (a); c) comments that are received during the environmental assessment; d) measures that are technically and economically feasible and that would mitigate any significant adverse environmental effects of the Project;	 5.0 – 8.0 9.0 10.0 5.2 - 5.14

TABLE 1.5-1 (Cont'd)
EIS Correlation with EIS Guidelines

EIS Guidelines Requirements	EIS Section
Part II Content of the EIS	
e) purpose of the Project;	1.1.3
f) need for the Project;	1.1.3
g) alternatives to the Project;	1.1.3
h) alternative means of carrying out the project that are technically and economically feasible and the environmental effects of any such alternative means;	2.2
i) measures to enhance any beneficial environmental effects;	5.2 - 5.14
j) the requirements of a follow-up program in respect of the Project;	11.0
k) the capacity of renewable resources that are likely to be significantly affected by the Project to meet the needs of the present and those of the future; and	6.1
l) consideration of community knowledge and Aboriginal traditional knowledge.	10.6
5.0 Context Introduce the geographic setting, the Project, the underlying rationale for the project, the proponent, the federal JRP process and the content and format of the EIS.	Various (as below)
5.1 Setting Provide a concise description of the geographic setting in which the Project is proposed to be constructed.	1.1.2
5.2 Project Overview and Purpose Summarize the Project, its purpose, location, scale, components, activities, scheduling and costs.	1.1.1 1.1.3 1.1.4 1.4.1
5.3 Proponent Introduce OPG with summary information the nature of the management structure and organizational accountability.	1.1.5 2.7
5.4 The Environmental Assessment and Regulatory Process and Approvals	1.2.1 – 1.2.6 1.3
5.5 International Agreements	1.2.6

TABLE 1.5-1 (Cont'd)
EIS Correlation with EIS Guidelines

EIS Guidelines Requirements	EIS Section
Part II Content of the EIS	
6.0 Public Participation Demonstrate how EIS has engaged interested parties that may be affected or have an interest in the Project.	10.0
6.1 Aboriginal Peoples Describe involvement of any Aboriginal people that may be affected by the Project.	10.6
6.2 Government Agencies Describe involvement of provincial and federal government ministries, departments or agencies and local governments.	10.2.2
6.3 Stakeholders Describe involvement of stakeholders (e.g. local businesses, neighbouring residences, cottagers, outdoor recreational interests and environmental non-government organizations).	10.2.3
6.4 Other Public Participation Describe any other public engagement undertaken by the proponent prior to submitting the EIS.	10.1 10.2
7.0 Project Justification	
7.1 Purpose and Need for the Project Describe the need for the proposed new nuclear power plant.	1.1.3
7.2 Alternatives to the Project Describe functionally different ways to meet the project's need.	1.1.3
7.3 Alternative Means of Carrying out the Project Identify and describe alternative means to carry out the Project that are, from the perspective of the proponent, technically and economically feasible; and describe the environmental effects of each alternative means.	2.2
8.0 Description of the Project Describe the Project as it is planned to proceed from site preparation through to construction, operation and maintenance, decommissioning and abandonment.	2.0 12.0
8.1 General Information and Design Characteristics	2.0
8.2 Site Preparation	2.5
8.3 Construction	2.5
8.4 Operations and Maintenance	2.6
8.5 Modifications	2.6.14
8.6 Decommissioning and Abandonment	12.0
8.7 Waste and Used Fuel Management	2.5.8, 2.5.11, 2.6.10, 2.6.11, 2.6.12, 2.6.13

TABLE 1.5-1 (Cont'd)
EIS Correlation with EIS Guidelines

EIS Guidelines Requirements	EIS Section
Part II Content of the EIS	
8.8 Malfunctions and Accidents and Malevolent Acts	7.0
8.9 Environmental Protection, Policies and Procedures	2. 9
9.0 Environmental Assessment Boundaries Define the spatial and temporal boundaries of the project as a frame of reference for assessing environmental effects	3.1
9.1 Spatial Boundaries and Scale Describe geographic study areas that encompass the areas of the environment that can reasonably be expected to be affected by the Project: • Regional Study Area. • Local Study Area. • Site Study Area.	3.1.3
9.2 Temporal Boundaries Indicate the range of appropriate scales at which particular baseline descriptions and the assessment of environmental effects are presented: • Project timeframe. • Cumulative effects assessment.	 3.1.2 8.2
9.3 Valued Ecosystem Components Describe general criteria used to identify VECs that may be affected by the Project	3.2.4 4.2 - 4.14
10.0 Existing Environment Provide a baseline description of the environment	4.0
10.1 Bio-Physical Environment	
10.1.1 Geology and Geomorphology	4.6
10.1.2 Surface Water	4.3
10.1.3 Groundwater	4.6
10.1.4 Terrestrial Environment	4.5
10.1.5 Aquatic Environment	4.4
10.1.6 Ambient Radioactivity	4.7
10.1.7 Climate, Weather Conditions and Air Quality	4.2
10.1.8 Noise	4.2.4
10.2 Socio-Economic Conditions	4.11
10.2.1 Economy	4.11.5
10.2.2 Land Use and Value	4.8; 4.11.3
10.2.3 Aboriginal Land, Aquatic Area and Resource Use	4.12
10.2.4 Land-Based Transportation	4.9
10.2.5 Navigable Waters	4.9
10.2.6 Human Health	4.13
10.2.7 Physical and Cultural Heritage Resources	4.10
11.0 Effects Prediction, Mitigation Measures and Significance of Residual Effects	5.0

TABLE 1.5-1 (Cont'd)
EIS Correlation with EIS Guidelines

EIS Guidelines Requirements	EIS Section
Part II Content of the EIS	
11.1 Effects Prediction Describe any changes in the environment caused by the Project, including effects of these environmental changes on: • Health and socio-economic conditions. • Physical and cultural heritage. • Current use of lands and resources for traditional purposes by Aboriginal persons. • Any structure, site or thing that is of historical, archaeological, paleontological or architectural significance. Describe changes to the Project caused by the environment.	5.0 6.2 – 6.4
11.2 Mitigation Measures Describe general and specific measures intended to mitigate the potentially adverse environmental effects of the Project, including: • Which measures respond directly to statutory or regulatory requirements. • Proposed monitoring programs (for verifying mitigation measures were implemented) that will be designed.	5.2 – 5.14
11.3 Significance of Residual Effects Identify the criteria used to assign significance ratings and provide a detailed analysis of the significance of potential residual adverse effects of the Project.	9.0
11.4 Bio-Physical Environment	
11.4.1 Geology and Geomorphology	5.6
11.4.2 Surface Water	5.3
11.4.3 Groundwater	5.6
11.4.4 Terrestrial Environment	5.5
11.4.5 Aquatic Environment	5.4
11.4.6 Radiological Conditions	5.7
11.4.7 Atmosphere	5.2
11.4.8 Noise and Vibrations	5.2
11.4.9 Effects of the Environment on the Project	6.2
11.5 Socio-Economic Effects	
11.5.1 Economy	5.11
11.5.2 Land Use and Value	5.8; 5.11.5
11.5.3 Aboriginal Traditional Land Use	5.12

TABLE 1.5-1 (Cont'd)
EIS Correlation with EIS Guidelines

EIS Guidelines Requirements	EIS Section
Part II Content of the EIS	
11.5.4 Land-Based Transportation	5.9
11.5.5 Navigable Waters	5.9
11.5.6 Human Health	5.13
11.5.7 Physical and Cultural Heritage Resources	5.10
11.5.8 Natural Resources	5.5; 5.11
12.0 Accidents, Malfunctions and Malevolent Acts	7.0
12.1 General Considerations For each category of accidents and malfunction, define one or more limiting source terms and provide quantitative information on all radioactive and hazardous substances that could be released to the environment in significant quantities	7.1
12.2 Nuclear Accidents	7.3
12.3 Conventional Accidents	7.2
12.4 Malevolent Acts	7.4
13.0 Cumulative Effects Identify and assess the cumulative adverse and beneficial environmental effects of the Project in combination with other past, present and reasonably foreseeable projects/activities in the study areas.	8.0
14.0 Capacity of Renewable Resources Describe the effects of the Project on the capacity of renewable resources to meet the needs of the present and those of the future.	6.1
15.0 Follow Up Program Include a framework upon which environmental monitoring will be based throughout the life of the Project.	11.0
16.0 Assessment Summary and Conclusion Summarize the overall findings with emphasis on the main environmental issues.	13.0

1.5.2 Technical Support Documents

The EIS has been derived largely from EA studies that were carried out within a framework of individual aspects or "components" of the environment and that are documented in TSDs. The environmental components that were deemed to be relevant in the context of the Project are:

- Atmospheric Environment;
- Surface Water Environment;
- Aquatic Environment;
- Terrestrial Environment;
- Geological and Hydrogeological Environment;
- Land Use;
- Traffic and Transportation;
- Radiation and Radioactivity Environment;
- Physical and Cultural Heritage Resources;
- Socio-Economic Environment;
- Aboriginal Interests;
- Health - Human; and
- Health – Non-Human Biota (Ecological Risk Assessment).

Other EA-related studies addressed subjects not associated with a specific environmental component, but which were necessary to support the EA program. These included:

- Scope of the Project for EA Purposes (i.e., Project Description);
- Emergency Planning and Preparedness;
- Communications and Consultation;
- Malfunctions, Accidents and Malevolent Acts; and
- Nuclear Waste Management.

In most cases where the TSDs relate to environmental components, separate documents were prepared to describe: i) existing environmental conditions; and ii) likely environmental effects. In other cases, the subject of the study is included in a single TSD.

(If there are differences in the information provided in the EIS and TSDs, this EIS will take precedence.)

1.5.3 Indicative Timeline for EA and Related Activities

A JRP under the *CEAA* and the *NSCA* is being established to undertake an EA and regulatory review of the Project. The JRP will consider and evaluate all information that pertains to the EA and information in support of OPG's application for a Licence to Prepare Site for a Class 1 Nuclear Facility. This EIS which consolidates and summarizes all aspects of the EA will form part of the submission to the JRP in mid 2009. It is anticipated that a decision by the JRP will occur in early 2011 at which time a Licence to Prepare a Site for a Class 1 Nuclear Facility will be issued. It is noted, however, that the time frames indicated are subject to change as Project planning evolves.

2. THE PROJECT FOR EA PURPOSES

2.1 Introduction

This Chapter presents an overview description of the NND Project, including a brief history of the DN site and its suitability for development and operation of new nuclear reactors. The discussion also profiles the proponent, OPG, and its approach to nuclear power generation, safety and environmental performance. Sections 2.1 to 2.3 offer a general description of the Project and its historical and operational context. Section 2.4 describes how the Project has been defined for purposes of the EA in a manner that recognizes several of its key features will remain undefined until a vendor has been selected by the Province of Ontario; and that some elements of it may be implemented in alternative ways. Sections 2.5 and 2.6 describe the specific works and activities of the Site Preparation and Construction phase, and the Operation and Maintenance phase, respectively, in a framework of fundamental construction parameters, operational facilities and system groups. The remainder of the Chapter offers further details concerning the organizational structure of OPG and its programs of particular relevance to NND.

The pages that follow are a summary of a more detailed description of the Project prepared as a separate document. For the most complete description of the Project, the reader is directed to the *Scope of the Project for EA Purposes Technical Support Document.*

2.1.1 The Proposed Project

The NND Project involves the preparation of available land within the existing DN site for construction of up to four nuclear reactor units (capable of producing up to 4,800 MW of electricity), operation and maintenance of the reactor units through approximately 60 years of electricity production, subsequent placement of the reactors into safe storage, construction and operation of nuclear waste management facilities associated with operation, and planning for the eventual decommissioning and abandonment of the reactors and associated facilities.

The *CEAA* encourages proponents to conduct EAs as early as possible in the planning and development stages of a project, before key project decisions become irreversible, so that the results of the EA can help decision makers determine whether and how to implement the project. In the case of the NND Project, because the EA was carried out early in the Project planning stage, the reactor technology had not yet been selected at the time of EA submission.

In the "Project Description for Site Preparation, Construction and Operation of the Darlington B Nuclear Generating Station" submitted by OPG in April 2007 (OPG 2007a), four alternative reactor technologies were described. Three different reactors (one pressurized hybrid reactor and two pressurized water reactors) are currently being considered by the Province of Ontario (which is responsible for reactor procurement – see Section 1.4.1). In order to carry out the EA as early as possible in the Project planning stage, the Project is defined and described in this EIS in a manner that provides for an effective assessment of potential environmental effects that might result from the range of reactor technologies and types, as well as the number of units considered feasible for the DN site. Should the design that is ultimately selected by the Province be other than those considered in this EIS, any necessary adjustments would be made to the EIS to take into account any substantial changes in the environment, the circumstances of the Project, and new information of relevance to the assessment of effects of the Project.

This approach to defining the Project incorporates a Plant Parameter Envelope and a bounding site development layout that, when considered together, represent limiting values for key aspects of different design options being considered. The bounding concept is further detailed in Section 2.4.

2.1.2 The Darlington Nuclear Site

The location and general description of the DN site are included in Section 1.1.2. The following paragraphs provide a brief review of the original selection and acquisition of the site in the 1970s, the early vision of development capacity of the site, development of the site to date and rationale for its selection for further nuclear power development.

Original Selection and Acquisition of the DN Site

The DN site was originally identified by Ontario Hydro (OH, predecessor to OPG) in the late 1960s as a good site for a future electricity generation centre. In 1971, the provincial government granted OH approval to acquire land for the site in Darlington Township and the local council gave its approval to develop the site as an energy centre, subject to other applicable approvals. Subsequently, OH acquired most of the land now occupied by the DN site in the early 1970s for future power generation purposes.

OH's acquisition of the DN site lands was in response to increasing demand for electricity in Ontario as a result of population and economic growth. It was also consistent with provincial plans for the area, which included the objective of stimulating growth in the Toronto to

Bowmanville corridor; and municipal plans which had included designation of most of the shoreline lands between Bowmanville and Darlington Provincial Park for industrial use.

The site was selected for nuclear power development in the mid-70s for several reasons, the major ones being land availability (including sufficient size to build at least two multi-unit generating stations); proximity to the Ontario electricity load centre and the east-west transmission corridor which was being planned at the time; history of support from local and regional governments; and extensive operating experience in the region (i.e., Pickering NGS), site knowledge and an experienced workforce.

Ontario Hydro's Early Vision for the DN Site

From the outset, OH viewed the DN site as a potential energy centre with an ultimate generation capacity of up to 12,000 MW. Between 1974 and 1976 OH undertook a public consultation program to ensure that all concerns were identified and taken into account; and in 1975, a preliminary environmental assessment was distributed to the community and a series of meetings held with interested groups and individuals. In total, 17 meetings were held between 1974 and 1976, 12 with interest groups and five with local officials.

In November 1976 Ontario Hydro submitted a proposal to the provincial government for the development of the Darlington Nuclear Generating Station, which considered the impact of construction and operation on both the environment and the community and included a summary of the government review and public participation process (Ontario Hydro, 1976). Site approval was granted by the then Atomic Energy Control Board (AECB) on June 29, 1977 and in July 1977, the Province approved Ontario Hydro's proposal for the DNGS. The AECB approved Ontario Hydro's construction license in June 1981.

The DNGS development proposal which was the basis for the Province's approval of the project in 1977 included a conceptual layout for a second four-unit station in the area now being considered for the NND Project. This future second station was taken into account in developing the physical layout of DNGS, which was sited on the western half (approximately) of the DN site with opportunity for some common service facilities in the centre area to also support a future station. Although OH's original vision for the DN site included a possible third station, either nuclear or fossil-fuelled, this option was not explicitly included in the 1975-76 proposals as plans were not sufficiently developed to support it.

Existing Development on the DN Site

Work began in 1978 to develop the DN site, beginning with construction of DNGS on the western half of the site, south of the CN rail line. Other facilities were subsequently added as required to support the operation of DNGS and other OPG nuclear stations. Development of the DN site to date includes the following nuclear facilities:

- Four-unit DNGS, with a total output of 3,524 MW(e), located in the southwest quadrant of the site, in service since 1990;
- A Tritium Removal Facility (TRF), serving all of OPG's nuclear reactors, located immediately south of DNGS, in service since 1988; and
- The initial phase of the Darlington Waste Management Facility (DWMF), providing interim dry storage of used fuel from DNGS, located east of the station, in service since late 2007 (additional phases to be added as required).

The DN site also includes a Visitor Information Centre, a Hydro One switching station (leased to Hydro One) connecting DNGS to the 500 kV east-west transmission corridor, security facilities and technical and administrative support facilities. The DN site also accommodates recreational features outside the Protected Area that are available to the public, including soccer fields in the northwest corner and a 7.5-km section of the Waterfront Trail which traverses the DN site north of the rail line.

Rationale for Selection of DN Site for the NND Project

In June 2006, the Ontario Minister of Energy directed OPG to begin the federal approvals process, including an EA, for new nuclear units at an existing site. OPG subsequently began this process, choosing its existing DN site as the preliminary basis for its planning and assessment studies pending the Province's selection of a site for the Project. In June 2008, the Province announced the selection of the DN site as the location for the first new nuclear units to be built.

The factors that make the DN site a preferred choice for further nuclear power development at this time are the same as those that led to its selection for the same purpose in the 1970s plus the current benefits of a local skilled nuclear workforce and detailed knowledge of the interactions between the existing plant and the surrounding environment. As noted above, the DN site was originally planned and the current station designed with the intention of eventually becoming a multi-station facility. Nothing has transpired in the subsequent years that render the site unsuitable for this purpose.

An evaluation of the DN site to confirm its suitability for the NND has been carried out by OPG in compliance with the CNSC Regulatory Document RD-346, *Site Evaluation for New Nuclear Power Plants* (CNSC 2008c). Based on the evaluation, OPG has determined that the DN site is suitable to construct and operate NND. The details of the site evaluation program are included in material submitted to the CNSC by OPG in support of its revised application for a licence to prepare the site (originally submitted in September 2006 and revised in September 2009). Also and as noted above, the DN site has been home to the operating DNGS since 1990 and the performance and operational history of that facility has clearly demonstrated the suitability of the DN site for that purpose. Accordingly, further site selection protocols (including that as documented in *Environmental Codes of Practice for Steam Electric Power Generation – Siting Phase* (Environment Canada 1987)) have not been applied for the Project. Nonetheless, it is also to be noted that the environmental criteria included in the Code of Practice are represented in the environmental components and sub-components adopted for this EIS (see Chapters 4 and 5).

2.2 OPG and Nuclear Power Generation

2.2.1 OPG and Its Power Generation System

OPG, one of several successor corporations to the former Ontario Hydro, is an Ontario-based electricity generation company whose principal business is the generation and sale of electricity in Ontario. It is incorporated pursuant to the *Ontario Business Corporations Act* and its shares are wholly owned by the Province of Ontario. As one of the largest generators of electricity in North America, OPG employs approximately 12,000 people and owns and operates three nuclear, five fossil-fuelled, 65 hydroelectric and two wind power generating stations collectively capable of producing more than 21,000 MW of electricity. OPG also has an ownership interest in two recently-constructed gas-fuelled generating stations.

OPG owns and operates the Pickering A, Pickering B, and Darlington nuclear generating stations and related radioactive waste management facilities at the Pickering, Darlington and Bruce nuclear sites. OPG also owns two nuclear generating stations located at the Bruce site, Bruce A and Bruce B, which are currently operated by Bruce Power under a long-term lease arrangement. In recent years, OPG has generated approximately 70% of the electricity used in Ontario and nuclear generation has contributed nearly 50% of OPG's total power production.

In addition, OPG purchases approximately $1 billion in goods and services annually from primarily Ontario-based suppliers and contributes to the Province in taxes, dividends and other payments.

2.2.2 OPG Commitment to Nuclear Excellence, Safety and Sustainable Development

OPG's commitment to nuclear excellence is demonstrated by the operational, safety and environmental performance of its nuclear facilities. DNGS is consistently one of the top performers in the nuclear energy industry. The station's capability factor (i.e., the percentage of the maximum electricity that a plant can supply to the electric grid) has averaged over 80% since it began operation in 1990. In recent years, the capability factor has often been in the 90% range and during the first quarter of 2008, it was nearly 100%. DNGS recently received an award from the Institute of Nuclear Power Operators (INPO) for its safety and operational performance. OPG's overall nuclear power production over the years has benefited from the outstanding performance of DNGS.

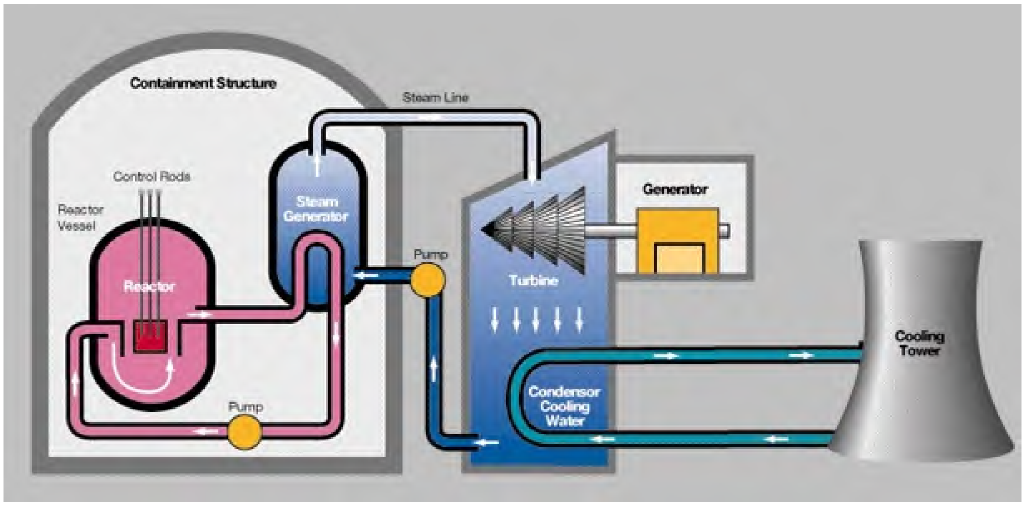
A key element of OPG's environmental policy is its objective of meeting and where appropriate and feasible, performing better than legal requirements. DNGS has never exceeded the regulatory limits on radioactive emissions. Emissions have always been a small fraction of the emission limits specified by the regulator. As a result, the additional radiation exposure of people living near the station has been calculated each year to be a small fraction (less than 1%) of the exposure permitted by regulation and an even smaller fraction of the exposure due to natural background radiation. OPG's monitoring and calculations of public exposure are supported by independent assessments.

OPG's ongoing programs in the areas of security and safety (including radiation protection), environment (including monitoring and biodiversity) and sustainability are summarized in Sections 2.8 to 2.10.

2.3 Overview of a Nuclear Power Plant

2.3.1 How Nuclear Energy is Produced

Electricity is generated in a nuclear power plant in much the same way that it is generated in a power plant that uses fossil fuel (coal, oil or gas). Heat is produced to convert water into steam which is used to spin a turbine, which in turn spins a generator to produce electricity. In a nuclear power plant, the heat is produced in a reactor using a uranium based fuel, whereas in a fossil fuelled power plant, the heat is produced in a furnace which burns coal, oil or gas.



Typical Nuclear Power Electrical Generation Schematic
(Nuclear Tourist Web Site 2008)

In the reactor core, heat is produced when a neutron strikes an atom of uranium in the fuel, causing it to split into lighter atoms. In addition to heat, this fission reaction releases additional neutrons that can split other uranium atoms in a chain reaction. To slow down the neutrons and control the fission process, the reactor contains a moderator (which may be light or heavy water). Water is passed over the fuel and through a series of pipes to transfer the heat to a set of steam generators (i.e., boilers). This water is the reactor coolant and the system is collectively the Primary Heat Transport System (also known as the Reactor Coolant System).

The heated reactor coolant water enters the tubes of the steam generators (i.e., the primary side of the steam generators). The heat is conducted across the tubes of the steam generator, resulting in boiling of the feedwater on the shell side of the steam generators (i.e., the secondary side of the steam generators). The tubes in the steam generator prevent mixing of reactor coolant water from the primary heat transport system with the feedwater steam on the shell side of the steam generators.

The steam produced in the shell side of the steam generators is transferred through a system of pipes that form a second closed-loop system (i.e., Secondary Heat Transport System). The steam passes through the turbines, causing the turbine rotors and the attached generator rotor to rotate. The spinning of the generator rotor results in the production of electricity.

After the steam passes through the turbine, it is cooled and converted to water in the condensers and redirected to the steam generators. The condensers are cooled by another separate flow of water (the Condenser Circulating Water – CCW System) that travels through the condenser tubes. As with the relationship between the reactor coolant water and the feedwater, the feedwater and the condenser circulating water do not mix. The circulating cooling water system may be part of a "once-through" cooling system such as that at DNGS. Alternatively, it may be part of a "closed loop" cooling tower system as illustrated in the figure above. In both cases, substantial volumes of cool water are cycled through the condensers thereby converting the turbine steam to water.

All nuclear generating stations incorporate comprehensive safety features and processes. Fast-acting safety systems and safety-related systems are in place to prevent and mitigate potential accidents. Further, the design and operation of a nuclear generating station incorporates defence-in-depth. This concept acknowledges that design flaws, equipment failures and/or mistakes may occur. However, there will be multiple, redundant, independent barriers in place such that no single mistake or failure can cause significant detriment to human health and/or the environment.

The safety and related systems are further described in Section 2.6.4.

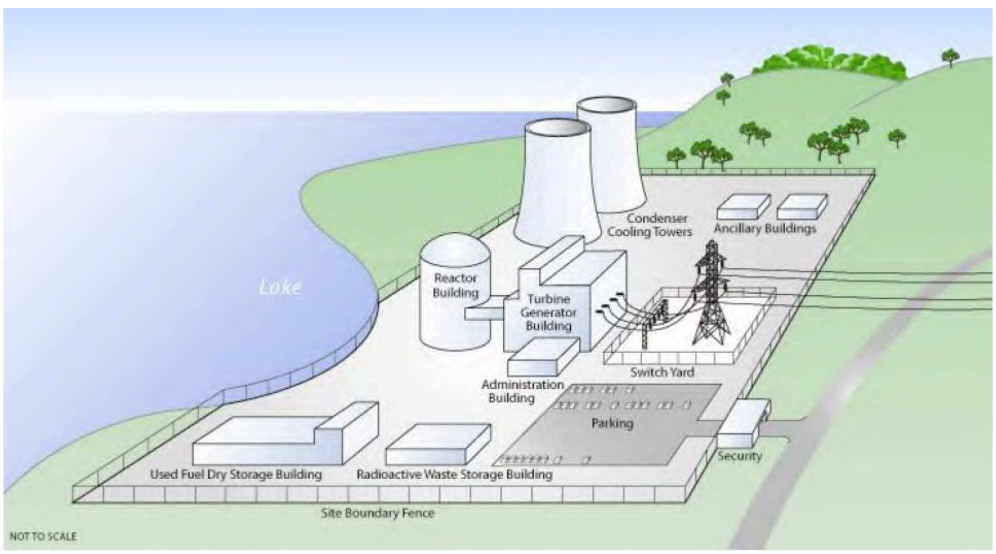
Nuclear reactor fuel for typical Generation III reactors is manufactured off-site and delivered to the generating facility in various configurations depending on the reactor type (e.g., fuel rod assemblies or fuel bundles). The three reactors currently being considered by the Province all use low enriched uranium fuel (i.e., up to 5% enrichment). When removed from the reactor, used fuel is transferred to a water-filled Used Fuel Bay (alternatively known as Spent or Irradiated Fuel Bay) where it is contained to cool for a period of several years. Following the period of wet storage, the used fuel is transferred to dry storage containers and placed into appropriate facilities, also specific for the fuel type. The used fuel from all reactors in Ontario is currently stored in Spent Fuel Bays and dry storage facilities at the stations where the fuel was used. The Nuclear Waste Management Office (NWMO) created under the auspices of the federal *Nuclear Fuel Waste Act (NFWA)*, is charged with development of a long-term management approach for used fuel, which is subject to a separate federal approvals process.

In addition to used fuel, nuclear generating stations all produce a volume of low and intermediate level (L&ILW) radioactive waste. These waste products will be processed on-site and stored or otherwise managed in appropriate facilities either on-site or shipped to licensed off-site facilities. OPG's Western Waste Management Facility currently receives and manages such wastes from existing OPG nuclear generating stations.

2.3.2 Typical Components of a Nuclear Power Plant

In addition to the station elements that are related directly to the function of the reactor, a nuclear generating station also requires an extensive related infrastructure to support its operations. A typical, stylized (one-unit) nuclear power generating station is illustrated in the following graphic. It depicts the reactor and other operational features important to station function, as noted below:

- Reactor Building - within which are housed the reactor assembly and steam generators;
- Turbine Generator Building (i.e., Turbine Hall, Powerhouse) - within which the turbines and generator are housed;
- Switchyard to connect the plant to the provincial electricity grid;
- Condenser Cooling Towers – features of the CCW system noted above (and which could alternatively consist of a once-through lakewater cooling system for the NND);
- Buildings and facilities for interim storage of used fuel and other radioactive wastes resulting from operation and maintenance of the plant, as noted above; and
- An administration building and various ancillary buildings and features including a parking area, perimeter fence and related security building to control access to the plant.



Features of a Typical Nuclear Generating Station
(Nuclear Tourist Web Site 2008)

2.4 Definition of the Project for EA Purposes

The portion of the DN site proposed for development as NND is primarily the eastern one third (approximately) of the DN site property. It is generally bounded by the DN site property limits on the east and north boundaries, extending into Lake Ontario on the south, and by Holt Road on the west. It may be that other areas of the DN site will also be used during the construction-related activities (e.g., excavated soil disposal in the Northwest Landfill Area); however, following construction of NND, its operational activities will be focused within the area described above (see Figure 2.4-1 as an example of the overall spatial distribution of the Project and its associated elements).

Site preparation will involve all activities within and around the subject portion of the DN site necessary to facilitate subsequent construction and operation of the new nuclear power plant. For EA purposes, it is assumed that site preparation activities for the maximum number of reactors (i.e., up to four) and support facilities/structures would be completed at the outset, even though initially only two reactors would be constructed. For planning purposes, it was further assumed that two reactors will initially be constructed generally in parallel although with one slightly delayed behind the other, and as such, the first reactor will become operational as the second reactor is being constructed. Construction activities, many of which may take place concurrently with site preparation works, will involve the development of nuclear–related features of the Project including the reactor power block(s), condenser cooling facilities, and radioactive waste management facilities. The remaining one or two reactors would begin construction at some point after the first two are in service.

The Operation and Maintenance phase of the Project will involve the routine and on-going operation of the reactors and ancillary features during the proposed 60-year functional period. Operation and maintenance will also involve the management of low and intermediate-level radioactive waste (L&ILW) and used fuel, as well as any refurbishment (or similar outage or non-outage-related) maintenance actions, and plant modifications that may be required during the operating life of the units. L&ILW management facilities will go into service concurrently with the first reactor but it is not expected that used fuel dry storage facilities will be required until about 2025 because when the fuel is initially removed from the reactor, it is placed in the water-filled used fuel bays. The Operation and Maintenance phase also includes part of the safe storage phase (a period of time following removal of fuel and process fluids from the reactors) prior to commencement of decommissioning.

As has been noted, the essential aspect of the approach for defining the Project for EA Purposes is the use of a bounding framework that brackets the range of variables to be assessed. This bounding framework incorporates the Plant Parameter Envelope (PPE). The PPE is a set of design parameters that delimit key features of the Project. In so doing, it represents the limiting values for salient elements of the different design options being considered. The PPE as it was developed for the NND is described in *Use of Plant Parameters Envelope to Encompass the Reactor Designs Being Considered for the Darlington Site* (OPG 2009j).

An EA, when conducted using a PPE, evaluates project elements that are common among the designs (e.g., condenser cooling system; turbine hall construction), elements that are common among a technology family (e.g., pressurized water reactor maintenance), and elements that are unique to particular technologies (e.g., radiological emissions). The bounding nature of the PPE allows for appropriate simplification of a range of variables within a project for the purpose of the EA while also recognizing the unique features of each design.

The use of the PPE is consistent with the expectations documented by the CNSC in their Information Guide INFO-0756, Rev 1, *Licensing Process for New Nuclear Power Plants in Canada* (CNSC 2008d) which recognizes that an application for a Licence to Prepare a Site may be submitted in advance of selection of a technology.

The use of the PPE and the bounding framework also allows alternative means of carrying out the Project to be incorporated into the Description of the Project for EA Purposes (see Section 2.4.3) such that the envelope that is the subject of the assessment of environmental effects represents the full reasonable range of possible ways that the Project might be implemented. Alternative means and their incorporation into the Project definition are discussed below.

2.4.1 Alternative Means of Implementing the Project

The EIS Guidelines require that the EIS include a relative consideration of the environmental effects of alternative means of carrying out the Project that are technically and economically feasible. For purposes of this EA, the following guiding principles were applied to determine the feasibility of possible alternative means of implementing the Project:

- An alternative means must be a variation of the manner in which the Project or components of it might be implemented while remaining within the overall objectives of the undertaking as it was described in the Project Description submitted to the CNSC by OPG to initiate the regulatory process (OPG 2007a). Variations that do not meet these objectives are not considered as alternative means of carrying out the Project (e.g., reactor siting variations other than within the DN site; and total generation potential significantly different than the objective (up to 4,800 MW) were not considered);

- Technical feasibility of a variation was determined on the basis of the professional judgement of the Project team (including applicable OPG personnel, technical group leads and EA professionals). Where, in the collective judgement of the team considering operational experience and precedent, there was no reasonable expectation that a suggested variation could meet the technical intention of the Project or component of it, that variation was not advanced as an alternative; and

- Economic feasibility was also determined on the basis of the professional judgement of the Project team. Because the EA was initiated very early in the planning stage of the Project, there were no established economic benchmarks for its individual components. However, based on experience and precedent and considering the relative difference of the magnitude cost of variations considered, it is possible to make reasonable judgements concerning the economic viability of those variations.

Some possible variations in the manner in which the Project might be implemented were screened from further consideration as alternative means early in the EA program as described below:

- **Variations on lake infilling:** The Project may require that a portion of Lake Ontario along its shoreline in front of the DN site be infilled to create the necessary surface area to accommodate the Project (including required space for construction and equipment laydown, as well as for security provisions along the lakefront); and stabilized to mitigate potential effects of the environment (e.g., flooding) on the Project. Early in the planning stages of the Project, it was determined that physical protection of the DN site would require some lake infill and a variation that did not involve lake infilling was screened out as not technically feasible given the space requirements of the Project and existing physical constraints on the site, including the CN railway tracks. The extent of lake infill assumed for EA purposes is considered the bounding condition and therefore, that which would result in the greatest associated effect. It may be that as the Project design advances, the extent of lake infilling would lessen with correspondingly reduced potential environmental effects; and

- **Switchyard location and design:** The Project will require a switchyard to facilitate the transfer of power from the generating station to the electrical grid. The Project as defined for EA purposes provides for the switchyard to be added as an extension to the existing DNGS switchyard. The physical constraints associated with the existing features on the site and the limited opportunities for new reactor placement effectively result in alternative switchyard locations, particularly those that would result in different environmental interactions, as being not technically feasible. In terms of switchyard design, although switch gear and associated equipment may vary to a degree, the overall physical attributes and function of the equipment variations are similar to the point that there would not be an appreciable difference in how they would interact with the environment. Accordingly, switchyard location and design variations were not advanced as an alternative means.

The Sections that follow describe the alternative means of carrying out the Project that were considered in the EA and the manner in which the alternatives were incorporated into the Description of the Project for EA Purposes.

2.4.1.1 Alternative Reactor Designs and Numbers of Units

Alternative reactor designs are considered in this EA through the PPE approach noted above. Although selection of the reactor design will be made by the Province of Ontario through its nuclear procurement process, this approach allows for the assessment of the potential adverse effects of a reasonable range of reactor designs in this EIS. At the outset of the procurement process, nine potential reactor vendors offering reactors in four reactor classes were considered. The reactor classes and their principal differences are noted in Table 2.4-1.

TABLE 2.4-1
Reactor Classes and Principal Differences

	Pressurized Water Reactor (PWR)	Boiling Water Reactor (BWR)	Pressurized Heavy Water Reactor (PHWR)	Pressurized Heavy and Light Water Hybrid Reactor (Hybrid)
Fuel	Low Enriched Uranium (LEU)	Low Enriched Uranium (LEU)	Natural Uranium	Low Enriched Uranium (LEU)
Moderator	Light Water	Light Water	Heavy Water	Heavy Water
Coolant	Light Water	Light Water	Heavy Water	Light Water
Reactor Vessel	Pressure Vessel	Pressure Vessel	Pressure Tubes	Pressure Tubes
Steam Generator	Steam is produced in separate steam generators	Water boils in the reactor vessel	Steam is produced in separate steam generators	Steam is produced in separate steam generators

The procurement process has progressed to the point that three reactor vendors offering two reactor types remain under consideration by the Province, as follows:

- The ACR-1000, a Hybrid offered by Atomic Energy of Canada Limited (AECL);
- The AP1000, a PWR offered by Westinghouse Electric Company LLC; and
- The US EPR (EPR), a PWR offered by Areva NP.

The framework bounded by the PPE has been established to ensure the potential adverse effects of any of the three reactor types currently under consideration by the Province are included for the purposes of the effects analysis. Accordingly, the significance of the potential adverse effects of any of these three reactor designs, or any other that is bounded by the analysis, has been considered in this EIS. As noted in Section 2.1.1, should the design that is ultimately selected by the Province be other than those considered in this EIS, any necessary adjustments would be made to the EIS to take into account any substantial changes in the environment, the circumstances of the Project, and new information of relevance to the assessment of effects of the Project.

The EA also considers the number of units of each reactor described below that would be required to achieve the 4,800 MW electrical power objective, (i.e., four ACR-1000s would generate 4,340 MW; 3 EPRs would generate 4,740 MW; four AP1000s would generate 4,148 MW). The Description of the Project for EA Purposes (Sections 2.5 and 2.6) includes the maximum potential development on the DN site.

To ensure that the complete range of potential Project-environment interactions and likely associated environmental effects were considered, the description of the Project in terms of the reactors was derived from information provided by the reactor vendors and compiled by OPG to form the PPE. The PPE represented the limiting values for the common elements of the different reactors being considered, and served as a conservative surrogate for actual reactor design information that varied among the options.

Although only one reactor operating scenario will ultimately be implemented, the EIS incorporates the scenarios for the three reactor types currently being considered by the Province of Ontario as representative of operating scenarios associated with a reasonable range of reactor types.

2.4.1.2 Alternatives for Condenser Cooling

For Project planning purposes, OPG commissioned a study to compare normal heat sink cooling system (i.e., condenser cooling) options for the NND Project (MPR 2009). The study considered the following seven options:

- Once-through lakewater cooling;
- Natural draft cooling towers;
- Mechanical draft cooling towers;
- Fan-assisted natural draft cooling towers;
- Hybrid (wet/dry) cooling towers;
- Dry cooling towers; and
- Spray/cooling ponds.

The study recommended that no further consideration be given to hybrid (wet/dry) and dry cooling towers due to their high capital and operating costs and because the DN site does not exist in a dry climate (these technologies are intended for climates where water is in short supply). It also noted that dry cooling towers can lead to substantial derating of the plant during hot weather, which corresponds to peak summer demand and therefore would reduce the new plant's output when it is needed most. Similarly, the study established that there was insufficient land area available for the spray/cooling pond option and it too, was dropped from further consideration.

For purposes of the EA, the options considered for condenser cooling included the four noted above that were deemed appropriate for the DN site, specifically: i) once-through lakewater, cooling; ii) natural draft cooling towers; iii) mechanical draft cooling towers; and iv) fan-assisted natural draft cooling towers (this latter option is considered bounded by the mechanical and natural draft cooling towers and was not addressed separately). The construction and operations-related elements of all four condenser cooling alternatives were incorporated into the PPE and as such, were considered in the EIS within the bounding framework. The operations-related aspects of each considered cooling technology were assessed individually. Each of the condenser cooling alternatives considered is further described below:

- **Once-Through Lakewater Cooling:** once-through lakewater cooling would involve the withdrawal of water from Lake Ontario, its circulation through the condensers, and its return to the lake through an open-loop intake and discharge system. For EA purposes, the once-through cooling water intake and diffuser structures at NND are assumed to be similar to the existing structures at DNGS, although appropriately sized to accommodate the associated water flow rates at NND. The intake structure is embedded in the lake bottom with a network of porous and non-porous concrete modules covering the intake shaft. In contrast to an open pipe intake, the increased surface area of the modules through which the water is drawn reduces the velocity of the intake flow, with consequential reduction in fish impingement. The discharge pipe includes a series of diffusers from which the water is discharged to promote rapid thermal mixing in the lake;

- **Cooling Towers – Natural Draft:** cooling by means of natural draft cooling towers involves a closed-loop system whereby water is drawn from the cooling tower, circulated through the condensers and returned to the tower(s) to be cooled. The warmer water from the condensers is sprayed into the tower interior as outside air is introduced to the tower near its base. As the air is cooler than the water, a transfer of heat takes place and the air warms. The principle of buoyancy creates a chimney effect, and the warm moist air will rise naturally, due to the density differential with the dry cooler outside air. Natural draft cooling towers are typified by a traditional hyperbolic shape and extend to approximately 150 m above finished grade. The evaporative effect results in a plume of moisture-laden air exiting the cooling tower. The visibility of the plume is largely dependent upon weather conditions;

- **Cooling Towers – Mechanical Draft:** cooling by means of mechanical draft cooling towers involves generally the same principle as natural draft towers (i.e., water is cycled between the condensers and the tower). However, in the case of mechanical draft towers, fans are used to force air through (fan at bottom of tower), or to draw air through (fan at top of tower) the tower to promote the cooling process. Mechanical draft towers are typically much shorter (approximately 20 m in height) than natural draft towers, but require a much larger land area and use more energy to operate the fans. The water is cooled by the same heat transfer principles of convection and evaporation. The evaporative effect associated with mechanical draft cooling also results in a vapour plume; and

- **Cooling Towers – Fan Assisted Natural Draft:** fan assisted natural draft cooling towers operate on a combination of the principles of natural and mechanical draft cooling towers. These towers have a slightly larger base dimension than the natural draft cooling towers and have fans placed around the base of the tower to increase the air flow rate. The towers have a hyperbolic shape generally similar to a traditional natural draft tower but are only about one-third the height. Their footprint is between those of natural and mechanical draft towers. Fan assisted natural draft cooling towers are a variation of the mechanical draft and natural draft cooling towers and their physical characteristics and potential interfaces with the environment are considered to be bounded by the other cooling tower options addressed in the EA.

2.4.1.3 Alternatives for Management of Low and Intermediate Level Radioactive Waste

Two alternative means of managing low and intermediate-level waste (L&ILW) are considered in the EA: i) management of the waste on the DN site in a new L&ILW management facility; and, ii) transport of the L&ILW off the DN site to an appropriately licensed facility elsewhere. In the case of storage at an off-site facility, processing and storage of the waste at that facility is not an element of this Project since that facility will have been subject to its own approval process. For example, if the L&ILW is to be stored at OPG's Western Waste Management Facility (WWMF), that facility is currently approved to store OPG's L&ILW.

Both options are incorporated into the Description of the Project for EA Purposes (Sections 2.5.8 and 2.6.10) and were assessed individually including aspects associated with transportation to an off-site facility (Section 2.6.11). This approach ensured appropriate consideration of the likelihood that even if it was elected to ship the L&ILW to an off-site facility, it would be likely that some quantity of this waste would continue to be managed on-site because of the impracticality of shipping it off-site (e.g., over-sized components such as steam generators resulting from mid-life refurbishment activities). The evaluation of alternative on-site locations for a L&ILW management facility is considered in the framework of the bounding site development layout (see Section 2.4.2).

2.4.1.4 Alternatives for Storage of Used Fuel

Design-specific used fuel storage facilities will be a feature of any reactor type selected by the Province. In all cases, however, the storage system will consist of the transfer of the used fuel from the reactor to a water-filled storage pool (i.e., Spent Fuel Bay, alternatively known as Used Fuel Bay or Irradiated Fuel Bay) in which the used fuel is stored for a period of decay and cooling. After the used fuel has cooled sufficiently (i.e., typically over a period of 10 years), it will be transferred into dry-storage containers and further stored on-site in a purpose-built used fuel storage facility.

Although each reactor will require design-specific used fuel management components, most notably, the dry storage containers, alternatives for those containers are considered in the EA. Two technologies are included for used fuel stemming from ACR-1000 operations; the AECL MACSTOR system and OPG's dry storage containers (DSCs). The used fuel from operations of the EPR and AP1000, both PWRs, will be similar and the dry storage technologies considered in the EA include metal casks, concrete canisters, and concrete modules.

As above for the L&ILW management facility, evaluation of alternative on-site locations for the used fuel dry storage facility is considered in the framework of the bounding site development layout (see Section 2.4.2).

2.4.1.5 Alternatives for Excavated Material Management

The NND Site Preparation and Construction phase will require excavation and management of large quantities of soil and rock. Until a reactor vendor is selected and the detailed design phase is complete, specifics concerning the scope and form of the overall site development, including quantities of excavated material and the strategies for its management, cannot be determined. To facilitate the EA studies, therefore, and consistent with the PPE approach to Project definition, bounding characteristics for site development were established by conceptualizing a series of site layout scenarios that incorporated variations in the manner key features of the Project might be developed within the site. When the layout scenarios are considered collectively (i.e., overlain) they combine to represent a reasonable bounding configuration for overall site development.

An outcome of this bounding approach to conceptualization of site development is the substantial range in the quantity of material to be excavated and managed, with the primary factors affecting this range being elements of the Project that are currently uncertain, including the type of reactors (e.g., which affects numbers and areal footprint) and condenser cooling (once-through lakewater versus cooling towers). The options available for management of the excavated material are limited to: i) on-site use and disposal; and ii) transport of surplus soil to off-site disposal. However, variations on these options are possible based on consideration of the capacity and locations for on-site use and disposal of such material. The overlaid individual conceptual layouts established the all-encompassing configuration and provided the means for determining the bounding values for excavated material quantities and for assessment of the options for its management. Development of the conceptual bounding site development layout is described in the following section.

2.4.2 Bounding Site Development Layout

The EA studies considered full development of the NND which may be up to 4,800 MW and as many as four reactors; and the alternative means of implementing the Project, as described in Section 2.4. To create the bounding site development layout, three separate model plant layout scenarios were conceptualized, with each one representing the reasonable maximum extent for key parameters of the Project. Where applicable, the works and activities associated with the Site Preparation and Construction phase (see Section 2.5) adopted the maximum values among the three scenarios for relevant parameters (e.g., maximum quantity of soil excavation). The maximum value for the relevant parameter was used in the assessment of effects for the individual environmental components. Accordingly, the assessment bounds the conditions defined collectively by the three model plant layout scenarios.

The model plant layout scenarios were developed on the basis of conceptual design considering the characteristics of the DN site, the fundamental Project design elements, and opportunities to accommodate the design elements within the site. When the final NND Project layout has been designed, it will be confirmed to be enveloped within the bounding site development layout for EA purposes, and the conclusions of the EA also confirmed.

2.4.2.1 Model Plant Layout Scenario 1

Model Plant Layout Scenario 1 is illustrated in Figure 2.4-1. It represents the maximum power generation capability (i.e., four reactors). Variations on reactor locations are not considered as alternative means in this EIS because to achieve the Project objective of 4,800 MW, accepting the safety and security requirements for separation from property boundaries, regardless of type and number of units, it was assumed that multiple reactors must be generally located as shown (i.e., in the north-south orientation with appropriate set-back from the easterly property line). This scenario also includes the once-through lakewater condenser cooling layout option.

An area of Lake Ontario will be infilled and the new Northeast Area and the closed Northwest Landfill Areas will receive surplus excavated materials (inert materials only). Site development will involve the excavation and handling of approximately 9.4 million cubic metres (Mm^3) of soil and rock. Of this, 4.5 Mm^3 will be placed in the Northeast Landfill Area and approximately 1.2 Mm^3 will be added to the existing Northwest Landfill Area. Approximately 3 Mm^3 will be placed as lake infill, and the remainder, about 0.7 Mm^3, will be transported to off-site disposal.

2.4.2.2 Model Plant Layout Scenario 2

Model Plant Layout Scenario 2 is illustrated on Figure 2.4-2. This scenario depicts a mechanical draft cooling tower layout and is considered to represent the maximum extent of land area requirements for the Project assuming the relevant PPE values.

An area of Lake Ontario will be infilled and the Northeast and Northwest Landfill Areas will receive surplus excavated materials (inert materials only). Site development will involve the excavation and handling of approximately 9.8 Mm^3 of soil and rock. Of this, 4.5 Mm^3 will be placed in the Northeast Landfill Area and approximately 1.2 Mm^3 will be added to the existing Northwest Landfill Area. Approximately 3 Mm^3 will be placed as lake infill, and the remainder, about 1.1 Mm^3, will be transported to off-site disposal.

2.4.2.3 Model Plant Layout Scenario 3

Model Plant Layout Scenario 3 is illustrated on Figure 2.4-3. This scenario depicts a natural draft cooling tower layout and represents the reasonable maximum excavation requirement.

An area of Lake Ontario will be infilled and the Northeast and Northwest Landfill Areas will receive surplus excavated materials (inert materials only). Site development will involve the excavation of approximately 12.4 Mm^3 of soil and rock. Of this, 4.5 Mm^3 will be placed in the Northeast Landfill Area and approximately 1.2 Mm^3 will be added to the existing Northwest Landfill Area. Approximately 3 Mm^3 will be placed as lake infill, and the remainder, about 3.7 Mm^3, will be transported to off-site disposal.

2.4.3 Description of the Project for EA Purposes

The Project as defined within a bounding envelope is described subsequently for purposes of the EA, in a framework of its Site Preparation and Construction phase (Section 2.5); and Operation and Maintenance phase (Section 2.6). The division of site preparation and construction activities is required for purposes of licensing a nuclear power plant, however, this separation is not relevant for EA purposes since both will involve construction of physical works and to a large degree, they will be carried out concurrently. Nonetheless, to acknowledge the regulatory distinction, the works and activities associated with site preparation and construction are described separately except for those elements that are in common with both and where separation for descriptive purposes would create duplication.

It is recognized that: i) only one type of reactor will be constructed and operated; and ii) several key elements of the Project may be implemented in alternative ways. Accordingly, the alternative means of implementing the Project (as described in Section 2.4.1) are incorporated into the Description of the Project for EA Purposes in the manner described, also in Section 2.4.1.

A conceptualized timeline for the NND Project is presented as Figure 2.4-4. A timeline, also conceptualized, describing selected key Project works and activities is presented as Figure 2.4-5.

A conceptual decommissioning plan for the Project is provided in Chapter 12 of this EIS.

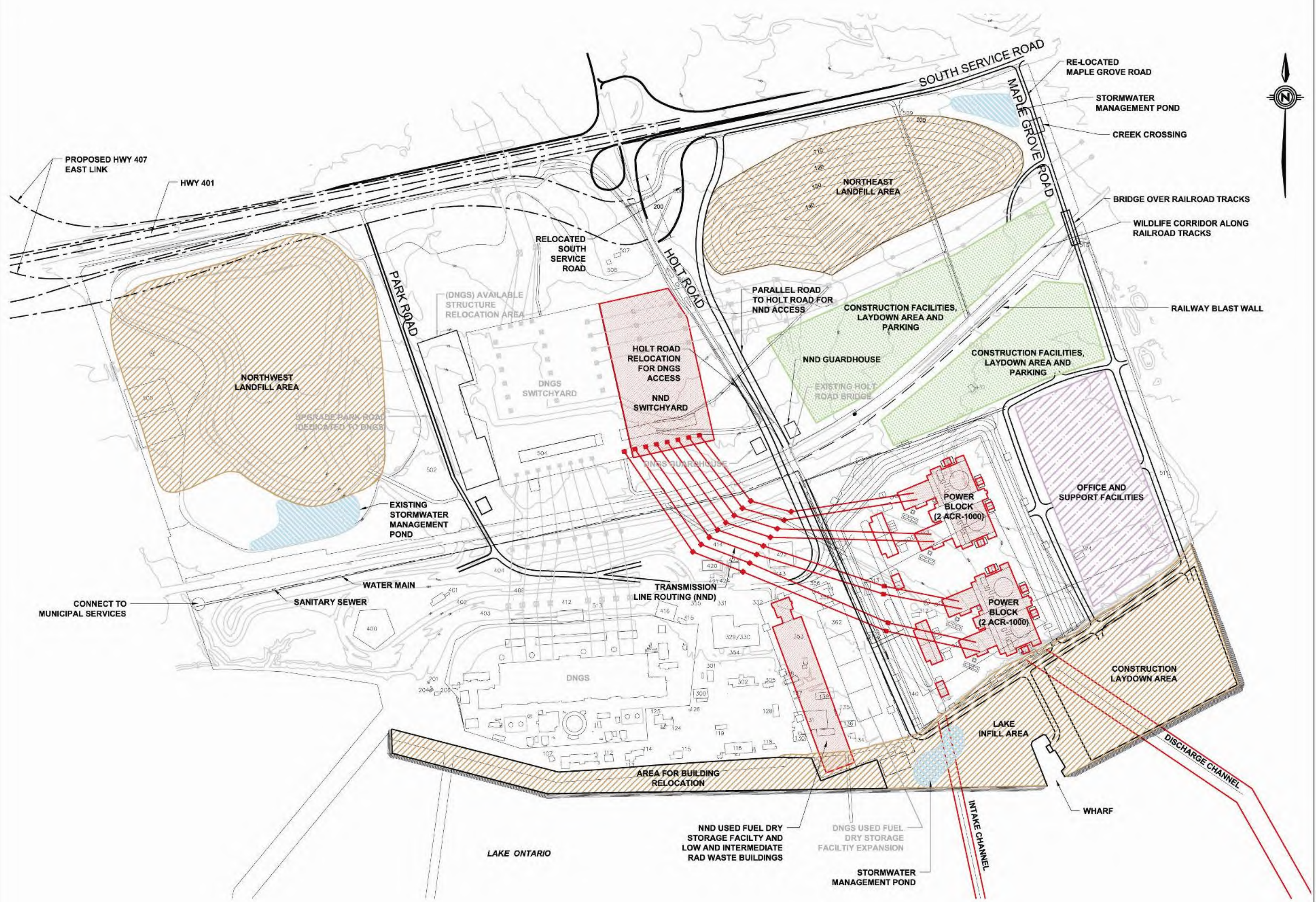


Figure 2.4-1

Model Plant Layout - Scenario 1: Four ACR-1000s with Once-Through Lake Water Cooling

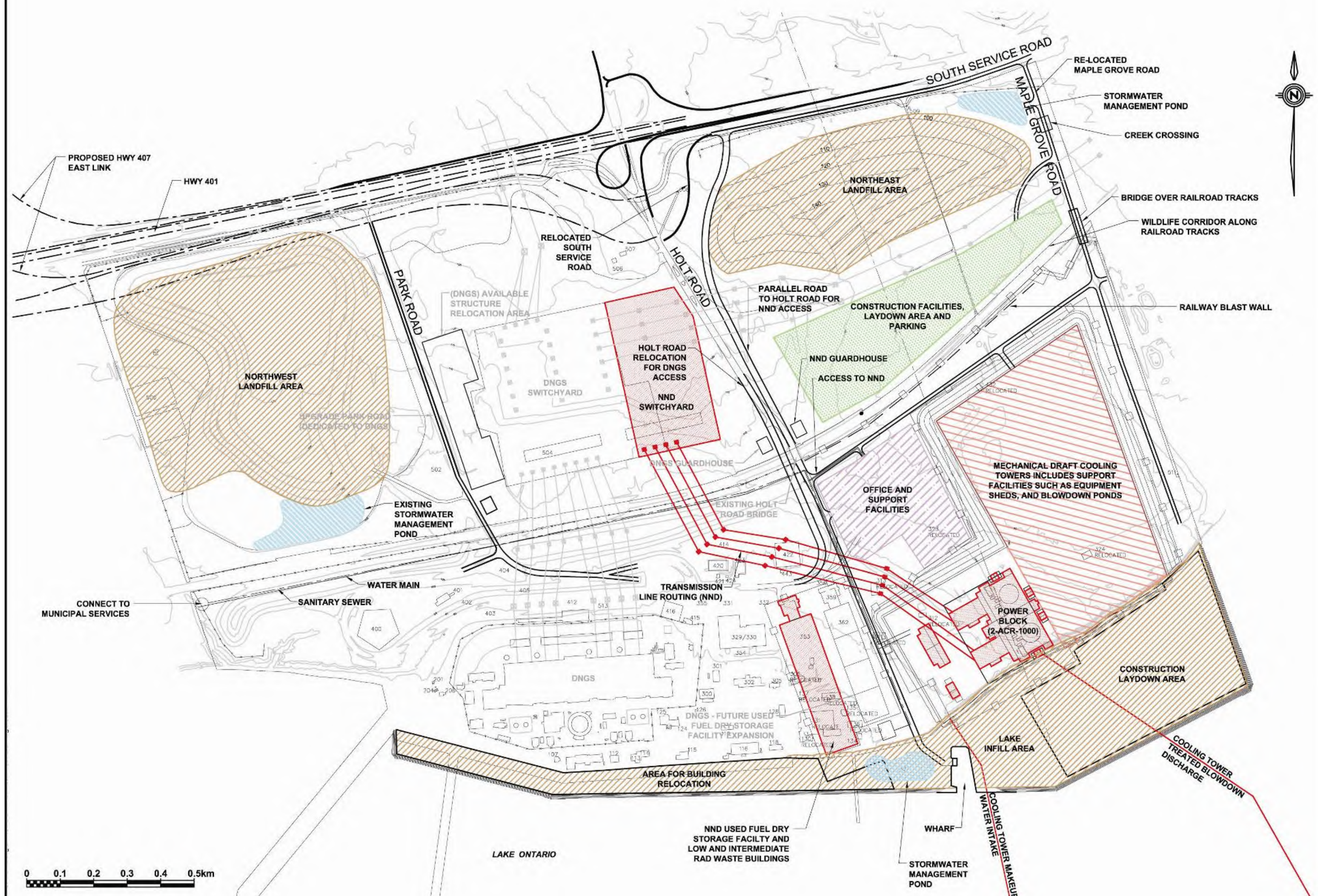
Date: September 2009

Project: 34500

ONTARIO POWER GENERATION

Figure 2.4-2

Model Plant Layout - Scenario 2: Two ACR-1000s with Mechanical Draft Cooling Towers



Date: September 2009

Project: 34500

ONTARIO POWER GENERATION

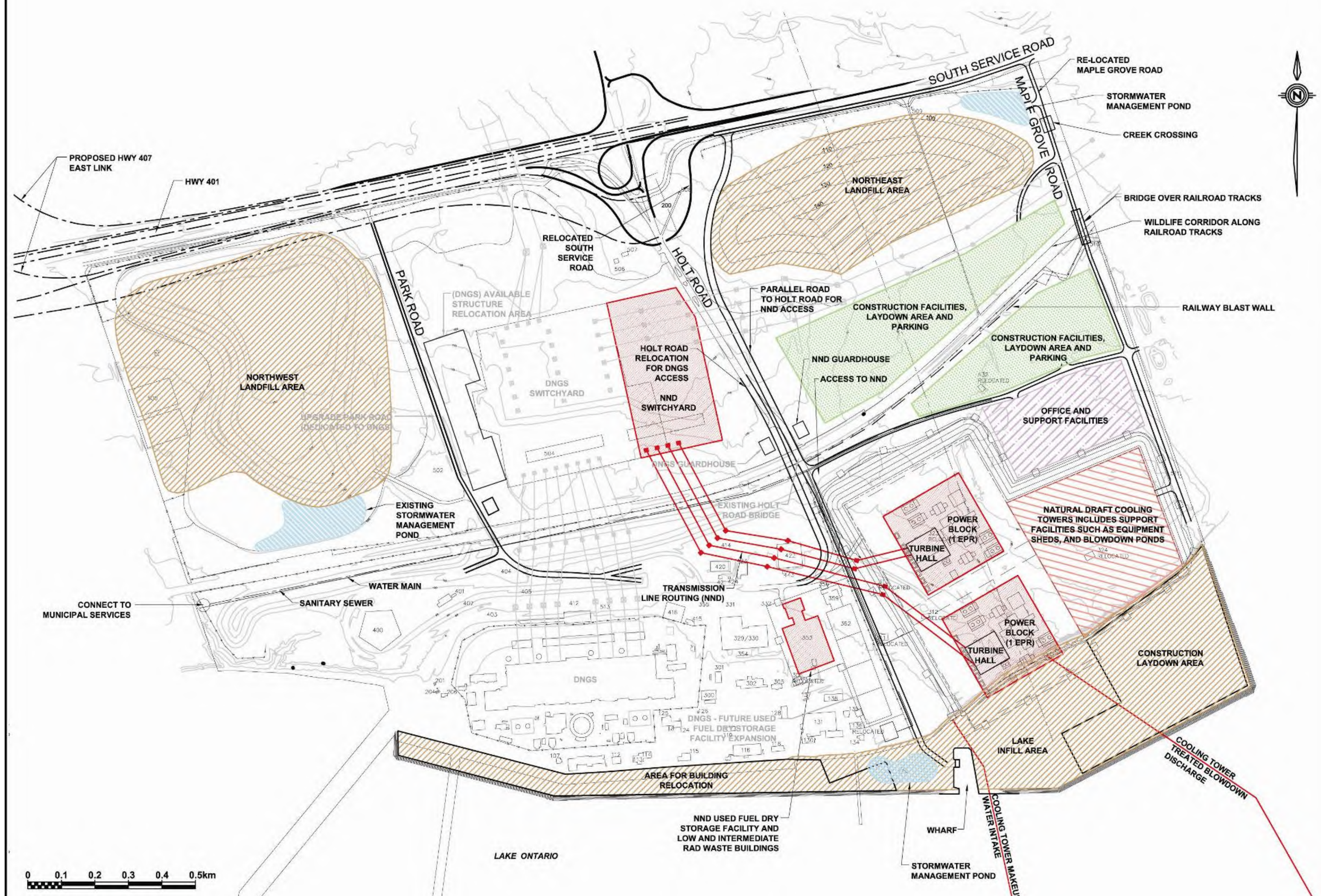


Figure 2.4-3

Model Plant Layout - Scenario 3: Two EPRs with Natural Draft Cooling Towers

Date: September 2009

Project: 34500

ONTARIO POWER GENERATION

FIGURE 2.4-4
Conceptualized Timeline for NND Project

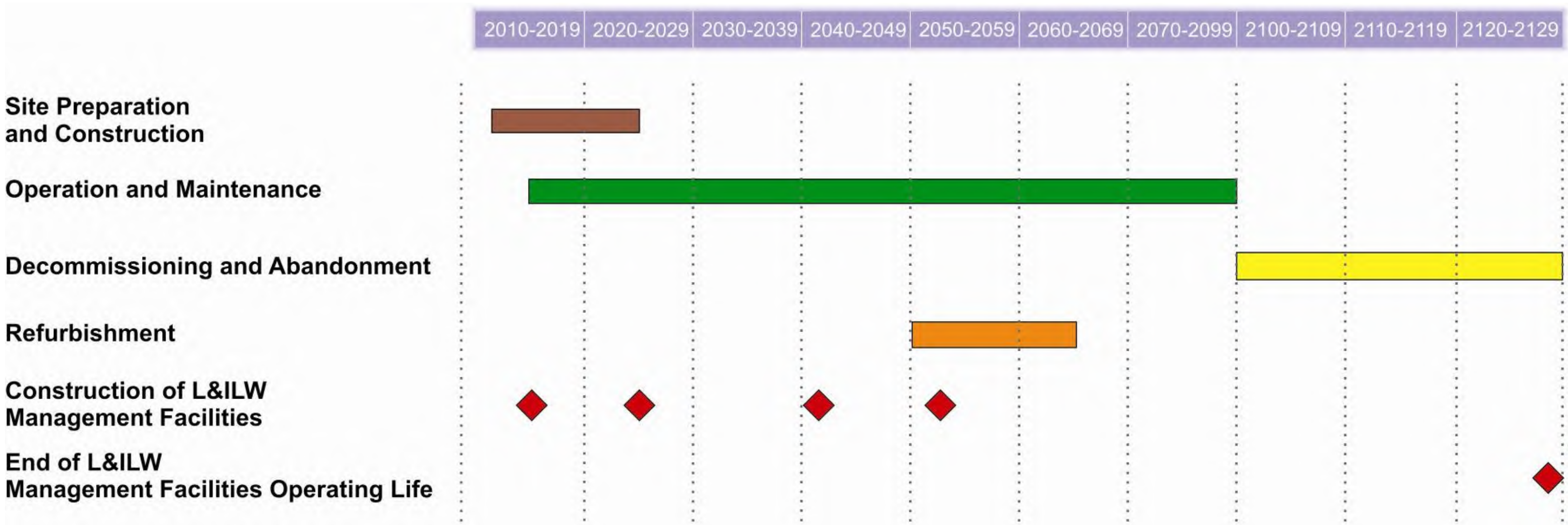
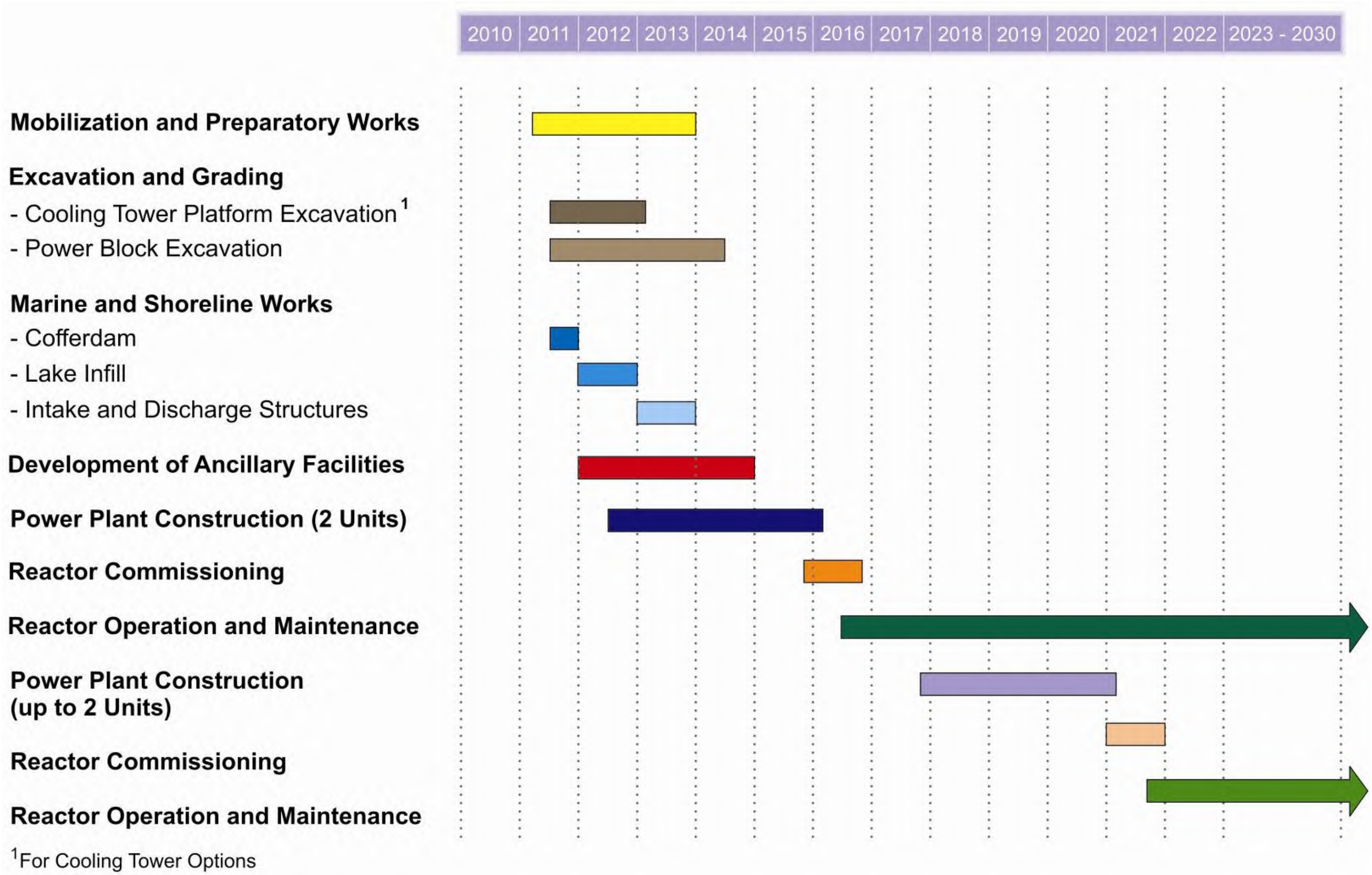


FIGURE 2.4-5
Conceptualized Timeline for Key NND Project Works and Activities



2.5 Site Preparation and Construction Phase

Because the type and number of reactors and the method of condenser cooling have not yet been determined, a bounding site development layout is considered in the EIS (the bounding site development approach is described in Section 2.4.2). Also of note is that should the maximum reactor build-out occur, it is likely that their construction would be phased over time. For EA purposes, it is assumed that two reactors will initially be constructed although the schedule for the second will slightly lag behind the first. As such, the first reactor will become operational as the second reactor is being constructed and/or commissioned. Management facilities for L&ILW will be required at the time the first reactor goes into service and the approximate in-service date for processing and dry storage facilities for used fuel associated with NND is 2025. However, this EA considers full build-out; therefore, site preparation and construction activities are described for the maximum complement of units and associated facilities.

The Site Preparation and Construction phase of the Project is described in terms of the various individual works and activities that collectively represent the complete implementation of the work associated with that phase. These works and activities are the basis for the assessment of effects. They are described in a summary manner in the following sections. A complete description of each work and activity is described in the *Scope of the Project for EA Purposes Technical Support Document.*

The principal works and activities associated with the Site Preparation and Construction phase are:

Site Preparation Works and Activities

- Mobilization and Preparatory Works;
- Excavation and Grading;
- Marine and Shoreline Works;
- Development of Administration and Physical Support Facilities;

Construction Works and Activities

- Construction of Power Block;
- Construction of Intake and Discharge Structures;
- Construction of Ancillary Facilities;
- Construction of Radioactive Waste Storage Facilities;

Common to Site Preparation and Construction Works and Activities

- Management of Stormwater;
- Supply of Construction Equipment, Material and Plant Operating Components;
- Management of Construction Waste, Hazardous Materials and Fuels and Lubricants; and
- Workforce, Payroll and Purchasing.

For assessment purposes, it is assumed that the entire site will be prepared for construction at the outset of the Project. This is a bounding assumption for site preparation activities since it represents the greatest amount of related work in the shortest period of time. This assumption also recognizes that the greatest potential for environmental effects associated with site preparation and construction activities is directly related to the area of physical disturbance and the quantity of material to be excavated, handled and disposed. The bounding site development layout considers the physical aspects (e.g., excavation quantities) and land area requirements for the maximum power production and the various condenser cooling options. It assumes that the entire area of the DN site east of Holt Road will be disturbed by the site preparation and construction activities and that up to 12.4 million cubic metres (Mm^3) of soil and rock will be excavated.

For purposes of the EA, it is also assumed that all existing features, structures and residual conditions (e.g., legacy contaminated soil) within the area proposed for the Project, that are associated with, or resulting from DNGS activities will be addressed in advance of this Project.

2.5.1 Mobilization and Preparatory Works

<u>Mobilization (Construction Workforce and Equipment)</u>

The initial, and an ongoing, activity, will involve mobilization of equipment and the construction workforce to the site. Following mobilization, the daily movement of workers and equipment to and from the worksite will be ongoing throughout the Site Preparation and Construction phase and related aspects of it will be represented within other works and activities (e.g., Construction Material and Operating Equipment Supply; Workforce, Payroll and Purchasing).

The physical aspects of mobilization will involve the establishment of parking areas for staff and equipment, service areas for construction offices and equipment storage; construction-phase fencing for security and safety; security/guardhouse and reception facilities.

Clearing and Grubbing

Vegetation within areas of future construction will be removed. A variety of methods including the removal of trees by truck, chipping of smaller vegetation and grubbing with a dozer or excavator will be used to remove vegetation. Marketable wood products will be salvaged and removed from the site by truck. Stumps and roots will be transported to off-site disposal or placed in a designated on-site spoil area. Where possible, material will be recycled.

Environmental effects management measures will be applied during the work (e.g., minimizing the area to be cleared to the extent feasible and complying with seasonal constraints and regulatory requirements for clearing operations). Appropriate measures will be taken to protect habitat and other environmental and on-site recreational features in areas outside the working limits (e.g., adequate flow into, and water quality management of, Coot's Pond will be maintained to protect the current habitat function of the pond; to the extent practicable, access for movement on the existing east-west wildlife corridor will be maintained during construction activities and enhanced during operations; while access to the on-site portions of the Waterfront Trail may be lost because of public safety concerns, it will be restored when site preparation activities are complete).

Installation of Services and Utilities

Installation of services and utilities will include both the temporary services and utilities required during construction and the permanent services and utilities required to support operations. Wherever possible, utilities and services will be installed to accommodate the needs of both the construction and operation phases. Utilities and services will include: fuel depot for trucks, and other equipment; electrical services; potable water; sanitary sewage collection infrastructure discharging to a municipal water pollution control plant; telephone service; public address system; and temporary as well as permanent (e.g., around the site perimeter) fencing. Excavation to install services is included in other earthmoving activities.

Good Industry Management Practices will be incorporated into all aspects of servicing the DN site. Of particular regard will be the design and installation of fencing systems to reduce incidence of bird entanglement; and of lighting systems to reduce bird strikes and to reduce the extent of unnecessary illumination into off-site areas.

Development of Roads and Related Infrastructure

Development of roads and related infrastructure will involve improvements to existing, and construction of new, on-site features to allow access into, and movement throughout, the site.

This will include local access roads, a new rail siding on the DN site (if required) and parking facilities to accommodate workforce-related and other traffic during both construction and operation phases.

The existing access point into the easterly portion of the DN site at Maple Grove Road will be relocated to the DN site east boundary and will be constructed as a two lane heavy duty roadway to act as construction access for the Project. This relocated road will require a crossing at Darlington Creek and a new bridge over the Canadian National Railway (CNR). A new road dedicated for NND access will be constructed parallel to the existing Holt Road and this road will also require a new bridge crossing at the CNR. The existing Holt Road access will remain in service as a dedicated access for DNGS.

For EA purposes, it is assumed that off-site parking facilities may be used with workers transferred to the NND via shuttle-buses. It is reasonably anticipated that any such off-site parking would be at existing facilities (i.e., not at greenfield locations) and accordingly, for EA purposes the bounding case (i.e., for traffic studies) is that all workers will commute to the DN site.

2.5.2 Excavation and Grading

Excavation and Grading will comprise all earth and rock-handling activities including earthmoving and grading, rock excavation and development of construction laydown areas. Excavation and grading activities will be limited to the DN site. All cut and fill slopes, particularly those adjacent to off-site properties and the lakeshore bluff areas, will be shaped and constructed in a manner that will prevent instability in off-site areas. Appropriate protocols will be developed in advance of the work and Good Industry Management Practices followed to mitigate potential associated effects. These protocols and practices will address issues including soil/rock environmental quality characterization to plan for appropriate handling and disposal strategies; dust and noise control (Dust and Noise Management Plans will be prepared); and erosion and sediment control (stormwater management). In addition, the design for grading and contouring of the site will optimise reasonable opportunities to incorporate natural visual screening features (e.g., soil berms, plantings) into the completed topography.

The bounding site development layout involves the excavation and handling of approximately 12.4 Mm^3 of soil and rock. Of this, 4.5 Mm^3 will be placed in the Northeast Landfill Area and approximately 1.2 Mm^3 placed in and adjacent to the existing DNGS soil stockpile in the northwest quadrant of the DN site (i.e., Northwest Landfill Area). Approximately 3 Mm^3 will be placed as lake infill, and the remainder, about 3.7 Mm^3, will be transported to off-site disposal within 25 km of the DN site. As indicated, the bulk of the soil, and some rock, being excavated will be placed in the proposed Northeast Landfill Area and to a lesser extent, at certain portions of the Northwest Landfill Area (if re-opened). Constructions wastes and hazardous materials will be sent to appropriate off site waste management facilities for disposal

Excavator and Off-Highway Truck (Caterpillar Inc. 2008)

<u>On-Land Earthmoving and Grading</u>

During site preparation activities, effectively all land areas east of Holt Road will be disturbed to a large extent. Soil and like materials within areas of construction will be excavated and graded by means of suitable earthmoving equipment (e.g., excavators and trucks). The earth material will be excavated from areas of earth cut and transferred to areas of earth fill. Earth cut materials in excess of earth fill requirements will be transferred to the designated spoils disposal areas (Northeast Landfill Area, Northwest Landfill Area), used as lake infill (see below) or transported to off-site disposal.

On-site soil handling practices will include measures to minimize surface erosion and dust generation (e.g., minimize surface area of active operations; stabilize surfaces in inactive areas and completed works; suspend work during adverse weather conditions; apply appropriate dust suppression procedures) and to control related aspects including noise and vehicle emissions.

Current design planning anticipates possible placement of surplus excavated soil in the area of the Northwest Landfill. The area immediately west of this landform is thought to include a cemetery (Burk Pioneer Cemetery). If it is determined necessary for soil placement to encroach into the area occupied by the cemetery, the cemetery will be closed in accordance with the provincial *Cemeteries Act* and all remains re-interred in a local cemetery. The presence of this cemetery and its possible closure as an in-design feature of the Project is further discussed in

Section 5.10. OPG will also address decreased levels of service for the soccer fields stakeholders should there be any effects.

Transport of Surplus Soil to Off-site Disposal

Should it be necessary to do so, surplus soil will be transported to disposal at an off-site location(s). The material may be used to rehabilitate extraction pits and quarries or other development sites, or similar beneficial use. OPG will also explore opportunities for use of this material on other construction projects. For example, it is anticipated that construction of Highway 407 and its East Link to Highway 401 may require substantial quantities of borrow material, some or all of which may be provided from the NND Project. The soil will be transported using highway-licensed vehicles at an estimated rate of 200 trips per day during the Site Preparation phase. The destinations for this material have not yet been determined and transport routes for the material will depend on the receiving destinations ultimately selected. However, regardless of the final destination for this material, it is reasonably assumed that east-west routing will utilize Highway 401; and for purposes of the EA, Holt Road is identified as the likely northbound route. A Traffic Management Plan, including elements to address nuisance effects (e.g., dust, noise) will be developed and implemented to reduce transportation-related effects of the off-site soil transport activities.

Rock Excavation and Grading (Drilling, Blasting, Boring)

Rock Excavation and Grading will involve the excavation and grading of rock and like material, and associated activities such as drilling or blasting to facilitate its excavation and transfer to fill areas (e.g., lake infill, Northeast and Northwest Landfill Areas). Drilling and blasting operations will consist of drilling into the rock mass by pneumatic means (e.g., compressors, track-mounted drilling machines, jack hammers), and the placement and detonation of explosive charges to displace and fragment the rock. Given the very close proximity of the DNGS, blasting operations will be rigidly controlled to prevent effects on its operations and it can reasonably be expected that there will be no noticeable ground motion or vibration in areas beyond the DN site. A Noise Management Plan, including provisions, as necessary, to alert area residents in advance of blasting operations, will be instituted.

Development of Construction Laydown Areas

Construction laydown areas are specific locations developed as staging areas for contractor operations and storage areas for construction equipment and materials. Laydown areas will be graded (see Excavation and Grading), temporarily fenced, and surfaced, depending on function, with granular material or asphalt.

2.5.3 Marine and Shoreline Works

Marine and Shoreline Works includes all works and activities conducted within or adjacent to Lake Ontario such that they are likely to interact with the marine and aquatic environment. Marine and shoreline-related works and activities will include those described below. Good Industry Management Practices and full compliance with applicable regulatory requirements will be maintained throughout these activities to control sediment/silt releases into the lake and any associated environmental consequence.

<u>Lake Infilling and Shoreline Protection</u>

Cofferdam Construction for DNGS

Lake infilling and shoreline protection will extend from the easterly limit of the DN site to approximately the DNGS intake channel; and about 100 m into the lake on its western limit to approximately 450 m on its most easterly dimension. Lake infilling will create a new landform of approximately 40 ha. The lake infill operation will begin with the construction of a low-permeability coffer dam on its outer perimeter to contain the deposit lake infill materials and isolate the area from lakewater intrusion. Although cofferdams are constructed using different techniques, the principles are similar in that a low-permeability core is placed to control the water inflow into the dammed area, following which an embankment is placed over the core to provide long-term integrity. The core would typically consist of low-permeability soils or compacted granular materials, driven or vibrated steel sheeting, or drilled caissons. The overlying embankment would typically consist of an appropriate soil or graded granular with a protective surface to prevent erosion and failure of the dam. For some temporary installations, an overlying embankment may not be placed because of the short-term nature of the structure.

The cofferdam for DNGS was constructed using crushed rock and it is reasonably assumed for EA purposes that the cofferdam required for this Project would be similar. The cofferdam will consist of appropriately graded crushed rock end-dumped into the lake from both ends of the lake infill area and compacted to form a competent engineered structure. Armour stone or similar revetment will be placed by crane on the lake side of the dam. Any fish within the area to be dammed will be directed out of the work area by progressive seining and other appropriate means as the dam is placed. Once the cofferdam is complete, the water contained within it will be pumped out and discharged to Lake Ontario (taking measures to control sediment discharge to the Lake). The material placed within the cofferdam to create the new landform will originate on-site and be placed as part of the Excavation and Grading activity.

Construction of Wharf

A wharf will be developed in a portion of the lake infilled area likely in front of the power block. The cofferdam in the vicinity of the wharf area will have been configured to accommodate the wharf and its function as a receiving dock.

The wharf will be used during construction for off-loading oversize and over-weight components and its construction will be appropriate for this purpose. The wharf may ultimately be retained as a permanent facility.

Lake Bottom Dredging

Dredging activities are expected to be minimal, but may be required at the point where the cooling water intake tunnel opens to the lake bottom, at the locations of intake and outfall structures and potentially in the wharf and wharf-approach areas. Any such minor dredging will involve conventional equipment designed and operated for the designated purpose (hydraulic and/or mechanical). All dredged sediment will be offloaded and disposed of in accordance with applicable regulations.

2.5.4 Development of Administration and Physical Support Facilities

Administration and support facilities comprise various buildings housing staff, equipment and operations necessary to provide ongoing operational support to NND. These will include offices, workshops, maintenance, storage and perimeter security buildings, and utilities operating centres. All such buildings will consist of conventional steel and masonry structures containing typical mechanical and electrical components for minor processing, comfort and amenities, and ventilation.

2.5.5 Construction of Power Block

Construction of CANDU-6 Nuclear Power Plant at Qinshan, China
using Liebherr LR1600/175- Very Heavy Lift Crane
(Rixin and Petrunik 2003)

The power block includes the reactor building, the generator building/turbine hall (powerhouse) and related structural features that are physically associated with them. Development of the power block includes the installation of all power generation equipment within it, including the reactors, primary and secondary heat transport components, and all powerhouse components including turbines, generators, heat exchangers, pumps and standby power systems. Preparation for construction of the power block will be completed during the Site Preparation phase of the Project. Supply of construction materials and operating equipment to the site is included in the Construction Material and Operating Equipment Supply work and activity.

Foundations for the power block will extend into bedrock and may require drilling and blasting. Some elements of construction may be further supported on steel piles.

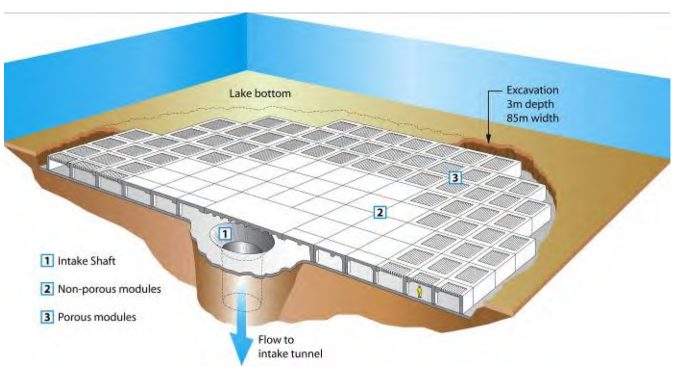
Above-grade construction will involve techniques typical of heavy industrial development. Placement will involve extensive use of heavy equipment, including heavy-lift fixed and mobile cranes. Installation of operating equipment will involve movement and placement of large and specialty components using various standard and extraordinary procedures, depending on the size and weight of the component.

2.5.6 Construction of Intake and Discharge Channels and Structures

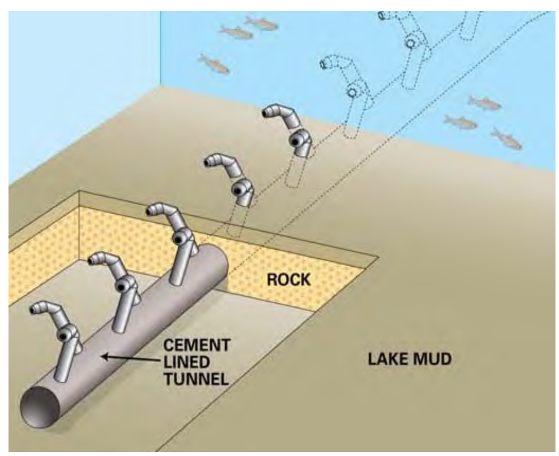
Intake and Discharge Tunnels and Structures for Once-Through Lakewater Cooling

Once-through lakewater cooling involves the withdrawal of water from Lake Ontario, its circulation through the condensers, and its return to the lake through an open-loop intake and discharge system. For EA purposes, the once-through cooling water intake and discharge structures at NND are assumed to be similar to the existing structures at DNGS, although appropriately sized to accommodate the associated water flow rates at NND. The DNGS intake is a 7.5-m diameter tunnel approximately 800 m long (from the forebay to the intake structure). The intake structure is embedded in the lake bottom with a network of porous and non-porous concrete modules covering the intake shaft. Water is drawn through three rows of porous modules on the periphery of the network. In contrast to an open pipe intake, the increased surface area of the modules through which the water is drawn reduces the velocity of the intake flow, with consequential reduction in fish impingement.

The DNGS discharge tunnel has a 9-m diameter face area and is approximately 1,700 m long. The discharge pipe includes a series of diffusers from which the water is discharged to promote rapid thermal mixing in the lake. Intake for the once-through lakewater cooling system will also include plant service water needs such that additional intake and discharge structures will not be required for service water.



DNGS Intake Structure
(OPG 2007)



DNGS Discharge Pipe and Diffusers
(OPG 2007)

The tunnels at DNGS were constructed using typical underground mining techniques involving blasting and excavation. Tunnels for once-through cooling water at NND may be constructed similarly or by boring using a purpose-built tunnel boring machine (TBM). Any underwater blasting operations will comply with applicable guidance to reduce incidental fish mortality. The intake and discharge structures will be located so as to avoid more productive nearshore habitats and spawning areas. The intake will be located at a minimum water depth of 10 m.

Intake and Discharge Structures for Cooling Tower Water Makeup

Although the water from both mechanical draft and natural draft cooling towers is recirculated, some make-up water is required to replace tower blowdown and other losses (e.g. evaporation). This make-up water will be drawn from Lake Ontario via intake and discharge pipelines. The open-cut drill-and-blast method is likely to be used to excavate trenches. Pipes will be placed in the trenches, and backfilled with granular materials and armour stone surface protection.

The trenches and pipes will be sized to consider the water volumes required and both the intake and discharge structures for makeup water will be substantially smaller than those required for once-through lakewater cooling due to the smaller associated water volumes. The discharge is assumed to be a single-port diffuser installed at a water depth of approximately 10 m. The intake and discharge structures for cooling towers will also be located so as to avoid more productive nearshore habitats and areas with potential for future spawning.

2.5.7 Construction of Ancillary Facilities

Ancillary facilities include all features necessary to support operations of the reactors and generation of electricity, although not physically associated with the power block. Clearing and grubbing and major earthmoving and grading to accommodate development of the ancillary features are included in the Mobilization and Preparatory Works, and the Earthmoving and Grading activities, respectively.

Expansion of Existing Switchyard

Expansion of the existing switchyard at the DN site will involve the physical enlargement of the footprint of the switchyard, and an increase to its electrical capacity to accommodate its use for NND and its connection to the existing electrical grid. The switchyard expansion will be within the area bounded by Holt Road and Park Road. Electrical switching and distribution equipment will be erected on concrete pads and footings. High voltage lines and bus bars will be installed to connect the power block to the switchyard, and the switchyard to the grid.

Cooling Towers – Mechanical Draft

Cooling by means of mechanical draft cooling towers involves a closed-loop system whereby water is drawn from the cooling tower, circulated through the condensers and returned to the tower(s) to be cooled. In the case of mechanical draft towers, fans are used to force air through (fan at bottom of tower), or to draw air through (fan at top of tower) the tower to promote the cooling process.

Construction of mechanical draft cooling towers will include the towers and the associated infrastructure to support their operation. The towers will be approximately 20 m in height above finished grade and their foundations will extend into bedrock and therefore, may require drilling and blasting. Some elements of construction may be further supported on steel piles. The cooling towers will be assembled at site using conventional methods and materials, primarily steel framing and concrete, with mechanical and electrical components.

Mechanical Draft Cooling Towers at Prairie Island, Minnesota
(Nuclear Tourist Web Site 2008)

Cooling Towers – Natural Draft

Cooling by means of natural draft cooling towers also involves a closed-loop system whereby water is drawn from the cooling tower, circulated through the condensers and returned to the tower(s) to be cooled.

Construction of natural draft cooling towers will include the towers and the associated infrastructure to support their operation. Up to two natural draft towers may be constructed for each unit (depending on the design). The towers will be the traditional hyperbolic shape and will extend to approximately 150 m above finished grade.

Natural Draft Cooling Tower at Nine Mile Point, NY
(Nuclear Tourist Web Site 2008)

Foundations for the cooling towers will extend into bedrock which may require drilling and blasting. Some elements of construction may be further supported on steel piles. The towers will be constructed of steel reinforced concrete with structural and mechanical and electrical components and will be erected by means of traditional construction methods (e.g., slip forming, crane lifts), and conventional construction materials.

Cooling Towers – Fan Assisted Natural Draft

Because they are a variation of the mechanical draft and natural draft cooling towers noted above, the physical characteristics and potential interfaces with the environment of fan-assisted natural draft cooling towers are bounded by the other cooling tower options that are addressed in the EA. Fan assisted natural draft cooling towers have a slightly larger base dimension than the natural draft cooling towers, and have fans placed around the base of the tower to increase the air flow rate. These towers have a hyperbolic shape similar to a traditional natural draft tower, but are only about one-third the height.

Fan Assisted Natural Draft Cooling Tower
(SPX Cooling Technologies 2008)

Cooling Tower Blowdown Ponds

For all cooling tower options, one or more ponds may be required to receive and treat blowdown from the towers. Blowdown is the portion of the circulating water flow that is removed in order to maintain the amount of dissolved solids and other impurities at an acceptable level. The ponds would be excavated into the ground surface and lined (e.g., with clay or synthetic materials) to ensure appropriate containment. The ponds will be sized to accommodate the required volume, and the water would be appropriately treated to comply with discharge water quality criteria, prior to discharge.

2.5.8 Construction of Radioactive Waste Storage Facilities

Management of L&ILW may be accommodated through new facilities on-site and/or transport to an appropriately licensed off-site facility. On-site radioactive waste storage facilities comprise used fuel dry storage facilities to process and house containerized spent fuel bundles following their removal from wet storage in the fuel bays, and L&ILW storage building(s). The facilities will consist of conventional steel and concrete structures containing typical mechanical and electrical components. For EA purposes, it is assumed that a processing and three storage buildings will be required (depending on reactor type) and that the first used fuel dry storage building for NND used fuel will be developed at about 2025. Storage for L&ILW will be required at the time the first reactor goes into service.

The preliminary safety assessment for the NND Project assumes that the waste processing and/or storage buildings for used fuel will be located at a distance of not less than 150 m from the DN site perimeter fence and south of the CN rail line. Should the vendor choose to locate these structures closer to the perimeter fence or north of the CN rail line, the safety assessment will be updated accordingly during the NND licensing process.

2.5.9 Management of Stormwater

As the site is developed, ditches and swales will be constructed to collect and convey surface water to stormwater management ponds and ultimately discharge to existing surface water courses or to Lake Ontario. Stormwater management features will be developed to address the requirements for runoff control both during site preparation and construction (temporary) and during operations (permanent).

To the extent practicable, stormwater management features will be designed and operated to reduce groundwater drawdown in areas north of the DN site; to promote recharge of surface water to the groundwater regime; and to contribute additional baseflow into Darlington Creek.

Stormwater management ponds will be developed as necessary and will be sufficient in number and size to provide adequate retention times for collected runoff in advance of its discharge to surface water. Protocols and physical features will be developed to ensure appropriate control of sediment transport, collection and treatment of dewatering flows, and collection and treatment of all water that will have come into contact with contaminants, including blasting agents.

Good Industry Management Practices will be applied to ensure that appropriate and effective stormwater control and management features are incorporated into all phases of the Project, and that all discharges from related facilities will meet applicable quality criteria. Wherever possible, stormwater management features will consider the needs of both construction and operation phases.

2.5.10 Supply of Construction Equipment, Material and Operating Plant Components

Supply of construction equipment, materials and operating plant components includes the delivery to the site of all necessary materials and components for construction of NND. While much of the material that will be delivered to the site will be via the road network, large components may be delivered by rail (to an existing rail siding on a neighbouring property and then transported overland to the site or to a new rail siding on the DN site); or by marine transport to a commercial port and then by barge to the new wharf.

Construction Equipment

Construction equipment comprises all mechanized and related equipment required to support construction. Heavy earthmoving equipment will be typical of large-scale construction projects (e.g., trucks, dozers, loaders, excavators, scrappers, graders, compactors).

Aggregate and Concrete

For EA purposes, it is assumed that mixed concrete will be provided by an off-site supplier operating on a nearby property or raw material will be delivered (sand, washed aggregate, cement etc.) and mixed on site in a dedicated concrete batch plant.

For assessment purposes it is assumed that a total of approximately 750,000-1,000,000 m^3 of concrete may be required for the complete four-unit station (as noted, however, only two units will be constructed at one time). It is further assumed that the maximum concrete delivery rate for NND would likely be similar to DNGS. At that time, the supplier was required to provide up to 150 m^3/hr of concrete over the course of a 16-hour day.

Delivery of imported crushed rock for cofferdam construction is estimated to be up to 200 trucks per day, based on the experience of the cofferdam construction at DNGS.

Manufactured Construction Materials

Construction materials will include items associated with site preparation (e.g., precast concrete structures, culverts and utility piping, fence), structural components for buildings and other facilities (e.g., fabricated steel products, masonry), mechanical and electrical components for buildings and facilities, and various sundry items (e.g., interior finish components). All manufactured construction materials will be delivered to the site via highway-licensed trucks travelling on provincial and municipal roads, by rail, or by barge. Aside from concrete, the largest single quantity of material that will be delivered to the site will be steel (rebar, structural steel, etc).

Plant Operating Components

Plant operating components are fixtures and components associated with an operating nuclear plant. These will include conventional items (e.g., pumps, turbines, electrical power systems) as well as those that are unique to nuclear plants (e.g., calandria). Most operating components will be delivered to the site via highway-licensed trucks travelling on provincial and municipal roads. Some oversize items will require special permits and transport provisions, and others are likely to be transported to the site by rail, and/or by marine transport to a commercial port and then by barge to the DN site.

2.5.11 Management of Construction Waste, Hazardous Materials, and Fuels and Lubricants

Construction Waste

Construction-related waste will be transferred from the site to disposal or recycling at appropriately-licensed waste management facilities. This activity does not include disposal of excavated spoil (see Excavation and Grading).

Hazardous Materials

Hazardous materials (e.g., solvents, chemicals, compressed gases) associated with site preparation and construction will be managed, including storage, use and disposal, in compliance with applicable legislation, codes and practices. These materials will include chemicals, cleaners, paint, aerosol cans and electrical components. Non-radioactive oil and chemical wastes will be removed from the site for disposal.

Explosives required for the rock excavation activities will be delivered to the site on an as-required basis by an appropriately qualified and licensed contractor. All use and management of explosives, including storage in on-site magazines, if required, will be in compliance with the federal *Explosives Act* and its regulations.

Fuels, Lubricants and Chemicals

Fuels and lubricants required for mechanical construction equipment will be delivered to the site in appropriately-qualified vehicles and/or containers, stored in purpose-built facilities, and dispensed and used, all in compliance with applicable legislation, codes and practices. Contingency plans for a detailed response system in the event of a spill will be developed.

2.5.12 Workforce, Purchasing and Payroll

Site preparation and construction will require a contractor labour force that will vary in size throughout the work based on the scope and nature of the activities underway at any given time. This activity will represent the daily transportation-related aspects of workforce commute as well as the economic aspects associated with payroll and construction-related capital purchases.

It is estimated that the labour force associated with the Site Preparation and Construction phase will peak in the early years of the Project (approximately 2012-2016), at approximately 3,800 workers, with some 300 involved in project management; and 3,500 in construction activities. Site preparation activities, would occur in advance of construction activities and would have a labour force of approximately 100.

In the later years of the Site Preparation and Construction phase, the construction complement may range from 1,750 to 3,500 workers depending on how many reactors are constructed. If two additional reactors are constructed, the Project related workforce would be approximately 5,200, which includes approximately 1,400 workers involved in reactor operation.

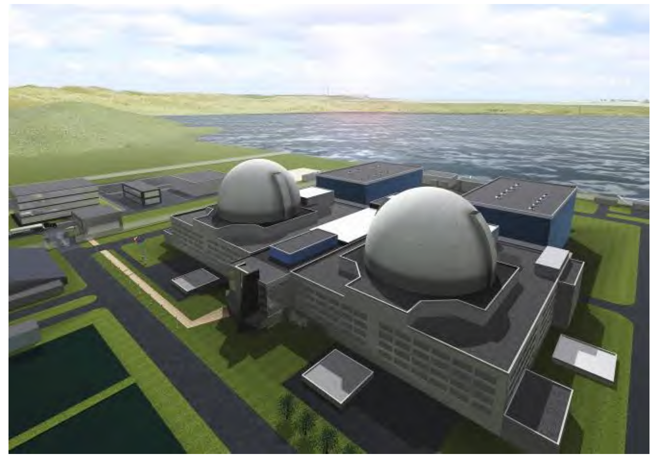
The above totals are all in addition to the DNGS operating staff of approximately 2,800. DNGS-related staff will increase by a further 2,000 workers during its refurbishment period (2016-2023). This will represent the maximum period for total DN site-related workforce when approximately 10,000 workers will be present on the DN site.

2.6 Operation and Maintenance Phase

As has been noted above, the reactors currently being considered for the NND Project are the ACR-1000, the EPR and the AP1000. Each of these reactors is described below in a framework of a common set of Operation and Maintenance phase works and activities. The description is presented in the context of systems and operating aspects with potential to interact with, and potentially affect, the environment and are, therefore, relevant to the EA. Complete details of this phase are provided in the *Scope of the Project for EA Purposes Technical Support Document*.

Atomic Energy of Canada Limited (AECL) - Advanced CANDU Reactor (ACR-1000)

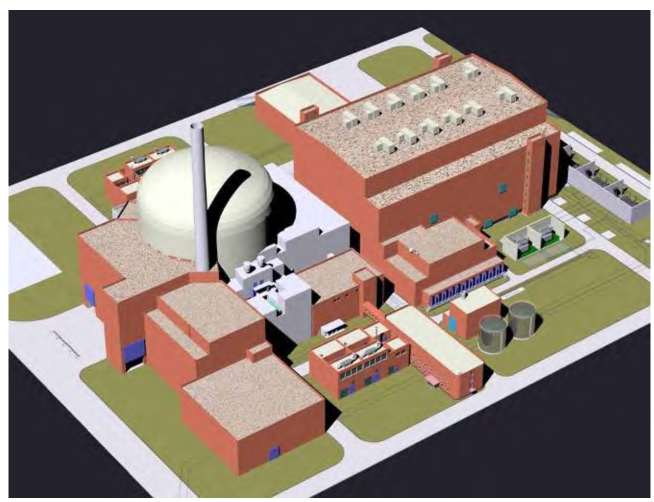
The ACR-1000 is a pressurized hybrid reactor (PHR) based on the CANDU technology currently in use in Canada and elsewhere. The reactor uses light water (H_2O) to cool the fuel and heavy water (D_2O) for the moderator. The reactor has a net electrical output of approximately 1,085 MW. It operates with low enriched uranium fuel (enrichment up to 2.5%).



ACR-1000 Two-Unit Integrated Plant Illustration
(See *Scope of the Project for EA Purposes TSD* for details)

AREVA NP - US EPR (EPR)

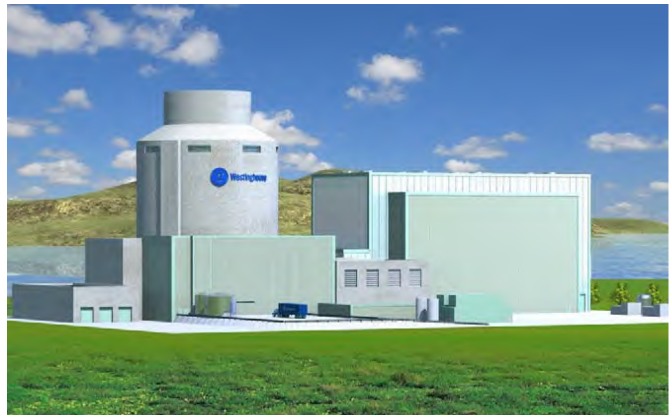
The EPR is a pressurized water reactor (PWR) with a rated electrical power of 1,580 MW (net). The reactor operates with enriched uranium fuel (enrichment up to 5%) and uses light water as the moderator and to cool the fuel.



EPR One-Unit Plant Illustration
(See *Scope of the Project for EA Purposes TSD* for details)

Westinghouse Electric Company LLC AP1000 reactor (AP1000)

The AP1000 is also a PWR and has an output of 1037 MW (net). It operates with enriched uranium fuel (enrichment of up to approximately 4.5%) and uses light water as the moderator and to cool the fuel.



AP1000 One-Unit Plant Illustration
(See *Scope of the Project for EA Purposes TSD* for details)

The Operation and Maintenance phase of the Project will commence with the receipt of the first load of fuel for the reactor and end when the reactor has been defuelled in preparation for decommissioning. For purposes of the EA, it is assumed that the reactors will operate for at least 60 years before decommissioning is required. Commissioning activities including start-up testing of systems and components, accompanied by the gradual increase in reactor power over a period of time are also part of the Operation and Maintenance phase. The environmental effects of commissioning activities will be bounded by the effects of operations and maintenance activities.

Maintenance, both routine and major, is also included in this phase of the Project. The general forms of maintenance performed include preventative maintenance, corrective maintenance and improvement or upgrade activities. Some maintenance can be performed with the reactor units at power, while other maintenance requires a unit outage. In addition to maintenance, routine surveillance and testing is required to ensure safe and efficient operation of the units.

Following are brief descriptions of each of the principal works and activities associated with reactor operation and maintenance. These are:

- Operation of Reactor Core;

- Operation of Primary Heat Transport (and Moderator) System;
- Operation of Active Ventilation And Radioactive Liquid Waste Management Systems;
- Operation of Safety and Related Systems;
- Operation of Fuel and Fuel Handling Systems;
- Operation of Secondary Heat Transport System and Turbine Generators;
- Operation of Condenser And Condenser Circulating Water, Service Water and Cooling Systems;
- Operation of Electrical Power Systems;
- Operation of Site Services and Utilities;
- Management of Operational Low and Intermediate-Level Waste;
- Transportation of Operational Low and Intermediate-Level Waste;
- Dry Storage of Used Fuel;
- Management of Conventional Waste;
- Replacement/Maintenance of Major Components and Systems (including refurbishment);
- Physical Presence of the Station; and
- Administration, Payroll and Purchasing.

As indicated in Section 2.4.1.1, the scenarios adopted to evaluate the potential environmental effects during the Operation and Maintenance phase of the Project consider the number of reactor units associated with the maximum generation capacity of 4800 MW(e) for the Project. The scenarios are:

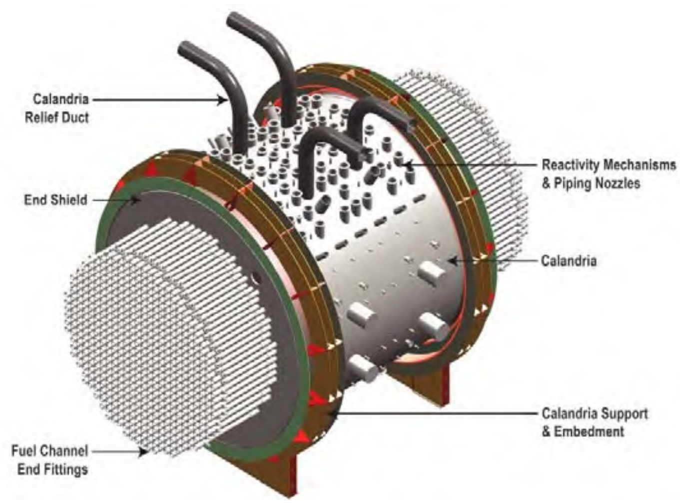
- Four ACR-1000s - generating a total of 4,340 MW (net);
- Four AP1000 reactors - generating 4,148 MW (net); and
- Three EPRs - generating 4,740 MW (net).

The assessment considers the potential effects associated with the multiple units as noted above. The EIS evaluates the three reactors currently under consideration by the Province of Ontario (i.e., the ACR-1000, the EPR and the AP1000) as representative of the range of operating and maintenance scenarios associated with a reasonable range of reactor types.

2.6.1 Operation of Reactor Core

The reactor consists of the reactor assembly and reactivity control devices. The reactor core is the starting point for the generation of energy and the source of radioactivity. This activity includes operation, start-up and shut-down. Considerations are in place to protect reactor core operation as the foremost source of radioactivity during a nuclear malfunction or accident.

In an ACR-1000, the reactor assembly comprises a cylindrical calandria vessel assembly, calandria tubes, fuel channel assemblies, and reactivity control units. The fuel bundles are arranged in horizontal strings in the fuel channel assemblies. The calandria vessel assembly supports and contains the calandria tubes, fuel channel assemblies, reactivity control units, and heavy water moderator. Demineralized light water fills the shield tank surrounding the reactor assembly which serves both as a radiation shield and as a cooling medium. The reactor core of the ACR-1000 is shown below.



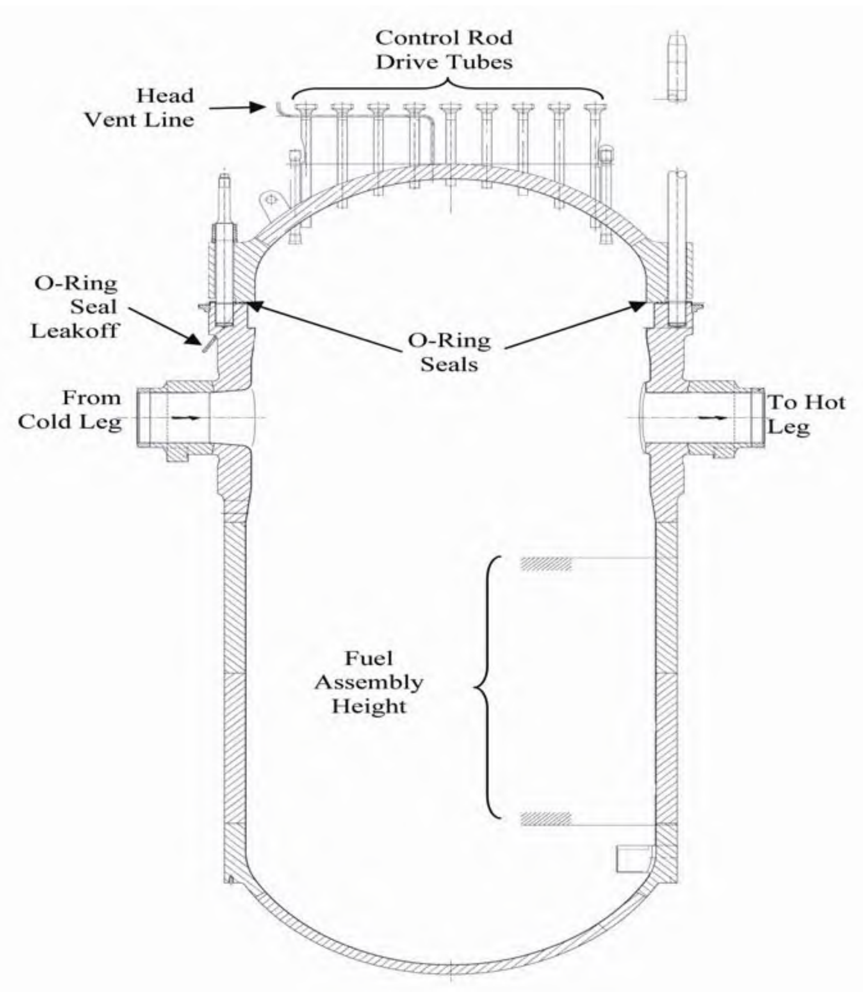
ACR-1000 Reactor Core
(AECL 2007a)

The reactivity mechanisms used in the ACR-1000 include control absorber units and zone control units, shutoff rods, and liquid poison. During normal operation and routine refuelling, the zone control units are used to control the reactivity in the reactor core. Under accident conditions, the reactor is shut down rapidly either by inserting the shutoff rods into the reactor core, or by injecting a neutron absorbing liquid "poison" (which works to reduce the reactivity in the core by absorbing the neutrons that cause the fission reaction) into the moderator water in the calandria.

In the EPR and AP1000 reactors, a pressure vessel contains vertically oriented assemblies of fuel rods. The reactor pressure vessel is designed to provide the volume required to contain the reactor core, the control rods, and the supporting and flow-directing internals. The fuel assemblies, containing various fuel enrichments, are configured into the core arrangement located and supported by the reactor internals. The reactor internals also direct the flow of the coolant past the fuel rods. The reactor pressure vessel for the EPR is shown below, and the vessel in the AP1000 reactor is similar in configuration.

In the EPR, the reactivity of the core is controlled at power by changing the boron concentration and/or inserting/withdrawing rod cluster control assemblies. The rod cluster control assemblies are also dropped into the core by the shutdown system when a fast shutdown is required. All rod cluster control assemblies are of the same type, consisting of twenty-four individual and identical absorber rods fastened to a common spider assembly. These rods are constructed of stainless steel tubing that contains neutron absorbing materials.

In the AP1000, the reactivity of the core is controlled at power by changing the boron concentration and/or inserting/withdrawing rod cluster control assemblies and gray rod control assemblies. These rods are constructed of stainless steel tubing, some of which contain neutron absorbing materials. Gray rod control assemblies are typically used instead of changing the boron concentration in the Reactor Coolant System when there are changes in demand for electrical power output from the reactor, because they eliminate the need for continually processing the reactor coolant to increase and then reduce boron concentration.



Schematic of the EPR Reactor Pressure Vessel (Framatome 2005)

2.6.2 Operation of Primary Heat Transport System

The function of the Primary Heat Transport System (also referred to in the EPR and AP1000 reactors as the Reactor Coolant System) is to move heat from the reactor core to the steam generators. This system will generate L&ILW such as filters and ion exchange resins (see Management of Operational Low and Intermediate Level Waste). Maintenance of the Primary Heat Transport System includes periodic chemical cleaning of the steam generators and replacement of parts during refurbishment. Water losses are captured under the ventilation and active drainage Project works and activities. For all of the technologies, the chemistry of the reactor coolant is controlled by filtering, ion exchange, and chemical addition. For all technologies, the pressure and volume control system is used to maintain pressure and inventory in the Primary Heat Transport System.

In an ACR-1000, the Primary Heat Transport System circulates light water (H_2O) through the reactor fuel channels to remove the heat produced by the fission of uranium fuel within the fuel bundles. Coolant from the fuel channels passes to one of the four steam generators where the heat is transferred to the secondary side to generate steam to turn the turbine rotors and attached generator rotor.

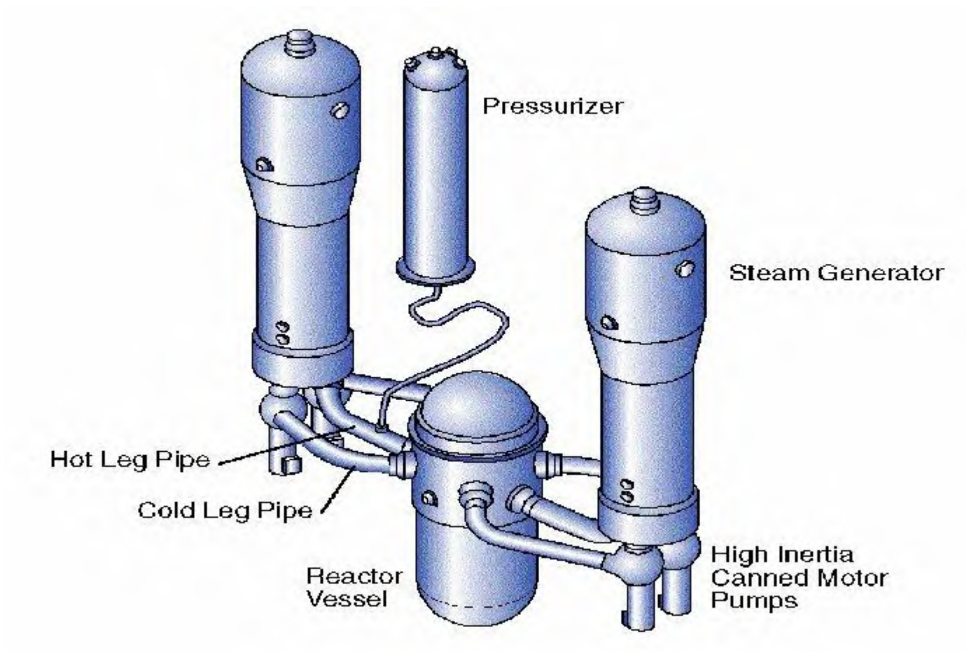
In an EPR, core cooling and moderation are provided by light water at high pressure. Soluble boron is injected into the coolant as a neutron absorber. The coolant is circulated through four cooling loops, each containing a steam generator where the heat is transferred to the secondary side to generate steam to drive the turbines. As the boron in the coolant water is irradiated by high-energy neutrons, tritium may be produced in the coolant.

The AP1000 reactor uses two cooling loops instead of four, and therefore, uses only two steam generators. The remainder of the system is similar to that of the EPR. As an example, the AP1000 Primary Heat Transport System is shown below.

<u>Moderation</u>

The moderator acts to slow down the high energy neutrons released by fission in the reactor core to promote further fissions, permitting the controlled, sustained nuclear reaction. In the PWR designs, this function is performed by the water in the Primary Heat Transport System. In the ACR-1000, this function is performed by a separate closed Moderator System containing heavy water (D_2O). The inventory and purity of the D_2O moderator is managed by the D_2O Supply System, the D_2O Vapour Recovery System and the D_2O Cleanup System. The D_2O will be upgraded at the site or shipped to an external D_2O upgrader to increase the proportion of D_2O to H_2O (increase the isotopic content) when needed.

As the moderator slows down high-energy neutrons, some neutrons collide with the deuterium atoms, creating tritium. In the case of the ACR-1000, moderator water may be transported within the DN site and processed at the existing DN site Tritium Removal Facility or be transported off-site to an appropriate licensed facility to remove tritium from the moderator water. For EA purposes, no credit is taken for tritium removal when estimating plant radiological emissions and doses.



AP1000 Primary Heat Transport System Schematic
(Westinghouse 2008)

2.6.3 Operation of Active Ventilation and Radioactive Liquid Waste Management Systems

Radioactive Liquid Waste Management

The Radioactive Liquid Waste Management System (RLWMS) collects, provides short-term storage, processes, and cleans the waste streams produced by drainage, purge, venting, or leakage from systems containing radioactivity. The active drainage system segregates liquid waste by the degree of contamination and directs it to the receiving tanks of the RLWMS. This system, also called the Liquid Waste Processing System in the EPR and the Liquid Radwaste System in the AP1000, receives and treats the waste streams directed to it by the active drainage systems. The system will discharge treated wastes at a controlled rate to Lake Ontario after treatment and stringent testing to confirm acceptable activity levels for release. The RLWMS will also ensure the discharged wastes comply with applicable chemical discharge criteria.

Radioactive Gaseous Waste Management

Gaseous wastes from potentially active areas, such as reactor buildings, will be monitored for activity before release to the atmosphere. The gases from the active ventilation stacks are filtered through HEPA and charcoal filters before being released, to minimize the release of radioactivity. In some cases, the release of active gaseous waste is delayed to allow for decay of short lived isotopes.

2.6.4 Operation of Safety and Related Systems

The concept of defence-in-depth is applied throughout the plant design to provide a series of levels of defence, including measures to prevent accidents and measures to provide protection in the event that prevention fails. The fundamental safety functions (Control, Cool, Contain and Monitor) are generally provided by redundant systems. The following discussion provides a summary of information regarding the safety systems; additional details can be found in the *Malfunctions, Accidents and Malevolent Acts TSD.*

The ACR-1000 has five primary safety systems: Shutdown System 1 and Shutdown System 2, which provide emergency safe shutdown capability for the reactors, the Emergency Core Cooling System, which supplies emergency coolant to the reactor, the Emergency Feedwater System, which provides an additional source of water to the secondary side of the steam generators, and the Containment System that acts as an envelope around the nuclear components of the Heat Transport System.

The EPR design includes four primary safety systems: the Shutdown System which drops the Rod Cluster Control Assemblies (RCCAs) into the core to provide rapid neutron absorption and reactor shutdown; the Safety Injection System and Residual Heat Removal Systems which provide emergency cooling; the Emergency Feedwater System which provides a source of water to the steam generators to cool the Reactor Coolant System when all the other systems that normally supply water to the steam generators are unavailable, and the Containment System.

The AP1000 reactor includes four primary safety systems: the Reactor Trip System that is initiated automatically in the case of the reactor approaching an unsafe operating condition; the Passive Core Cooling System which is designed to provide emergency core cooling; the Containment System which is a steel vessel surrounded by a concrete shielding structure; and the

Passive Containment Cooling System which provides for the removal of heat from the containment vessel using water and airflow.

2.6.5 Operation of Fuel and Fuel Handling Systems

All three of the reactor designs use fuel that is enriched in the U-235 isotope, up to 5% enrichment. The enrichment level and configuration of the fuel differs based on the reactor class and the operational conditions of the core. A diagram of a fuel assembly for the ACR-1000 and the EPR is shown below. The fuel for the AP1000 is similar in configuration to the EPR fuel. Fuel will be shipped to the NND site in protective flame retardant containers. These containers are different in size and shape from those currently used at DNGS. New fuel will be shipped to the station at a rate sufficient to maintain reactor operation. Upon receipt, it will be placed into secure purpose-built storage facilities with design considerations to prevent out of core criticality such as high density racks with neutron absorbing material. Further information regarding the prevention of out of core criticality is included in Chapter 7.

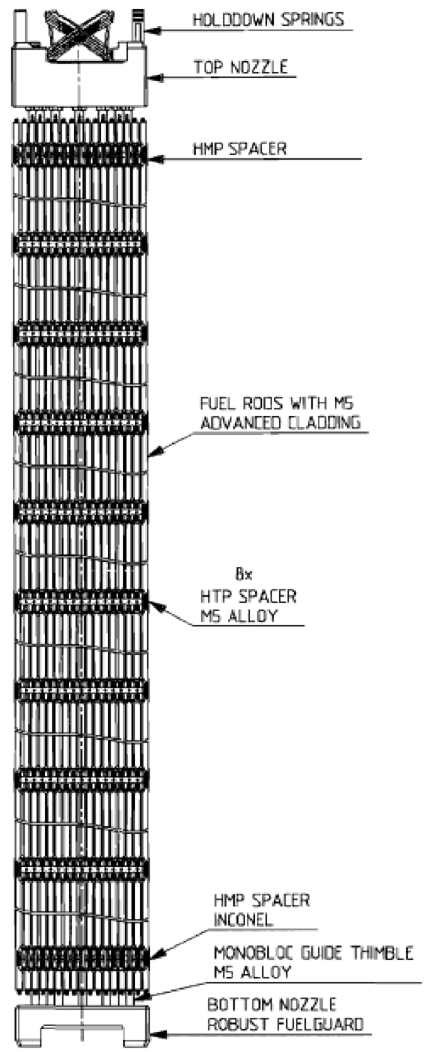
Refuelling of the ACR-1000 is performed on-power and remotely using two fuelling machines. Initially, one fuelling machine is loaded with new fuel. A fuelling machine is connected to each end of the fuel channel being fuelled. New fuel is inserted from one end of the fuel channel being fuelled, while the irradiated fuel is transfer to the other fuelling machine. End fittings and closure plugs are replaced and irradiated fuel is discharged to the used fuel bay. The fuelling machine provides cooling of the fuel until the irradiated fuel is discharged to the used fuel bay.

Refuelling of both the EPR and the AP1000 reactors is done during a unit outage. Initially, the reactor pressure vessel head, instrumentation and rod cluster control assemblies are disconnected. The reactor cavity, internals pool and fuel transfer pools are flooded with borated water to provide shielding for radiation and cooling. Fuel assemblies are remotely removed from the reactor pressure vessel by the fuel handling devices (used fuel mast bridge, transfer tube, and refuelling machine) and sent to the used fuel bay through the fuel transfer tube. New fuel assemblies are placed into the reactor pressure vessel by the refuelling machine. When the refuelling is complete, instrumentation and rod cluster control assemblies are reconnected, the reactor vessel head is fastened onto the reactor pressure vessel, and the borated water is drained.

For all considered reactors, once removed from the reactors, the used fuel is placed into a used fuel bay until it has cooled sufficiently for storage using an alternative means. This wet storage system, a part of the reactor facility, allows for fuel cooling for a period of up to 10 years. The design and location of the used fuel bay, as well as the number of pools required, is dependent upon the reactor technology and the level of fuel enrichment. A Used Fuel Bay Cooling and

Purification System is used to maintain chemical composition, volume, activity level and temperature of the water in the fuel bay at desired levels. Filters, ion exchange columns and heat exchangers may be used depending on the specific reactor design selected.

CANFLEX ACR Fuel Bundle. Source: AECL 2007b



EPR Fuel Assembly
(Framatome ANP, Inc. 2005)

2.6.6 Operation of Secondary Heat Transport System and Turbine Generators

The Secondary Heat Transport System consists of the secondary (shell-side) side of the steam generators, the main steam system, the turbines, condensers, condensate and feedwater systems. These systems are similar for the ACR-1000, EPR and AP1000 reactors. This system also includes the turbine generator oil supply and the associated fire suppression systems. Interactions with the environment resulting from this activity include oil leaks and water usage. The blowdown water from the steam generators is processed to remove impurities and then returned to the steam/feedwater cycle for reuse.

Each reactor has one turbine generator unit and associated auxiliary systems. Each turbine-generator unit is fully independent, operating in conjunction with its own nuclear reactor.

The function of the Secondary Heat Transport System is to transport the steam produced in the secondary side of the steam generators to the turbine set, causing the turbine rotors and the attached generator rotor to rotate. The function of the turbine generator is to use the mechanical energy generated by the spinning of the generator rotor to produce electricity. The specific configuration may vary by reactor design. Steam from the turbines exhausts into the condenser shells where it is condensed by cooling water (see Section 2.6.7, Condenser Circulating Water System) and is collected in the condenser hotwells. The condensate and feedwater systems collect the condensed steam from the turbine and supply it to the steam generators. External makeup to the closed loop steam and feedwater system is provided from the demineralized water storage tank. This configuration is independent of reactor technology selected.

The major turbine generator auxiliary systems include the sampling system, which permits sampling steam and feedwater for chemical analysis; the chemical control system, which eliminates the residual oxygen from the de-aerated feedwater and controls its pH; the turbine lube oil and generator seal oil systems, and the generator cooling system. These systems have different names depending on which reactor is being discussed but perform the same functions.

2.6.7 Operation of Condenser and Condenser Circulating Water (CCW), Service Water and Cooling Systems

The Condenser Circulating Water (CCW) System supplies water to the condenser tubes. The condenser removes the latent heat from the steam exiting the turbines, turning the steam back into water before it can be recirculated to the secondary side of the steam generators. Further, the large decrease in volume creates a vacuum in the condenser, which improves efficiency of the turbine. Options being considered for the configuration of the CCW System are once-through lakewater cooling; natural draft cooling towers; mechanical draft cooling towers; and fan-assisted natural draft cooling towers. More information on the physical features of the various cooling tower technologies is provided in Section 2.5.7.

The once-through lakewater cooling system draws water from Lake Ontario, pumps the water through the condenser tubes, and then discharges the water back to Lake Ontario. For all cooling tower technologies, makeup water is drawn from Lake Ontario to compensate for losses due to evaporation and blowdown. The blowdown flow is directed to blowdown ponds, where mineral and particulate impurities are removed as needed. Discharge will comply with appropriate criteria for surface water discharge to Lake Ontario. Withdrawal from the lake is at significantly lower rates than with once-through cooling, however, land use requirements are much greater with cooling towers because of the tower footprints as well as the areal requirements for blowdown treatment ponds.

Service water will be drawn from Lake Ontario and distributed to various systems. For the once-through lakewater cooling option, service water intake and discharge will be combined with the CCW system intake and discharge. For the cooling tower options, service water will be drawn from and returned into, the CCW closed loop and will not involve a separate service water discharge.

Demineralized water, plant intake and fire water will also be supplied from the forebay. NND will include two demineralized water plants, which process raw water to remove impurities. The specific configuration of the demineralized water plant will be dependent on the reactor technology selected and the specific water quality requirements for the reactor process systems and feedwater. In general, the process of demineralization consists of pre-treatment (filtration or reverse osmosis) followed by an ion exchange process. Wastewater from the demineralized water plant may contain residual treatment chemicals and will be sent to the inactive drainage system for treatment (clarification) and mixing with other liquid effluent streams prior to release to Lake Ontario. Waste streams that are considered to be hazardous waste will be retained and shipped to an appropriately licensed facility.

The inactive drainage system will collect waste water in various buildings (e.g., turbine building, waste treatment building, pumphouses). This wastewater will be treated as required to comply with discharge criteria prior to discharge to either surface water or sanitary sewer.

2.6.8 Operation of Electrical Power Systems

Electrical power systems deliver power to and from the grid, generate emergency power and distribute power throughout the station. These systems will be similar for all reactor technologies as their operation is independent of the reactor itself. Possible environmental interactions may include noise, spills or leaks from storage tanks (either coolant or fuel-containing) and air emissions from the generators. All fuel and oil storage tanks and transformers will be installed in compliance with applicable codes and regulations and will include secondary containment to prevent contaminant discharge to the environment in the event of operational leakage, spillage or tank failure.

Switchyard and Main Transformers

A switchyard located adjacent to the existing DNGS switchyard is used to connect the station to the grid transmission lines. Any required improvements to the grid beyond the switchyard will be done by Hydro One and are not part of the Project.

The main transformers and associated service transformers are oil cooled. Sulphur Hexafluoride (SF_6) switchgear may be used for the switchyard, similar to that used for DNGS, or modern equivalents.

Generation of Emergency and Standby Power

On-site standby diesel generators provide back-up power sources to specific station loads. The configuration of the diesel generators is similar for all reactor technologies. Each reactor unit has several diesel generators.

2.6.9 Operation of Site Services and Utilities

Sewage System

The sewage system collects domestic waste (i.e. water from washrooms, showers and other domestic uses) throughout the complex and discharges it into the Regional Municipality of Durham sewage mains.

Stormwater Management

Design and development of stormwater management features has been described in Section 2.5.9. These systems will function and be maintained throughout the service life of the Project to meet the design objectives and comply with applicable regulatory requirements with respect to flow and quality parameters.

Domestic Water

The station domestic water system will be supplied from the Regional Municipality of Durham water mains. Considering that the source and routing of the domestic water are all separated physically from other water systems used at the station, there is no potential for radioactive contamination of domestic water supplies.

Domestic water may be used in the fire protection system where permitted by code. Alternatively, firewater will be drawn from Lake Ontario.

Compressed Air System

The compressed air systems consist generally of instrument air, service air, and breathing air. The instrument air system supplies compressed air for air actuated valves, air lock seals, and various other uses. The service air system provides a source of compressed air for air operated tools during maintenance activities. The breathing air system is supplied to face masks and plastic suits for breathing and body cooling, for work areas that may contain airborne radioactivity.

Heating and Ventilation

The heating and ventilation systems provide the appropriate environment for equipment and personnel working inside the plant and prevent equipment and line freezing during plant shutdown in the winter. Steam, electricity, and hot water are used for heating. Heat is provided by unit heaters or by hot water produced by a steam-water heat exchanger, normally supplied with steam from the turbine or alternatively from the auxiliary boiler system. Ventilation and air conditioning is provided by appropriate mechanical systems provided to control temperature, moisture and atmospheric conditions as needed for employees and station equipment.

On-Site Transportation

Development of the on-site roads network has been described in Section 2.5.1. This network will function throughout the service life of the Project. Routine maintenance will be performed to ensure performance standards are met on a continuing basis. Maintenance will involve grading and replenishment of granular surfaces and shoulders, rejuvenation, including replacement, of asphalt surfaces, winter plowing, and cleaning and reconstruction of ditches and other drainage features (e.g., maintenance holes and catch basins).

Other Auxiliary Systems

NND will include a dedicated on-site laundry facility for cleaning protective clothing and other applicable items. Other auxiliary systems will include: communication systems, site security facilities, auxiliary and service buildings, lighting systems and fencing. As will be the case for the installation of systems and services, Good Industry Management Practices will also be applied in their operation. These will include strategies to reduce potential effects on terrestrial biota and visual aesthetics associated with site lighting; and to reduce potential for entanglement of birds and other biota in perimeter and security fencing.

2.6.10 Management of Operational Low and Intermediate Level Waste

The operation and maintenance activities for the selected reactor will produce quantities of low level radioactive waste (LLW) and intermediate level radioactive waste (ILW). Examples of typical L&ILW include ion exchange resins, filters, rags, mops, floor sweepings, tools and clothing that become contaminated as part of operation and maintenance activities. The type and activity levels of this waste can be expected to be similar to that currently produced at DNGS and other existing OPG reactors. L&ILW will be managed in a similar manner regardless of the reactor selected.

For EA purposes, two options are considered for L&ILW:

- On-site management with appropriate packaging and interim storage in modular storage buildings, including compaction of a portion of the LLW. Eventually, the waste would be transported to an appropriate facility off-site for long-term management; and

- Transport off-site of the un-processed waste to an appropriately licensed off-site facility, (e.g., the Western Waste Management Facility – WWMF)) for processing, packaging and storage. Eventually, the waste would be transferred to an appropriate facility for long-term management. Transportation of the waste to the licensed off-site facility is included in the scope of this EA, but further off-site processing and storage is not within the scope of this EA.

On-site storage is assumed to be in "standard" low-level storage buildings, similar to the several Low Level Storage Buildings (LLSBs) that have been progressively brought into service at the WWMF since 1982. Each LLSB will have a nominal capacity of 7,000 m^3 and a segregated area for the ILW.

2.6.11 Transportation of Operational Low and Intermediate Level Waste to a Licensed Off-Site Facility

Transportation of L&ILW to the WWMF or another licensed facility and transportation of other radioactive materials, such as tritiated heavy water, will be carried out in accordance with the *NSCA* and its Regulations and other applicable regulations (e.g., as made under the *Transportation of Dangerous Goods Act)*. OPG has been safely transporting such wastes and other radioactive materials for over 35 years and they will apply this experience and expertise to this Project. All transportation will comply with OPG's existing, approved systems and processes and any additional transportation packages required for new waste streams will be designed, licensed, and procured following existing processes and meeting applicable CNSC and Transport Canada regulations. As is current practice, OPG will meet any requirements to advise and update appropriate emergency responders along transportation routes.

2.6.12 Dry Storage of Used Fuel

Used fuel will be stored in the used fuel bay (alternatively referred to as irradiated or spent fuel bay) for approximately 10 years after being removed from the reactors. After this initial decay period, the used fuel will be moved to dry storage containers that will be processed and stored in a Used Fuel Dry Storage (UFDS) Building developed within the DN site (the UFDS Building may be developed as an independent facility or as an expansion to the existing DWMF). Storage requirements will differ between the ACR-1000 and the two Pressurized Water Reactor technologies due to differences in fuel characteristics.

There are two potential systems for the dry storage of ACR-1000 used fuel:

- AECL MACSTOR - consisting of above-ground, air cooled storage modules, with the fuel placed into canisters and transferred from the used fuel bay storage in a reusable shielding cask, to the MACSTOR modules that are typically located on an engineered surface in an un-enclosed secure area. MACSTOR is similar to systems that AECL has deployed at Gentilly 2, Korea, and Romania. Eventually, the fuel would be transported to an appropriate facility off site for long-term management; and

- OPG Dry Storage Container (DSC) - consisting of reinforced concrete and stainless steel vertical containers with a removable sealing lid. When filled with up to 384 fuel bundles, the DSCs are placed into storage in an enclosed building facility similar to those currently in use at the Darlington, Pickering and Western Waste Management Facilities (DWMF, PWMF and WWMF). The DSCs would be modified as required to accommodate the ACR-1000 fuel bundles.

The fuels from the AP1000 reactor and EPR are similar both physically and radiologically. Three basic technologies are in wide use globally for dry storage of PWR fuels.

- Metal casks - consisting of solid metal casks suitable for transport or storage. The casks typically hold 24 to 40 PWR fuel assemblies. The casks may be stored either indoors (common in Europe) or outdoors on a simple concrete pad (common in the U.S.). For EA purposes, a standard cask size of 32 fuel assemblies has been assumed as a reasonable average to calculate storage space requirements;

- Concrete canister - consisting of an outer vertical concrete shield with an inner steel liner. The steel liner is loaded in the fuel bay and then transferred to the canister in a re-usable shielding cask. The inner steel liner typically has a welded closure. The concrete shield has integral air channels for convective cooling. The canister is generally located outdoors on a concrete pad and is not moved; and

- Concrete module - consisting of an outer horizontal concrete shield vault with an inner steel liner. The steel liner is loaded in the fuel bay and then transferred to the concrete module in a reusable shielding cask. The modules are ganged together to improve the shielding efficiency and are also stored outdoors.

The specific containers selected for dry storage of used fuel at NND will be selected to suit the chosen reactor technology and licensed for their function prior to use.

2.6.13 Management of Conventional Waste

The generation of non-radioactive (i.e., conventional) wastes will be minimized to the extent practicable through re-use and recycling programs. Typical of such programs are the following:

- Waste is minimized through re-use to the extent possible;
- Waste and recyclable materials are separated both at source (e.g., office paper) and at designated collection/sorting points;
- Waste audits and management plans are developed and updated regularly; and
- Construction waste (e.g., brick, wood, scrap metal or concrete) is separated and dispatched to appropriate re-use facilities rather than to landfill.

All residual waste (i.e., that remaining after diversion programs) will be collected regularly by licensed contractors and transferred to appropriately licenced off-site disposal facilities and no waste disposal facilities will be established on the DN site.

Any hazardous (non-radioactive) wastes generated at the NND will be handled, including disposal, in accordance with applicable regulations.

2.6.14 Replacement / Maintenance of Major Components and Systems

Throughout the lifetime of a nuclear power plant, some systems and components will require maintenance, replacement or upgrading. A maintenance program for the plant will be developed to address issues related to ageing, wear and degradation. This program will include monitoring activities to assess the status of the station systems and components, and repair, replacement or refurbishment of components as needed. A portion of this work will require the unit to be offline for these maintenance activities to be completed. Typically, this work is done during a maintenance or refuelling outage that occurs once every one to three years, depending on station protocols and an assessment of needs. During these outages, the unit is placed in a shutdown state and pumps, valves, actuators, motors, and other like components that cannot be accessed while the unit is operational will be maintained or replaced. Additionally, design modifications or upgrades, including required safety enhancements, will be made at this time.

During the 60-year life of the station, specific reactor components and the steam generators may require replacement. In addition to the steam generators, refurbishment of the ACR-1000 may require replacement of pressure tubes, fuel channel assemblies, calandria tubes and feeder pipes in addition to the steam generators. The EPR and AP1000 reactors may require replacement of the reactor vessel head in addition to the steam generators. Each of these activities will require that the reactors be removed from service for a period of up to two years.

The replacement of the fuel channels, calandria tubes and feeders pipes for the ACR-1000 may require the installation of new fuel channel assemblies and calandria tubes in the reactor core. New feeder piping will also be installed. Prior to removal of the old components, preparatory tasks such as vault decontamination, removal of feeder cabinet and reactor face insulation, installation of shielding and the installation of additional services to support the work (e.g., communications) will be undertaken. It is expected that volume reduction techniques such as cutting and crushing will be used for pressure tubes, calandria tubes and feeder piping prior to placement in appropriate containers and storage in the L&ILW storage facilities.

The EPR and AP1000 may require the replacement of the reactor pressure vessel head as part of refurbishment activities. To complete this task, the reactor would be shut down and cooled. With the containment structure intact, the fuel is removed from the reactor and placed into the used fuel bay. After de-fuelling, an opening is created in the containment structure for removal of the reactor pressure vessel head and installation of the new one. Upon switch-out of the pressure vessel heads, the containment structure would be re-sealed and the new pressure vessel head connected to the mechanical structures of the reactor vessel and tested prior to restarting the reactor.

Steam generators would likely be removed from the reactor building intact, with any openings capped to prevent the release of loose radioactive contamination. It may be necessary to create an opening in the roof or side of the reactor containment structure to remove the steam generators using heavy lift cranes. New steam generators would be shipped to the site (by rail or barge) and installed in place by reversing the removal procedure.

Replacement of reactor components will take place within the reactor containment structure. Some reactor components may require decontamination using a chemical process, prior to replacement. Shielding and automated tooling will be used where feasible to reduce worker dose. These materials will be placed into suitable containment packages for transfer to the waste storage facility. All L&ILW from refurbishment will be transferred to a purpose-built facility on-site or transported to an off-site licensed facility.

The final element in terms of component and systems maintenance is the placement of the reactors into safe storage. Preparation for, and safe storage of, a reactor will occur prior to decommissioning, as part of the Operating Licence. For purposes of the EA, one or more units could be taken out of service and placed into safe storage while others are still operating. The Project Decommissioning phase (which is discussed further in Chapter 12 of this EIS) would begin after a decision is made to cease operating the last unit in the station.

In preparing for safe storage, the reactors will be defueled and dewatered, and non-fixed external surface contamination will be removed from accessible areas of the station. During the safe storage period, resident maintenance staff will perform routine inspections and carry out preventative and corrective maintenance. An environmental surveillance program will be carried out to ensure that potential releases to the environment are detected and controlled.

It is reasonable to expect that the emissions and doses during the period in which the unit is in a safe storage state will be less than those of an operating unit. Therefore, the potential environmental effects associated with units in a safe storage state are bounded by those of the other activities in the Operation and Maintenance phase.

2.6.15 Physical Presence of the Station

When complete, NND will exist as a functioning nuclear power plant comprised of up to four individual reactors. A realistic frame of comparison is the neighbouring DNGS which also includes four reactors. The greatest potential difference between the new facility and the existing station are the cooling towers that may be included as an alternative to the once-through cooling which is used for DNGS. From a physical presence perspective, natural draft cooling towers would be the more dominant of the cooling tower options, with several towers likely, each extending to a height of as much as 150 m above finished grade. A visible steam plume would routinely be associated with cooling tower operation.

As illustrated in the bounding timeline (Figure 2.4-4), NND will exist as an operating station for approximately 60 years per reactor, following which it will undergo a decommissioning process for a further 40 – 50 years. During operations, used reactor fuel will be stored on-site in water-filled bays for a period of several years, following which it will be removed from the bays, repackaged into dry storage containers and placed into on-land storage, also on-site, for a period of up to several decades.

2.6.16 Administration, Payroll and Purchasing

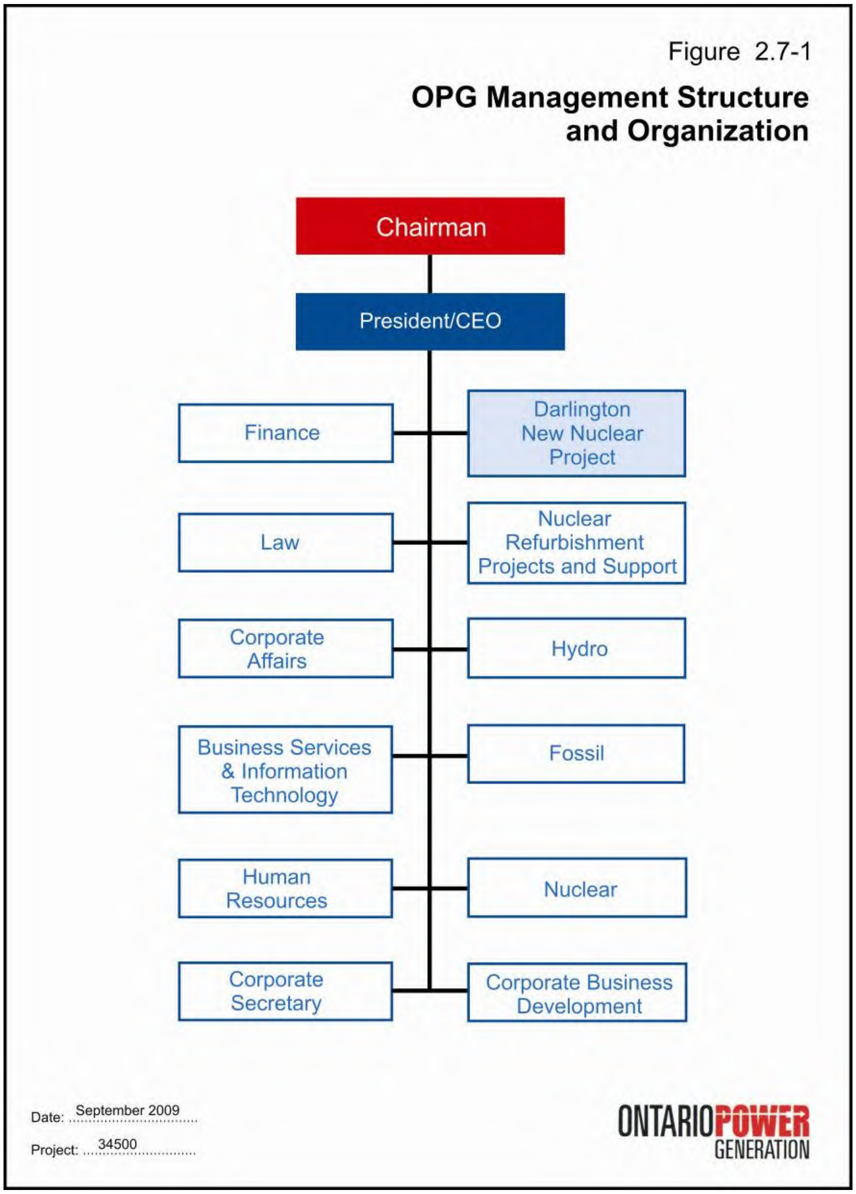
This activity will represent the daily transportation-related aspects of workforce commute as well as the economic aspects associated with payroll and capital purchases. The administration of the station will increase the annual taxes paid by OPG. OPG estimates that it will contribute approximately $2.7 million in annual taxes for two reactor units and $5.4 million for four units.

The labour force associated with the Operation and Maintenance phase will involve an estimated 1,400 workers once units 1 and 2 are operational in about 2016 and grow to double that (2,800 workers) when units 3 and 4 are operational in about 2025. During the period 2018-2024, the workforce involved in operations of units 1 and 2 will overlap with the workforce associated with construction of units 3 and 4.

The Project-related workforce will increase from the normal complement of 2,800 by a further maximum of 2,000 workers during NND refurbishment, expected during the period 2050-2065. The above totals are all in addition to the DNGS operating staff of approximately 2,800.

2.7 Management Structure and Organization

As one of the largest producers of electricity in North America, OPG is headed by a Chairman, and a President who is also the Chief Executive Officer. Reporting to the President are a number of Executive and Senior Vice-Presidents who are responsible for various aspects of the company’s activities related to Darlington New Nuclear Project, Business Services and Information Technology, Nuclear Refurbishment Projects and Support, Finance, Human Resources, Hydro, Fossil, Nuclear, Law, Corporate Secretary, Corporate Affairs and Corporate Business Development. This corporate structure is illustrated on Figure 2.7-1.



The following pages describes the management and organizational structures relevant specifically to the NND Project. Because of the unique aspects of the Project (i.e., construction followed by operation) the discussion is presented in a framework of its fundamental phases.

2.7.1 Site Preparation and Construction Phase

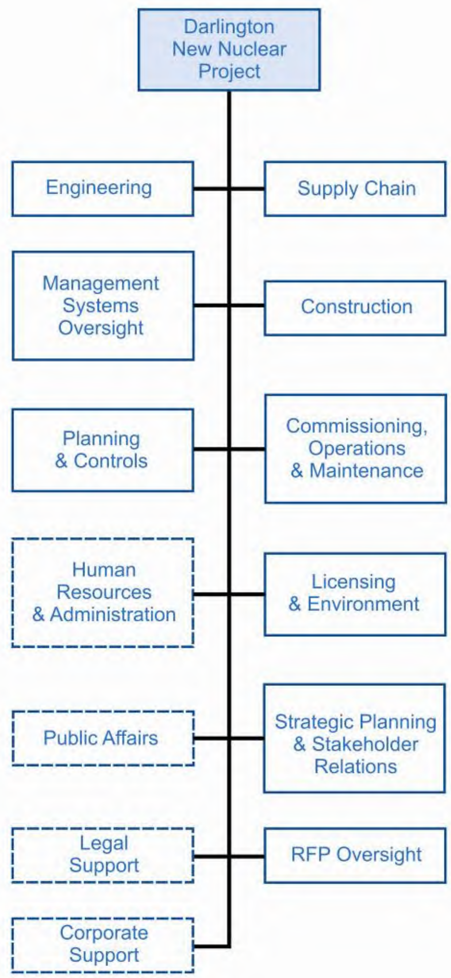
During the Site Preparation and Construction phase, OPG, as the proponent for the Project, will maintain overall responsibility for its development, although its primary function will be overseeing and monitoring the performance of the vendor in all aspects of design, construction, commissioning, turnover and construction phase closeout. The NND Project organization will also support Infrastructure Ontario which is managing the competitive commercial process (currently suspended) for selection of the reactor technology for deployment in Ontario (see Section 1.4.1). OPG's mission is to site, license and accept a new nuclear power station on the DN site that operates reliably at a high capacity factor for its expected life, and which meets all nuclear safety, environmental, health and safety, security, economic and quality requirements.

The operating model currently in place for this phase of the Project is one where the vendor will become the general contractor responsible for performance of the Project Agreement. OPG, as owner, will provide the overall direction, establish the performance requirements, and specify the requirements which must be met by the vendor. OPG will be the CNSC licencee and will retain full responsibility for ensuring that the site preparation, design, supply chain, construction, commissioning and initial operations meet all regulatory requirements. The vendor will be responsible for ensuring the Site Preparation and Construction phase of the Project is performed safely and that the facility will achieve the requirements specified by OPG.

The management and organizational structure relevant specifically to the Site Preparation and Construction phase is illustrated on Figure 2.7-2. The NND Licensing and Environmental organization is responsible for obtaining, with support from the vendor, the CNSC licences and undertaking the EA for this Project. Although the EA Department is coordinating the technical studies for the EA, it is supported by the Social Aspects and Environmental Assessments and Policy and Regulatory Affairs Departments, and many other organizations within OPG. Some of these include the Nuclear Waste Management Division, Nuclear Environment Programs, Darlington Environment, Darlington Public Affairs, Emergency Preparedness, and Nuclear Security. These organizations provide the oversight on the studies undertaken to ensure that they meet environmental, health and safety, security and quality requirements, and that the likely adverse environmental effects are identified and mitigated thus minimizing any risk to the environment. Once the EA is approved, OPG's objective will be to ensure that the vendor performs in a manner consistent with the commitments relating to mitigation measures and monitoring; and maintains Good Industry Management Practices throughout the Project.

Figure 2.7-2

DNNP Management Structure and Organization



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Note:

Organizations in dashed-line boxes represent corporate functions which support the NND Project.

Other organizations within OPG not specified also provide support (e.g., Nuclear Waste Management).

2.7.2 Operation and Maintenance Phase

OPG will have accountability for operation of NND in accordance with nuclear safety, health and safety, economic, environmental, security and quality requirements, including the implementation of environmental mitigation measures, environmental monitoring and management of potential adverse environmental effects.

It is anticipated that the operating licence, consistent with the licences for OPG's existing nuclear facilities, will include specific requirements to ensure that the operation of the nuclear facility will result in reasonable precaution against the potential risks to public safety, worker safety, the environment, and national security, and will ensure that all commitments made respecting safeguards are achieved.

Similar to OPG's well managed fleet of existing nuclear reactors, it is expected that NND will operate using governance appropriate for the selected technology to ensure the reactors are operated safely, and meet all regulatory requirements. A typical nuclear operational organizational structure has processes which include:

- Operations and Maintenance - including programs for operation, maintenance, radiation protection, fuel handling, chemistry and environment;

- Station Engineering - including components and equipment, performance engineering, reactor safety, engineering analysis and strategy, plant design, and station modifications;

- Support services - including oversight, nuclear waste, regulatory affairs, human performance, emergency response, supply chain, training, business and strategic planning; and

- Work management.

2.7.3 Refurbishment

OPG currently has in place an organizational structure and the processes to manage the refurbishment of its existing nuclear units. It is expected that when refurbishment of NND is contemplated, the organization would be similar to the current refurbishment organizational structure prior to implementation. A typical management and organizational structure includes:

- Licensing support;
- Planning and controls;
- Engineering;
- Nuclear safety;
- Human resources; and
- Quality management.

2.7.4 Decommissioning Phase

In the event a nuclear unit or station is no longer viable to operate and a decision is made to decommission it, a decommissioning program and organization will be established that will be consistent with the requirements delineated in CSA N286.6, Decommissioning Quality Assurance for Nuclear Power Plants. The preliminary NND decommissioning plan is provided in Chapter 12 of this EIS.

2.7.5 NND Project Governance

Good business practices, OPG's mission and vision statements, code of ethics, and legal, regulatory, licensing, and commitments recognize that there are hierarchical authority and administrative levels associated with safe and ethical conduct of a successful business. In meeting this mission, the NND Project organization has developed and implemented its own management system, based on CSA N286.05 Standard, with associated governance, for the Site Preparation and Construction phase of the Project to provide assurance that the associated activities will be carried out in accordance with OPG's policies, and applicable laws and standards.

Governance for NND during the Site Preparation and Construction phase has been developed to include a Charter, Program documents, procedures and where necessary, instructions for carrying out selected OPG processes that need particular rigour to ensure objectives regarding nuclear and conventional safety, environmental protection, quality, budget, schedule, minimal impact on existing operations and stakeholder relations are achieved. The combination of Governance, Project Charter, Project Execution Plan, and Project Organization comprise the NND Management System.

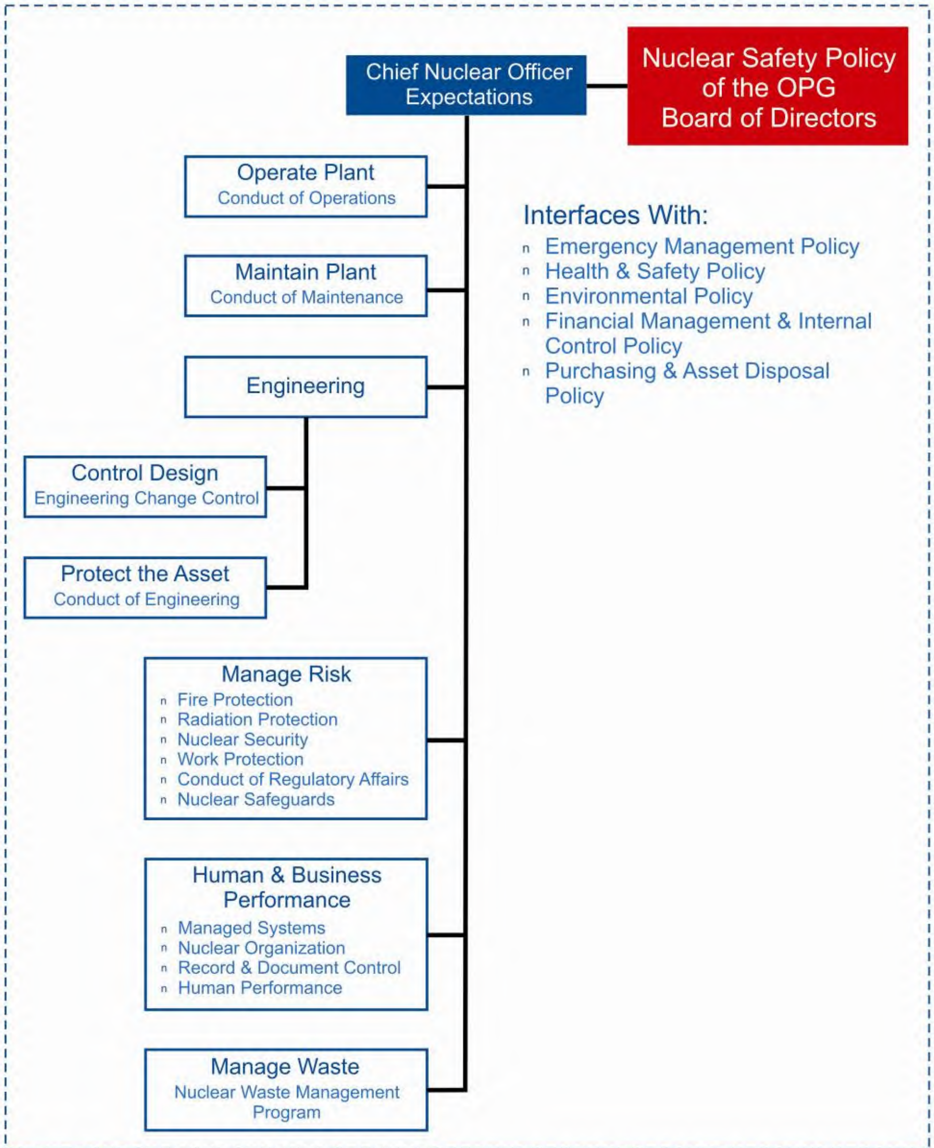
The NND Project organization has also developed Environment Program governance which provides the framework for ensuring that environmentally-related activities performed by OPG and the vendor will satisfy the requirements of OPG's Environmental Policy, Project Agreement, the EA, as well as obligations of the Host Municipality Agreement or other agreements that may be struck. OPG will ensure that the vendor, its contractors and its suppliers perform their activities in a manner that is consistent with the commitments made in this EIS, and in accordance with appropriate environmental management programs that will be required of the vendor. As the NND Project evolves, specific procedures will be developed for use by OPG staff to demonstrate that the approvals, licenses and permits and other requirements of applicable environmental law obtained by the vendor for its site preparation or construction activities are appropriate and sufficient.

For the Operation and Maintenance phase, it is expected that the existing or a modified governing document framework similar in intent to the Chief Nuclear Officer Expectations will be established, where the reactors will be operated and maintained using sound nuclear safety and defence-in-depth practices. Figure 2.7-3 illustrates the areas under which OPG has established policies, programs, standards and other controlled documents to ensure that systems, equipment and activities are of the required quality throughout their lifespan.

The existing governance ensures radiological risks to workers, the public, and the environment are as low as reasonably achievable, and in keeping with OPG Nuclear Safety Policy and the best practices of the international nuclear community. The existing quality program assures that safety-related systems, structures, and components and nuclear fuel are designed, procured, fabricated, installed, operated, and maintained in accordance with applicable regulations and standards. Sound and rigorous processes will be implemented, and all work activities will be planned and controlled to maintain plant configuration and condition within the design basis. Changes that could impact nuclear safety will be assessed and implemented in a controlled manner.

Figure 2.7-3

Extracts From OPG Existing Nuclear Governing Document Framework



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2.8 Security and Safety Programs

Security and safety programs will be developed based on applicable standards and good nuclear industry practices which exist at the time they are developed. These programs will likely include similar elements to the OPG programs currently in place at the reactor sites. A description of the programs established by OPG such as the Security and Safeguards Program, Radiation Protection Program, Occupational Health and Safety Program (non-radiological), Fire Protection Program and Emergency Response Program are provided as illustrations of the types of programs that will be applied at the NND.

As a Class 1 Nuclear Facility, NND will be obligated by regulation to ensure appropriate security systems are in place, meeting the CNSC's security requirements. OPG already has extensive fire protection and emergency response systems and plans in place at the DN site and these will be modified and expanded as necessary to meet the needs of NND.

2.8.1 Security and Safeguards

The EIS Guidelines require that information of a general nature be included in the EIS regarding facilities and systems for maintaining the security of the station, with the exception of prescribed information. Prescribed information in the *NSCA* and its Regulations is defined as information that concerns security arrangements, security equipment, security systems and security procedures established by a licensee in accordance with the *NSCA*. Disclosure of such information is restricted. Accordingly, the following description of these systems is limited and general in nature. Major aspects of these systems are described briefly below.

<u>Security</u>

Security procedures include staff training, positive identification of personnel, verification of documentation, physical searches, visitor escorts, and background checks. Physical barriers, monitoring devices and surveillance systems constrain and monitor activity at the DN site.

Security at the DN site is maintained by security staff including a force of appropriately equipped and trained security officers responsible for day-to-day operations, maintenance staff who ensure the condition and upkeep of the security infrastructure, Armed Nuclear Response Force Officers, and engineering staff who are responsible for system surveillance.

Safeguards

In 1970, the Treaty on the Non-Proliferation of Nuclear Weapons (IAEA 1970) was established. Canada was one of the first countries to ratify the treaty and accept IAEA inspection at its nuclear facilities. Power reactor operating licences typically require OPG to take all necessary measures to facilitate Canada's compliance with any applicable Safeguards agreement.

OPG reports and provides information to the CNSC as required. OPG also discloses to the CNSC, the IAEA or an IAEA inspector, any records required to be kept or any reports required to be made under a Safeguards agreement. Also, in accordance with the requirements of the Treaty, OPG provides access and assistance to IAEA inspectors for the purpose of verification of the declared nuclear material inventory, as well as the installation and maintenance of IAEA monitoring equipment. The IAEA Safeguards equipment includes surveillance cameras, fuel bundle counters, fuel verifiers and core discharge monitors.

2.8.2 Radiation Protection

As is the case at existing operating stations, it can be expected that its operating licence will require that OPG operate and maintain NND in compliance with the policies and procedures prescribed in the OPG documents entitled *Radiation Protection Policies and Principles* (OPG 2000c) and *Radiation Protection Requirements – Nuclear Facilities* (OPG 2001d). These radiation protection requirements have been developed within a broad framework of radiation protection within OPG and the principles which address the concept of "As Low As Reasonably Achievable" (ALARA). The following sections describe the radiation protection policies and requirements currently in use at OPG nuclear facilities and which were designed to meet the requirements of the operating licence and protect the health and safety of workers and the public.

2.8.2.1 Radiation Protection Policy

OPG is committed to the radiation safety of its employees and the public. This commitment is evident in the comprehensive and effective radiation protection program present at all its nuclear generating stations. Primary guidance for radiation protection is provided in OPG's *Radiation Protection Policies and Principles* (OPG 2000c). The policy identifies three governing objectives for the Radiation Protection Program:

- To prevent detrimental non-stochastic effects to employees and members of the public;
- To limit detrimental stochastic health effects (i.e. cancer, hereditary genetic effects) occurring in employees or members of the public to ALARA levels, social and economic factors being taken into account; and

- To provide a level of health and safety which is as good as, or better than, comparable safe industries.

Policies regarding accidents and mitigation measures are dealt with by different parts of the organization (safety assessment, risk assessment, emergency response, etc.).

To implement the objectives of the *Radiation Protection Policies and Principles*, OPG has a number of radiation protection programs that address specific aspects of radiation protection and ensure that they comply with corporate and legislated radiation protection requirements.

2.8.2.2 Radiation Protection Requirements

OPG's radiation protection requirements are enshrined in the document entitled *Radiation Protection Requirements – Nuclear Facilities* (OPG 2001d). They are summarized as follows:

- The Radiation Protection Program shall meet the intent of all applicable legislated and related regulations, and specifically the *NSCA* and its regulations. Those regulations set the limits for the doses to station staff and doses to members of the public from station-related activities. OPG also has derived dose limits for occupational exposures of staff that are more restrictive than the legislated requirements;

- Where specific applicable legislation or regulations do not exist, the program shall meet the intent of the recommendations of the International Commission on Radiological Protection (ICRP). The ICRP is an international organization that provides guidance on radiation protection and is widely accepted as the international authority on radiation protection issues;

- Radiation hazards shall be generally managed by adhering to the following basic directives in order of priority:
    - identification of hazards;
    - elimination of hazards where feasible;
    - control of hazards where they cannot be eliminated; and,
    - control exposures to acceptable levels.

- The Radiation Protection Program shall make provisions for radiation protection throughout the entire life cycle of facilities.

The *Radiation Protection Requirements – Nuclear Facilities* document also includes directives on other corporate mandates, personnel management, specific limits, facility design and operation, hazard and exposure management, radioactive material management, incidents and emergencies and information management.

2.8.2.3 Radiation Protection Program

The Radiation Protection Program implements a series of programs, standards and procedures for the conduct of activities within nuclear sites and with radioactive materials to achieve and maintain high standards of radiation protection including the achievement of the following objectives:

- Controlling occupational and public exposure:
  - Keeping individual doses below regulatory limits;
  - Avoiding unplanned exposures;
  - Keeping individual risk from lifetime radiation exposure to an acceptable level;
  - Keeping collective doses ALARA, social and economic factors taken into account.

- Preventing the uncontrolled release of contamination or radioactive materials from the nuclear sites through the movement of personnel and materials; and

- Demonstrating the achievement of the above through monitoring.

This program complies with the CNSC requirement that all licencees implement a radiation protection program, and establishes a quality program that meets the specific Canadian Standards Association (CSA) standards pertaining to radioactive contamination control and radiation safety.

2.8.3 Safety and Health Management System

As is the case at existing operating stations, it can also be expected that its operating licence will require that OPG operate and maintain NND in compliance with established safety procedures and practices. These practices and procedures are administered by OPG's Conventional Safety Section.

The Conventional Safety Section implements conventional health and safety policies, standards and programs. It implements risk assessment and controls for health and safety, and monitors the effectiveness of health and safety programs. The Conventional Safety Section also provides support for accident and incident investigations.

2.8.3.1 Occupational Health and Safety (Non-radiological)

NND will be subject to all provincially-legislated requirements with respect to health and safety in the workplace. Most notable among these requirements is the *Occupational Health and Safety Act (OHSA)*, R.S.O. 1990 and its associated regulations.

OPG implements its conventional health and safety program through an Occupational Health and Safety Management System (OHSMS). The objective of OHSMS is to ensure employees work safely in a healthy and injury-free workplace by reducing the risks associated with the activities, products, and services of nuclear operations to a value considered ALARA. Risk reduction is primarily achieved through the effective execution of operational controls and proper job planning.

This OHSMS complies with the British Standards Institution (BSI) Occupational Health and Safety Assessment Series (OHSAS) 18001:1999 Specification for OHSMS (BSI 1999). The 18001 Specification comprises seventeen elements that make up the systematic process for managing Occupational Health and Safety risks. This systematic approach is consistent with the Plan-Do-Check-Review principles within OPG Nuclear. The program implements governing documents that represent the framework for effective identification and control of conventional safety hazards.

Conventional health and safety is administered through a protocol hierarchy comprising the following elements:

<u>Policy</u>

The policy establishes the overall objectives of health and safety initiatives and defines the commitments and responsibility of management and staff. The OPG Health and Safety Policy advocates the right of employees to a safe and accident-free workplace. The key elements of the policy include:

- A commitment to the protection of health and safety through the design of the physical, physiological and psychological aspects of the work environment, the planning and performance of the work, and the provision and use of appropriate tools, equipment, procedures and support;

- A commitment to the involvement of employees in decisions that have an impact on their health and safety;
- Continuous evaluation of and improvements to health and safety performance;
- Recognition of standards of health and safety performance with correction as necessary; and,
- A commitment to compliance with legislated requirements for health and safety.

Program

The program provides the framework for implementation of health and safety initiatives. The Health and Safety Program applies to all employees, visitors and contractors. It is limited to conventional occupational health and safety. The program establishes the framework necessary for employee health and safety to be an integral part of business management, and plant operation and maintenance. All requirements of legislation, OPG corporate policies and nuclear governing documents are included in the program. It also integrates a number of broad-based implementation documents that represent the primary health and safety related aspects of plant operations.

Procedures

Procedures define the method(s) for effecting safe work practices as they relate to specific situations. OPG has developed written procedures to be followed with respect to safety, including electrical safety, falling object prevention, confined space and personal protective equipment. These procedures are readily available to all staff.

2.8.4 Fire Protection and Emergency Response Systems

2.8.4.1 Fire Protection

Fire protection programs are developed uniquely for each of OPG's nuclear facilities, including the documentation describing the program. Accordingly, each facility has in place a program that considers its specific characteristics. The fire protection documentation relative to each facility describes the physical details of fire prevention, fire detection and fire suppression systems and features for the facility. The existing fire protection features have been evaluated against the requirements of CSA N293-07 *Fire Protection for CANDU Nuclear Power Plants*, and associated codes and standards. The requirements of the National Building Code (NBC) and the National Fire Code (NFC) apply to the structures, systems and components comprising the nuclear facility. Fire protection related features of NND will comply with applicable regulatory requirements.

An Emergency Response Team (ERT) is the first line of defence in the event of a fire within the Protected Area of the DN site. Full-time teams are on duty around the clock and ready to respond promptly to any kind of emergency.

Team members continuously practice and upgrade their skills, training for two hours per crew per day on average. When not training, they patrol the station to ensure that fire prevention procedures are being followed and that fire protection equipment is in good working condition. The crews receive extensive fire-fighting, first aid, rescue and hazardous materials (HAZMAT) training. In an emergency, the Clarington Emergency and Fire Services, which is called upon after confirmation of a fire event, provides back-up support per the current Memorandum of Understanding for the ERT for the DN site.

2.8.4.2 Emergency Response

Each of OPG's facilities has emergency response capabilities that can be applied to deal with the range of emergency situations considered reasonable in the circumstances. These can include conventional emergency incidents or radiological-based incidents. Initiating events can include non-nuclear situations and also involve conditions external to the plant site. The designed emergency response capability and infrastructure is sufficiently flexible to be used for the broad range of potential events and accidents. The response infrastructure is able to draw upon additional support resources and use prioritization techniques when dealing with major events.

On-site emergency response is the responsibility of the ERT and the emergency response organization (ERO). The ERT responds to any conventional emergencies such as HAZMAT (i.e., hazardous materials), spills, fire or first-aid incidents. This team is also an integral component of the ERO which responds to large-scale conventional and all radiological-based incidents.

The ERO is made up of three tiers. The first two tiers comprise the site response organization. This includes shift 'duty' staff and augmentation staff who are called in to fill the Site ERO. Management, technical, operations, and support staff of the Site Management Centre (SMC) are assembled to fulfill their responsibilities and duties under the Consolidated Nuclear Emergency Plan. The third tier is the Corporate Emergency Operations Facility (CEOF). All members of the ERO are qualified individuals who undergo an initial training program and a requalification program to maintain their qualifications.

2.8.5 Nuclear Emergency Plan

OPG's generating stations are designed and operated in accordance with rigid safety standards to ensure that station personnel, members of the public, and the surrounding environment are protected from the effects of abnormal events that might occur during the life of the station. Facilities are governed by and operated according to licensed regulatory requirements. Design of the station accommodates all abnormal events that might reasonably be postulated to occur. Operation and maintenance of the station within the confines of the 'safe operating envelope' ensures a high level of safety. Since it is not possible to guarantee that abnormal events will never occur, it is considered prudent to develop and maintain an emergency plan and an organization to implement that plan should the need arise. NND will be integrated into this process.

2.8.5.1 Basis for Emergency Planning

The Provincial Nuclear Emergency Plan (PNEP) (Province of Ontario 1999) provides the off-site basis for emergency planning with the aim of ensuring public safety in the event of an emergency related to a radiological incident. In the context of this plan, a nuclear emergency is any emergency which poses an actual or potential radiation hazard to people or property off site. Part I, Provincial Master Plan of the PNEP, lays down the principles, concepts, organization, responsibilities, policy, functions, and interrelationships which will govern all off-site nuclear emergency planning, preparation, and response in Ontario. Other constituent parts are site-specific in nature and deal with the local characteristics, planning, and operational detail, including evacuation plans.

The PNEP requires OPG to support emergency planning and response for areas within a 10 km radius of all nuclear plants (i.e. the Primary Zone). The PNEP is implemented in OPG through OPG's Consolidated Nuclear Emergency Plan (CNEP) (OPG 2008f). The CNEP is also integrated with applicable municipal emergency plans. Each year OPG Nuclear provides direct support, including both funding and joint exercises, to the Province and the Region of Durham (within which the DN site is located). It jointly tests and evaluates its integrated emergency response during large-scale exercises involving off-site emergency reception centres, and local schools.

PNEP Part I has been revised and is now called the Provincial Nuclear Emergency Response Plan (PNERP). The PNERP received Cabinet approval at the end of January 2009 and was issued by an Order of Council on February 11th, 2009. OPG is now working with the Province to implement the PNERP.

2.8.5.2 Emergency Public Information

OPG has a responsibility to communicate with the public, media, stakeholders, and employees during (potential) nuclear emergencies. To facilitate this, OPG has in place a plan and procedure that govern the emergency communications response. OPG also participates with the Province and municipalities in a coordinated emergency communications response under the jurisdiction of the PNEP.

The main target audience of OPG's emergency public information program is the public living or working near the nuclear sites. Another audience is employees who need to know about the state of the facility. To reach this audience, the corporation will rapidly communicate with media outlets, employees and stakeholders in order that they are informed quickly about developing issues.

2.8.5.3 External Interfaces and Mutual Aid

The safety of the public and the environment outside the boundaries of the facility is the primary responsibility of the province with support from OPG and local municipal organizations. A number of provincial ministries, including the MOE, are represented at the Provincial Emergency Operations Centre (PEOC). Provincial decisions regarding emergency response are coordinated with municipal emergency operations centres as well as with OPG through its Corporate Emergency Operations Facility (CEOF). The CEOF would also interface with the CNSC Headquarters Emergency Operations Centre (HQEOC) and its respective staff.

Agreements exist with local fire departments for on-site fire fighting support. Arrangements and procedures also exist for local ambulance service and hospital support for casualties from the nuclear sites. The area is served by the Central East Local Health Integration Network (serving Regional Municipality of Durham, Peterborough County, Northumberland County, the City of Kawartha Lakes and East Scarborough in the City of Toronto) and the Central Local Health Integration Network (serving the Towns of Markham and Whitchurch-Stouffville in the Municipality of York). Memorial Hospital in Bowmanville maintains a close relationship with the DN site. This facility is equipped with radiation decontamination equipment which is regularly re-stocked by OPG which also provides radiation protection support when required. Toronto Hospital Corporation, Western Division has been provincially designated and funded as the radiation trauma centre for Ontario. This includes the capability to deal with contaminated casualties, trauma, and acute radiation syndrome. Agreements are in place to provide support from the local police force in the event of a security-related incident.

Provision for emergency engineering and technical support is available from the Canadian nuclear industry.

A series of protocols exist for provincial and federal government support and provision of emergency services. These are triggered through the provincial emergency operations functions to the federal government. Military support and access to the U.S. Federal Emergency Management Agency (FEMA) and U.S. Department of Energy (DOE) services are available at the federal government level. The federal government also has access to support from the International Atomic Energy Agency (IAEA) and member states.

2.8.5.4 Provincial Emergency Operations Centre

The Provincial Emergency Operations Centre (PEOC) is the provincial facility and organization that coordinates overall off-site operations of emergency response. PEOC makes the decision on what public protective actions are to be undertaken. PEOC is composed of representatives primarily from provincial ministries needed to manage an emergency. Staff expertise includes technical assessment, response operations, analytical and technical support and information dissemination. OPG supplies call-in staff to fulfill some technical positions in the PEOC Scientific Group and an official liaison position in the PEOC Operations Group. OPG has supported capital construction of the PEOC facility, provided software codes and development, technical documents and manuals, dedicated telecommunications links, and training and drills support to the PEOC.

2.9 Environmental Programs

OPG has developed a Darlington New Nuclear Project (DNNP) Environment Program (OPG 2009i). The Program is intended to ensure that Project activities are carried out in a manner that protects the environment through a systematic evaluation of potential environmental effects and the implementation of preventative and mitigation measures as appropriate. It incorporates the applicable elements of OPG's Environmental Policy, this EIS, the Agreement that will be established with the selected vendor, and the Host Municipality Agreement with the Municipality of Clarington.

Specific environmental practices that are routinely applied to the operations at other OPG facilities for protection of the environment are provided in the following sections as examples of those practices that are also likely to be applied for the NND Project.

2.9.1 Environmental Management Plan

Environmental effects of the Project will be precluded by the incorporation of Good Industry Management Practices into Project implementation. As the Project planning and design evolves, all Good Industry Management Practices (incorporating Good Utility Practices), will be integrated into a comprehensive and overarching Environmental Management Plan (EMP). Prior to commencing site preparation or construction, either OPG or the contractor will be required to prepare an EMP. The EMP will consolidate the strategic-level program for managing, through pro-active and pre-emptive means, the environmental effects of the Project.

A key element of the EMP will be the requirement to prepare detailed, implementation-level Environmental Protection Plans (EPPs) as necessary to address specific aspects of the works that may contribute to environmental effects. An EPP is a specific and detailed procedure to guide implementation of an activity in a manner that will protect against environmental effect. As an element of effects mitigation, EPPs become primary protocols for implementing environmentally-sensitive aspects of the work.

Examples of good practice will include, for example, measures for controlling effects related to, among others, airborne particulate and stormwater (e.g., water quality). Accordingly, these will require that EPPs be developed for excavation and soil handling and transport that will consider dust control, and surface water and erosion/sediment control. It can also be expected that EPPs will be prepared for other activities to prevent environmental impairment. These are likely to include EPPs for activities that may contribute to impacts related to noise and odour; groundwater; handling of fuels and lubricants during the construction activities; and contingency measures in the event of upset conditions.

Under the EMP, Construction Spill Response, Erosion and Sediment Control Plans, will be developed, and specific monitoring requirements will be identified. OPG will independently monitor aspects of the performance of the contractor where there is a risk to the environment identified by the site preparation or construction activities. Furthermore, a Spill Management Procedure will be in place. In the event of a spill, the Emergency Response Team (either OPG's or the contractor's, depending on the location of the spill) would be mobilized to contain the spill, stop the source where possible, and direct the subsequent clean-up.

2.9.2 Environmental Management System

OPG Nuclear has developed an Environmental Management System (EMS) to manage environmental aspects in accordance with elements of the ISO 14001 Environmental Management Systems Standard.

The OPG Environmental Policy (OPG 2006e) establishes guiding principles for environmental management and environmental performance for OPG Nuclear employees and those working on its behalf. It documents the principles and provides a framework for setting objectives and targets on which Nuclear EMS is founded. The key principles of the policy are the following:

- Pollution Prevention;
- Adherence to Regulations; and
- Continual Improvement.

An important component of the EMS is the identification of environmental aspects which are then ranked to establish those that are significant. An environmental aspect is defined as an element of an organization's activities, products or services that can interact with the environment (e.g., a discharge, an emission, consumption or reuse of a material, or noise). These significant environmental aspects (SEAs) are considered when setting environmental programs and objectives. Environmental programs include identification of responsibilities for achieving objectives at each relevant function and level of the organization, and the means and timeframe by which objectives and targets are to be achieved. The environmental programs for NND will be designed around the findings of this EIS and associated licensing documents as they are produced over the life of the Project.

2.9.3 Environmental Monitoring

OPG has over three decades of experience sampling, testing, documenting and reporting on air, water, soil and other media for substances related to the generation of electricity using nuclear power at the DN site. Although this discussion is relevant specifically to DNGS, it is summarized here as an example of what may also be relevant for NND.

The procedures and policies developed over that time to protect workers, the public and the environment are designed to ensure that the electricity is generated safely and responsibly. Through its monitoring programs, OPG demonstrates that emissions are kept within the appropriate limits. Monitoring and data analysis have been refined to facilitate early identification of unexpected events with subsequent implementation of corrective actions and reporting.

The emissions and environmental media currently monitored at DNGS are comprehensive in terms of substances and locations.

2.9.4 Site Biodiversity Plan

OPG's Environmental Policy (2006e) requires that environmental factors and stakeholder considerations be integrated into planning, decision-making and business practices. The corporate biodiversity policy requires the development and maintenance of management plans to address the biodiversity needs and enhancement opportunities of significant natural areas and species across all OPG properties, including the DN site.

A Wildlife Management Plan is currently in place as a feature of on-going DNGS operations. The Plan is certified by the Wildlife Habitat Council, a US-based non-profit organization dedicated to restoring and enhancing wildlife habitat on private lands. The Plan aspires to several goals including:

- Addressing biodiversity needs and enhancement opportunities of significant natural areas and species at the site;
- Maintenance of site access for community use;
- Naturalization of areas of the site where practicable to do so;
- Maintenance of wildlife corridor connection of the DN site to off-site areas; and
- Development of environmental education programs.

OPG remains committed to the principles of biodiversity and their application to the extent practicable during development of the NND Project. DNGS has received several awards for its efforts in conservation and sustainability. For example, in 2007 DNGS once again received the Wildlife Habitat Council's Signatures of Sustainability Award for their efforts on biodiversity conservation and environmental education.

2.10 Sustainable Development

As a company committed to sustainable development, OPG strives to minimize the environmental footprint of its operations while bringing social and economic value to the communities in which it operates. OPG publishes a report annually to describe its sustainable development performance. In its 2007 Sustainable Development Report (OPG 2007f), OPG defines sustainable development as *"embracing business strategies and activities that meet the needs of the enterprise and its stakeholders today while protecting and enhancing the human and natural resources that will be needed in the future."* In the report, its sustainability commitments are represented within three areas: i) environmental performance; ii) social performance and, iii) economic contribution. Each is addressed further as follows:

Environmental Performance

OPG works to comply with environmental laws, regulations, by-laws and requirements contained in operating license, permits and Certificates of Approval. Regulatory compliance is regarded as the minimum, non-negotiable standard for progress towards sustainable development. OPG has established voluntary internal environmental targets to help ensure that its overall performance continues to improve beyond compliance. Each year, key benchmarks for improving environmental performance are established, tracked, and managed through the Environmental Management System (EMS). For example, the Critical Group Dose levels at the nuclear generating stations in 2007 continued to be only a small fraction of both the regulatory limit and natural background.

Social Performance

OPG pursues excellence relative to a host of social performance initiatives. OPG believes that good corporate citizenship is directly based on operating its facilities in a safe, environmentally sound, productive and reliable manner. Further, a good company gives back to the communities in which it operates, clearly making a difference in the quality of life in those communities. To help ensure public safety around all watercourses, OPG staff work closely with its partners in its site communities to communicate safety messages to the public using radio and television advertisements, newspapers, magazines, brochures, videos and a computer game for children. Further, OPG is committed to building long-term, mutually beneficial working relationships with aboriginal communities located in close proximity to OPG's facilities and recently issued a Policy for Aboriginal Relations (OPG 2007f).

Economic Contribution

OPG works to bring value to Ontario, the communities in which it operates, and to its employees through a variety of responsible "best business" practices. OPG contributes to the provincial economy through the purchase of goods and services, competitive compensation to attract and retain a highly qualified workforce, and through payments made in lieu of taxes, gross revenue charges, dividends, interest on long term debt and other payments to the Province of Ontario. OPG has several new generation projects under development or which have recently come into service, including the Niagara Tunnel, the Lac Seul Generating Station and the Portlands Energy Centre. Through its wholly owned corporate venture capital group OPG Ventures Inc., OPG continues to manage a portfolio of investments in enterprises developing and commercializing leading-edge energy technologies. Further, OPG is considering and assessing the NND Project, the refurbishment of Pickering B and the refurbishment of Darlington as opportunities to meet the province's need to refurbish and/or replace 10,000 MW of nuclear energy.

The corporation tracks its performance in terms of each of the noted focus areas. Achievement in a context of sustainability parameters is detailed in the Sustainable Development Report published annually.

The EIS Guidelines require that the proponent consider sustainability of the Project in terms of the extent to which biological diversity may be affected by the Project; and the capacity of renewable resources that are likely to be significantly affected by it. That assessment is presented in Section 6.1. To meet the requirements of the Guidelines, it is framed in a geographical context of the Local and Regional Study Areas. That broader framework is not intended to suggest that sustainability objectives will not be an important consideration also in the Site Study Area, and it is within the site context that operational protocols will be implemented with regard for promoting sustainability at a grass-roots level. OPG as the Project proponent and facility operator will work with other relevant stakeholders, including the selected vendor, to promote sustainable practices throughout the Project. Examples of these practices include:

- Compliance with all applicable regulations, standards, codes of practice, and the terms of licences and permits to be issued, and this EA concerning environmental effects management;
- Implementation of the environmental management and monitoring programs as referenced above in Sections 2.9.1, 2.9.2 and 2.9.3;
- Continuation of the Biodiversity Plan as described above in Section 2.9.4;
- Promotion of energy-efficient features in the design of NND structures and operating facilities;
- Promotion of resource management strategies among staff and contractors (e.g., car pooling; alternative fuels);
- Setting of targets and strategies including research regarding alternative products, for reduction in use and discharge of chemicals and compounds;
- Performance of waste audits and improvements to waste reduction and re-use programs for conventional (e.g., non-radioactive) waste on an on-going basis; and
- Use of low environmental impact products at operating facilities, including on-site laundry, cafeterias, maintenance and fabrication shops.

3. METHODOLOGIES USED IN THE EIS

This Chapter describes the methodologies used in conducting the EA and preparing this EIS. As background for the discussion, Section 3.1 summarizes the overall context within which the EIS was developed. Descriptions of individual methodologies for the fundamental elements of the EA program are provided in Section 3.2.

3.1 Context for the EIS

3.1.1 EIS Framework

The Guidelines prescribe the overall framework for preparing the EIS and the general process for doing so. The elements of that framework that are relevant in terms of EIS preparation are:

- The purpose and need for the Project and the alternatives to the Project from the proponent's perspective. These topics have been addressed in Section 1;
- A description of the Project, addressing all of its phases, in sufficient detail to allow the JRP to assess potential adverse environmental effects and take into account, public concerns about the Project. The Project for EA Purposes is described in Chapter 2 of this EIS. The methodology applied for compiling this description is presented in Section 3.2.1;
- An analysis of alternative means of carrying out the Project that are technically and economically feasible. A consideration of alternative means of carrying out the Project was an inherent feature of the methodology applied for determining and describing the Project for EA Purposes. The methodology used for considering alternative means is described in Section 3.2.2;
- A description of the existing environment (i.e., pre-Project) as a baseline for identification, assessment and determination of the significance of potentially adverse environmental effects that may be caused by the Project; and to identify and characterize the beneficial effects of the Project. The description of the existing environment includes identification of Valued Ecosystem Components (VECs) that may be affected by the Project. The description of the existing environment is provided in Chapter 4 of this EIS. The methodology applied in developing the description is provided in Section 3.2.3. The methodology applied for identifying VECs is described in Section 3.2.4;
- An assessment of potential environmental effects associated with the Project. The assessment of Project-related effects is presented in Chapters 5 through 9. The methodologies applied in developing the assessment of effects are described in Sections 3.2.5 through 3.2.10;

- A description of the framework for developing a follow-up program to verify the accuracy of the environmental assessment and determine the effectiveness of the measures taken to mitigate adverse effects. The Preliminary Plan for the Follow-up Program is described in Chapter 11 of this EIS;

- A Communications and Consultation Program was developed to inform and solicit feedback from a range of stakeholder groups, including local residents and agencies. OPG also developed an Aboriginal Engagement Program to ensure that Aboriginal communities and organizations remained informed throughout the EA and had opportunities to provide input. Throughout the EA, OPG sought community confirmation of the work undertaken to date, and community direction for the next steps in the Assessment. The Communications and Consultation Program, including as it relates to Aboriginal Peoples engagement, is described in Chapter 10 of this EIS.

3.1.2 Project Time Frame

The EIS considers the complete temporal framework relevant to the Project. Potential environmental effects were predicted for the period beginning with site preparation and extending through construction, operation and maintenance (including repair/refurbishment where applicable) to eventual decommissioning and abandonment.

As described in Section 1.1.4, the Project will extend through the following three phases and time periods:

Project Phase	Start	Finish
Site Preparation and Construction	2010	2025
Operation and Maintenance	2016	2100
Decommissioning and Abandonment	2100	2150

By adopting a temporal framework that considers all stages of the Project from site preparation through to site abandonment, the requirements of the Guidelines concerning the temporal boundaries for the assessment are fully addressed. Specifically, the Guidelines prescribed that the temporal framework takes into account the following:

- The hazardous lifetime of the contaminants associated with the waste;
- The duration of the operational period;
- The design life of engineered barriers;
- The duration of both active and passive institutional controls; and

- The frequency and duration of natural events and human-induced environmental changes (e.g., seismic occurrence, flood, drought, glaciation, climate change, etc.).

3.1.3 Study Areas

The Guidelines require that the geographic study areas for the EIS encompass the areas of the environment that could reasonably be expected to be affected by the Project, or which may be relevant to the assessment of cumulative environmental effects. The Guidelines prescribed the following as the basis for establishing Project-specific study areas:

- **Regional Study Area (RSA):** the area within which there is the potential for cumulative biophysical and socio-economic effects. This includes lands, communities and portions of Lake Ontario around the DN site that may be relevant to the assessment of any wider-spread direct and indirect effects of the Project;

- **Local Study Area (LSA):** that area beyond the Site Study Area where there is a reasonable potential for direct effects on the environment, from any phase of the Project, either through normal activities or from possible accidents or malfunctions. The LSA should include all of the DN site, the lands within the Municipality of Clarington closest to it and the area of Lake Ontario adjacent to the facility; and

- **Site Study Area (SSA):** the facilities, buildings and infrastructure at the DN site, including the existing licensed exclusion zone for the site on land and within Lake Ontario, and particularly, the property where NND is proposed.

With the foregoing as guidance, generic Regional, Local and Site Study Areas were established for general application for the EIS. These study areas are illustrated on Figures 3.1-1, 3.1-2 and 3.1-3, respectively.

The generic RSA extends approximately 40 km east and west of the DN site. Its western limit is the Region of Durham boundary and it extends east to the Town of Cobourg (thereby including both the Pickering NGS and the Town of Port Hope historic low level radioactive waste sites, which are relevant from a cumulative effects perspective). In the north, the RSA includes the Oak Ridges Moraine and the provincially-designated greenbelt area south of it.

The generic LSA was expanded substantially beyond the area suggested in the EIS Guidelines and it includes all of the Municipality of Clarington and the easterly urbanized portion of the City of Oshawa. The LSA coincides generally with the Primary Zone for emergency response identified by Emergency Measures Ontario.

The generic SSA comprises the entire DN site and extends into Lake Ontario a distance of approximately 1 km.

The generic study areas were reviewed and adjusted as appropriate for specific application for each of the individual environmental components. The study areas as applied specifically for each environmental component are described in the relevant subsections of Chapter 4.

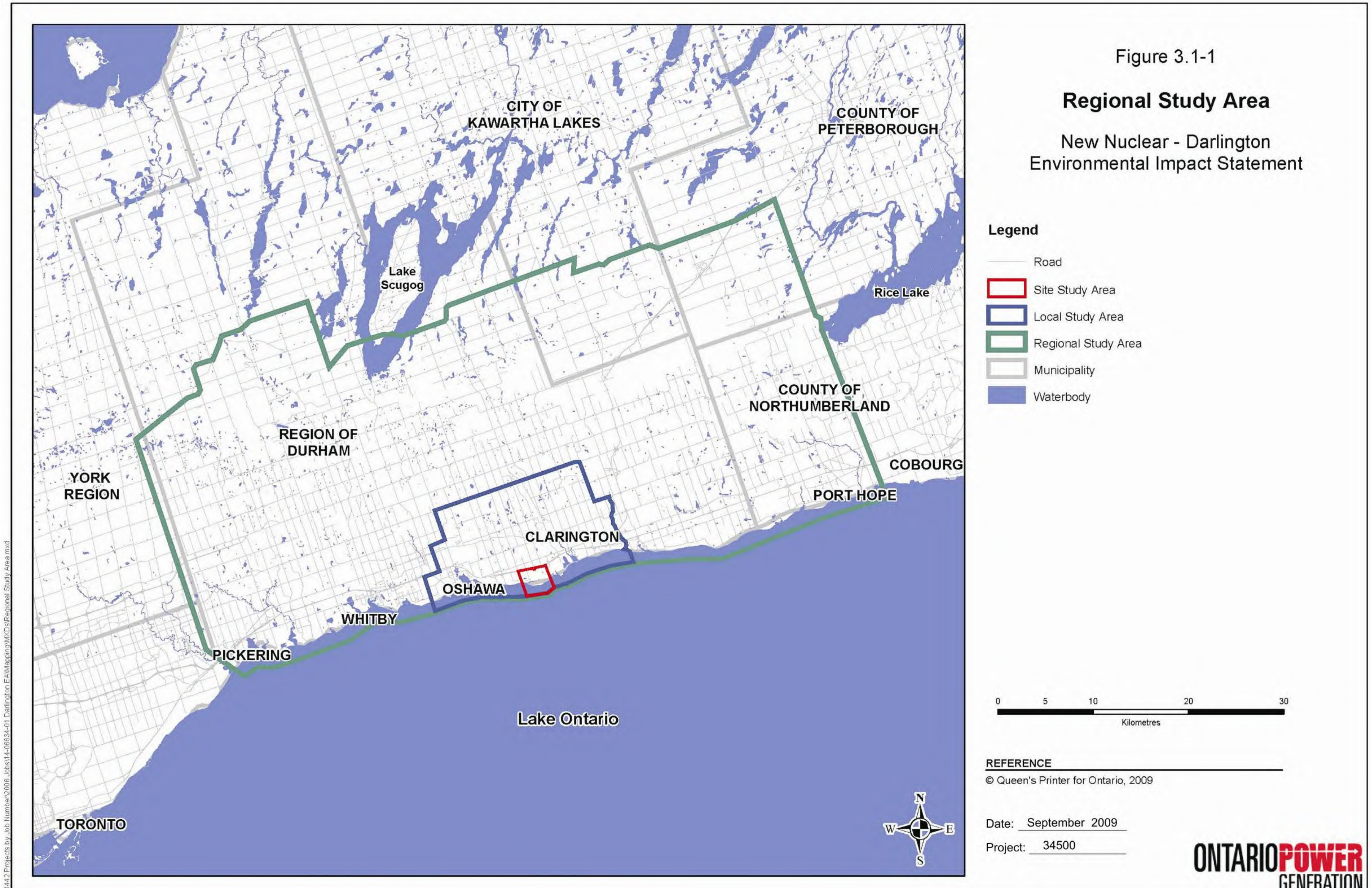
Figure 3.1-1
Regional Study Area
New Nuclear - Darlington
Environmental Impact Statement
Legend
Road
Site Study Area
Local Study Area
Regional Study Area
Municipality
Waterbody
CITY OF KAWARTHA LAKES
COUNTY OF PETERBOROUGH
Lake Scugog
Rice Lake
COUNTY OF NORTHUMBERLAND
REGION OF DURHAM
YORK REGION
COBOURG
PORT HOPE
CLARINGTON
OSHAWA
WHITBY
PICKERING
Lake Ontario
TORONTO
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Kilometres
REFERENCE
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Date: September 2009
Project: 34500
ONTARIO POWER GENERATION

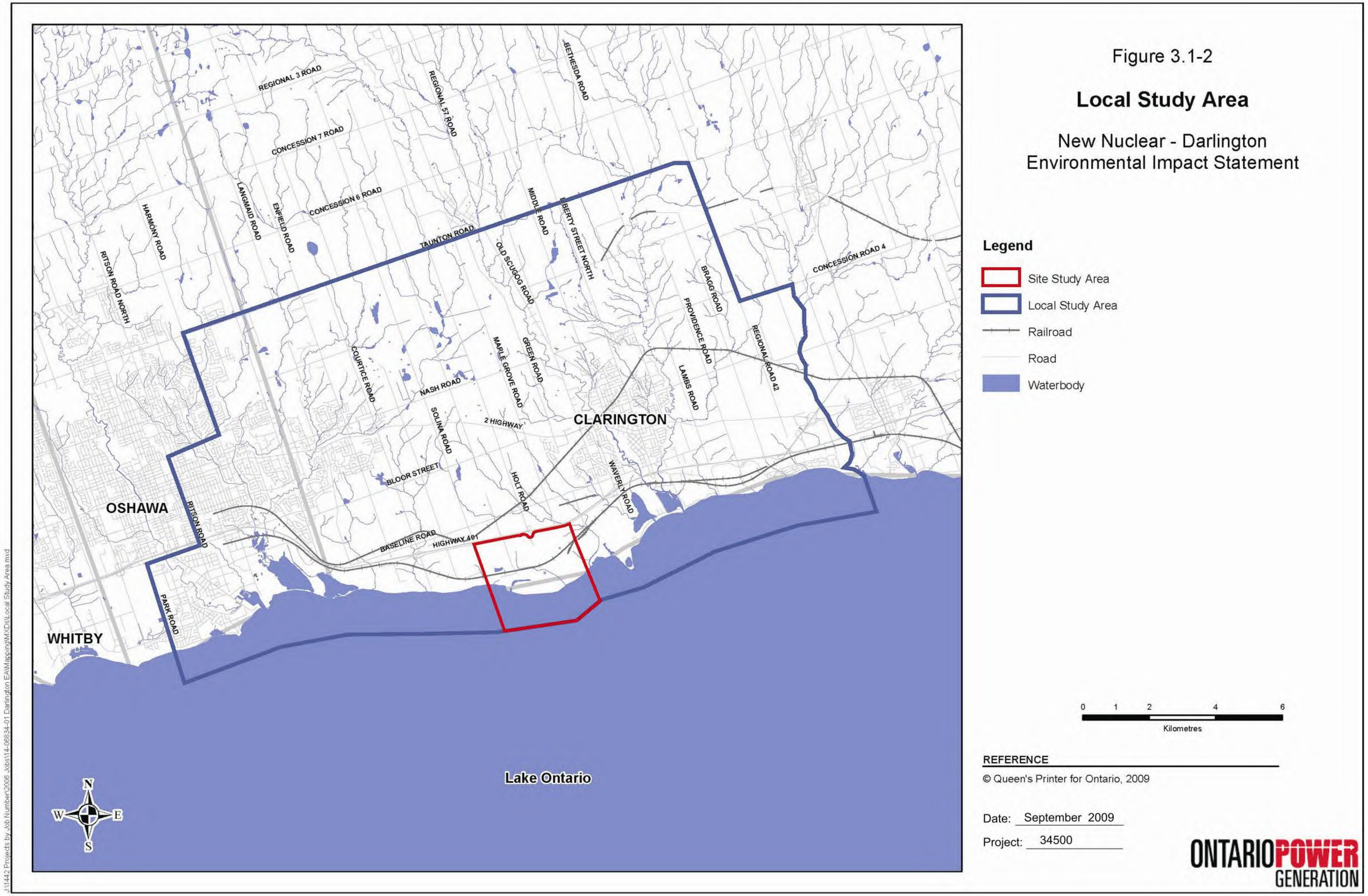
Figure 3.1-2
Local Study Area
New Nuclear - Darlington
Environmental Impact Statement
Legend
Site Study Area
Local Study Area
Railroad
Road
Waterbody
0 1 2 4 6
Kilometres
REFERENCE
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Date: September 2009
Project: 34500
ONTARIO POWER GENERATION
OSHAWA
CLARINGTON
WHITBY
Lake Ontario
REGIONAL 3 ROAD
CONCESSION 7 ROAD
CONCESSION 6 ROAD
TAUNTON ROAD
CONCESSION ROAD 4
NASH ROAD
2 HIGHWAY
BLOOR STREET
BASELINE ROAD
HIGHWAY 401
RITSON ROAD
PARK ROAD
HARMONY ROAD
RITSON ROAD NORTH
LANGMAID ROAD
ENFIELD ROAD
REGIONAL 57 ROAD
BETHESDA ROAD
MIDDLE ROAD
LIBERTY STREET NORTH
OLD SCUGOG ROAD
COURTICE ROAD
MAPLE GROVE ROAD
GREEN ROAD
SOLINA ROAD
HOLT ROAD
WAVERLY ROAD
BRAGG ROAD
PROVIDENCE ROAD
LAMBS ROAD
REGIONAL ROAD 42

Figure 3.1-3

Site Study Area

New Nuclear - Darlington
Environmental Impact Statement

Legend

- Road
- Railroad
- Site Study Area
- Waterbody

0 200 400 800 1,200
Metres

REFERENCE

Aerial photography (2005) provided by OPG
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Date: September 2009

Project: 34500

ONTARIO POWER GENERATION

3.2 EIS-Related Methodologies

Using the above-noted context for the EIS, a number of specific processes (i.e., methodologies) were developed to focus and guide its fundamental elements. These are described in the following sections.

3.2.1 Describing the Project for EA Purposes

Because the EIS was prepared as early as possible in the Project planning stage, the specific reactor type to be constructed and operated had not yet been determined. Accordingly, for purposes of the EIS and as well as the overall EA, the Project is defined and described in a manner that provides for an effective assessment of potential environmental effects that might result from the range of reactor types and number of units considered feasible for the DN site.

As noted in Section 2.4, the description of the Project was derived largely from information provided by three reactor vendors and compiled by OPG to represent a plant parameter envelope (PPE). A PPE is set of design parameters that delimit the bounding framework for key features of the Project. A fully developed PPE represents the limiting values for the common elements of the different design options being considered, and serves as a conservative surrogate for actual reactor design information that varies among the options.

The EA studies considered full development of the NND which may be up to 4,800 MW and as many as four reactors; and the alternative means of implementing the Project. Because the reactor type had not been determined, details concerning the manner in which the DN site would be developed during the Project could also not be determined. For this reason, works and activities associated with site development were also defined in a bounding framework. To create a bounding site development layout, three separate model plant layout scenarios were conceptualized, with each one representing the reasonable maximum extent for key parameters of the Project that would affect construction extent and effort. The three model plant layout scenarios were composited (i.e., overlain) to create an all-encompassing bounding site development layout which represented the maximum values among the three scenarios for relevant parameters (e.g., maximum quantity of soil excavation). This maximum value for each relevant parameter was used in the assessment of effects.

The bounding site development layout represents the reasonable bounding case in terms of likely construction-related works and activities, however, it does not represent the bounding conditions for reactor operations. For EA purposes, therefore, the numbers of reactors that would represent full build-out of the Project (for each reactor type) was adopted to consider the potential effects during the Operation and Maintenance phase of the Project. The options were derived based on the stated objective of the Project as described in the Project Description (OPG 2007a) submitted to the CNSC in April 2007, that being: *"…to produce up to 4800 megawatts (MW) of baseload electricity from up to four additional nuclear generating stations"*. Based on the electrical generation capability of the three reactors being considered, the following scenarios were adopted for assessment of environmental effects during the Operation and Maintenance phase:

- Four ACR-1000 reactors - generating a total of 4340 MWe (net);
- Four AP1000 reactors - generating 4148 - 4600 MWe (net); and
- Three EPR reactors - generating 4740 MWe (net).

The operations-related conditions relevant to each of the three scenarios are included in the Description of the Project for EA Purposes (see Chapter 2) and were applied as appropriate in the assessment of effects associated with the Project.

3.2.2 Evaluation of Alternative Means

The objective of the Description of the Project for EA Purposes was to define a bounding NND Project that included the range of alternatives ways in which it could reasonably be implemented. By assessing the effects of this bounding Project, therefore, all potential effects associated with the alternative means of implementing the Project, including the three operating scenarios described above, were included in the results of the assessment. Alternative means of implementing the following major elements of the Project were included in the EIS through this process:

- Reactor designs and numbers of units;
- Condenser cooling;
- Low and intermediate level radioactive waste;
- Storage of used fuel; and
- Excavated material management.

3.2.3 Characterization of the Baseline (Existing) Environment

The existing environment was characterized and described within the biophysical, and socio-economic (human and cultural) environmental components identified as relevant for this EA. Relevance of the environmental components was established based on past experience with similar projects and on the results of an early consideration of likely interfaces between the Project and the individual aspects (or "components") of the environment. Each environmental component was further refined into sub-components that represented fundamental constituent features susceptible to environmental effects and/or a potential pathway or mechanism for transfer of an effect to another component.

The environmental components and sub-components are:

- **Atmospheric Environment**: with its sub-components being air quality and noise;
- **Surface Water Environment:** with its sub-components being lake circulation, lake water temperature, site drainage and water quality, and shoreline processes;
- **Aquatic Environment**: with its sub-components being aquatic biota and aquatic habitat;
- **Terrestrial Environment**: with its sub-components being vegetation communities and species, insects, bird communities and species, amphibians and reptiles, mammal communities and species, and landscape connectivity;
- **Geological and Hydrogeological Environment**: with its sub-components being soil quality, groundwater flow regime and groundwater quality;
- **Radiation and Radioactivity Environment**: with its sub-components being radioactivity in the atmospheric environment, surface water environment, aquatic environment, terrestrial environment, the geological and hydrogeological environment, and in humans;
- **Land Use:** with its sub-components being land use, and landscape and visual setting;
- **Traffic and Transportation:** with its sub-components being transportation system operations (road, rail, marine), and transportation system safety (road, rail, marine);
- **Physical and Cultural Heritage Resources**: with its sub-components being archaeology, and built heritage and cultural landscapes;
- **Socio-Economic Environment:** with its sub-components being human assets, financial assets, physical assets, social assets, and natural assets;
- **Health – Human:** with its sub-components being health and well-being of the general public, and health and safety of workers; and
- **Health - Non-Human Biota (Ecological Risk Assessment):** although specific sub-components are not defined, the focus of this environmental component is terrestrial biota and aquatic biota.

The existing environmental conditions (i.e., environmental baseline) were described on the basis of available information of relevance to the DN site plus field reconnaissance and data gathering to augment this existing database where necessary. It is to be noted that because the DN site has hosted an operating nuclear facility for many years, there is a very large base of environmental information on which to draw from, therefore, the additional data gathering could be largely focused on filling gaps in the existing information base. Where it was appropriate to gather additional or updated data, the field data collection programs were developed and conducted within the basic framework described below:

Establish Data Quality Objectives

The ongoing process of reducing uncertainty in the EA began during the baseline characterization planning stage with the development of a strategy to determine the optimal use and benefit of baseline data, and to focus the data collection program so the appropriate data were collected. A step-wise framework was devised and documented in a guideline entitled *Data Quality and Design of Baseline Characterization Program Framework* (SENES 2007b) which was applied by all technical teams involved in the existing environment characterization studies. The framework was based on the following key elements:

Define the Baseline Data Requirements

A preliminary scope of required characterization for the environmental component was established. This was used to focus the subsequent gap analysis and work plan development on the relevant aspects of the environment. The preliminary scoping considered the following:

- Potential spatial extent of Project influence (i.e., study areas);
- Potential interactions between the Project and the relevant environmental component;
- Expected range of environmental conditions in the study areas; and
- Measurement indicators relevant to the environmental component.

Conduct Gap Analysis

The availability of existing environmental information to meet the baseline data requirements was researched and gaps in the database were identified. The gap analysis comprised three steps: i) determine data requirements; ii) review existing information; and iii) compare required data against available data to identify deficiencies (i.e., gaps).

Develop Baseline Data Collection Program

A work plan was developed to address all aspects of the data collection requirement and implementation program, including the nature of the required information; the format for its collection; collection program schedule, and protocols and methodologies to be applied in the program.

Implement Baseline Data Collection Program

The baseline data collection programs for the environmental components were carried out. For some environmental components, the data collection requirements considered seasonal variations and the program was staged appropriately to address changing conditions throughout the year. The data collection programs were re-evaluated on an ongoing basis throughout the baseline period and the information acquired during initial sampling and monitoring campaigns served to inform and provide renewed focus for subsequent campaigns.

Use of the data quality objectives (DQO) approach ensured that baseline information data needs were focused through an initial consideration of the potential environmental effects of the Project. Existing available information was gathered, data gaps identified and field programs designed to complete the baseline database. The review process ensured that the baseline monitoring was complete and met the data quality objectives. The baseline characterization program was subject to a peer review process with appropriately qualified specialists independent of the EA team providing technical oversight.

3.2.4 Identification of Valued Ecosystem Components

Characterization of the existing environment included the identification of Valued Ecosystem Components (VECs) within each of the environmental components. VECs are features of the environment selected to be the focus of the EA because of their ecological, social, cultural or economic value, and their potential vulnerability to effects of the Project. Intended to provide for meaningful measurement of environmental changes and effects that may be caused by the Project, they serve as endpoints for the assessment of environmental effects. Effectively, the EA study is an assessment of the effects of the Project on the VECs which have been selected to represent the overall environment.

VECs are often thought of in terms of the aquatic and terrestrial environments where ecological features, individual species, or important groups of species may be identified. The equivalent of VECs also exist, however, for cultural and socio-economic environmental components (sometimes described as Valued Cultural and Heritage Components [VCHCs] and Valued Socio-economic Components [VSCs], respectively). By convention, for simplicity all are collectively referred to as VECs.

Because VECs are used as the endpoints for the assessment of the potential effects of the Project, they were selected to be: i) representative of the overall environment; ii) subject to and appropriately sensitive to the stressors likely to be associated with the Project and, ii) measurable in terms of quantifiable and qualitative parameters of change and effect in the components of the environment for which they have been chosen to represent. VECs were identified individually for each environmental component with consideration for the following criteria:

- Abundance (i.e., representation) in the relevant study areas;
- Ecological importance (i.e., in a context of accepted scientific principles);
- Data availability (i.e., sufficient information must be available to allow an appropriate evaluation of effects);
- Native species (i.e., those that have been well established in the area over a long time period);
- Degree of exposure (i.e., the extent to which VEC may be exposed to “stressors” associated with the Project);
- Degree of sensitivity (i.e., the extent to which VEC may be sensitive to the “stressors” associated with the Project);
- Ecological and human health (i.e., the extent to which human health and the growth or sustainability of non-human biota may be affected);
- Socio-economic importance (i.e., value as a commercial, recreational or subsistence resource; inherent aesthetic value);
- Conservation status (i.e., the extent to which VEC may be specifically protected by law, designated as rare, threatened, or endangered);
- Traditional and current importance to Aboriginal Peoples; and
- Cultural and heritage importance to society.

A preliminary list of VECs was included in the EIS Guidelines (the list was unchanged between the draft and final Guidelines) with the direction that it be modified as appropriate by the proponent to consider input received during consultations with the public and other stakeholders. The process for selecting VECs for the NND Project EA began with a detailed comparison of the preliminary VEC list included in the Guidelines to VECs that have previously been used for other EAs and related programs with relevance to the NND. An important consideration in this respect was the substantial base of experience concerning VEC selection available to draw from as the starting point for choosing NND-specific VECs. This experience includes recent EAs for the refurbishment and continued operation of PNGS B, for the used fuel dry storage facilities at both DNGS and PNGS, for the return to service of PNGS A, and the Port Hope and Port Granby Projects (that together form the Port Hope Area Initiative).

The VECs and selection rationale for the above programs and the preliminary list in the EIS Guidelines were considered by the study teams conducting the individual baseline environment characterization program for various environmental components. A candidate VEC list was developed for each component and progressively refined based on the increasing knowledge of the existing environment relevant to the NND, the specific features of the Project (see Chapter 2), and how the Project and the environmental would be likely to interact.

Input to the selection of VECs was solicited from the public and other stakeholders. At Community Information Sessions held in the spring of 2008, OPG presented 22 environmental sub-components and 100 environmental features representing candidate VECs and VEC indicators as identified through the above process, for public discussion and feedback. The VEC selection program was reviewed with Aboriginal groups and Métis organizations and their input solicited during the Aboriginal Information Sharing Session held in May 2008. The final list of VECs ultimately selected for use in the EA considered all public and stakeholder feedback (as discussed further in Section 10.3.1.3).

Additional stakeholder input to the VEC selection program was contained in many of the responses by interested parties to the draft EIS Guidelines that were published for comment by the CNSC and the CEA Agency. More than 30 responses were received and published on the CEA Agency website. All were reviewed by the EA team and those that pertained to VECs were considered in establishing the final list of VECs to be used for the EA. The resolution of all comments received on the draft Guidelines concerning VECs is detailed in the individual sections throughout Chapter 4 where the final VECs are introduced.

The final VECs and the rationale for their selection are described in Chapter 4. Depending on circumstances and the nature of the evaluation, the VEC may be defined at a species level (e.g., Lake Trout) or in broader context (e.g., Predatory Fish) in which case individual species may be applied as VEC Indicators to support a more focused assessment of the broader category. In still other cases, the VEC is not the ultimate receptor of an environmental effect, rather it is the pathway or means for transfer of an effect to a VEC in another environmental component (e.g., VECs chosen for the Atmospheric Environment include air quality and noise as pathways for the transfer of effects to VECs in other environmental components [e.g., human health]).

3.2.5 Assessment of Likely Effects of the Project on the Environment

As described in preceding pages, in many respects, the assessment of effects was carried out using bounding conditions particularly with respect to the scope and nature of the Project work and activity being evaluated. Scientific uncertainty concerning the extent of potential effects is largely compensated for through the use of bounding conditions that typically reflect the outer range of possible conditions. The degree of uncertainty concerning the prediction of effects has been further reduced through the use of best practices by experienced professionals; incorporation of actual measurement data where available and applicable; use of approved models with a history of application; and the use of peer review throughout all stages of the EA to ensure that the science applied in the assessment was appropriate. Specific details with respect to uncertainties associated with the prediction of environmental effects are included in the applicable TSDs.

An additional key element in reducing the uncertainty of predicted effects has been the availability of extensive data and operational experience from DNGS, a fully-functioning nuclear power station within the DN site with almost two decades of operational and environmental performance data. The database of directly-relevant information pertaining to DNGS has provided an important opportunity to benchmark and confirm the validity of findings of the NND EA studies.

It is acknowledged, however, that in spite of best efforts, all EAs involve a level of uncertainty regarding the identification of environmental effects, the assessment of their significance, and the effectiveness of mitigation measures. For this reason, the *CEAA* prescribes a follow-up program for all projects that undergo an EA by comprehensive study or panel review. Furthermore, the Act indicates that adaptive management may be an integral element of follow-up as a means to consider inherent uncertainties in the EA. Adaptive management is further discussed in Section 11.3 in terms of its relevance to the EA follow-up program and its role in considering uncertainties in the EA process.

The assessment of effects of the Project on the environment was carried out as a series of progressive steps as described below. The assessment was an iterative process and as appropriate, steps were repeated and refined.

<u>Detailed Screening for Potential Project-Environment Interactions</u>

A preliminary screening for potential Project-environment interactions was conducted during baseline characterization studies to ensure appropriate focus of those studies. A more detailed screening was subsequently conducted for each component of the environment based on the description of the Project (as summarized in Chapter 2) to direct the effects assessment effort.

The screening approach allowed the EA studies to focus on the aspects of key importance, thus minimizing assessment effort where there is low potential for Project-related effect.

Each of the relevant Project works and activities was considered individually to determine if there was a plausible mechanism for the Project to interact with the environment. The identification of relevant physical and operational features of the Project and their potential interactions with the environment was based on the experience and professional judgment of technical specialists involved in the assessment.

Evaluation for Likely Measurable Changes in the Environment

Each potential interaction was evaluated to determine if it would be likely to result in a "measurable" change in the environment. For purposes of the EA, a measurable change was defined as a change that is detectable and quantifiable compared with existing (baseline) conditions. A predicted change that is clearly trivial, negligible or indistinguishable from background conditions was not considered to be measurable.

Assessment of Likely Effects on the Environment

Each Project-environment interaction that was judged likely to result in a measurable change in the environment was evaluated further to identify the likely effect of the change on a VEC relevant to the subject environmental component or on a pathway to VECs in other environmental components. Consideration was given at this stage of the assessment to the benefit of in-design mitigation measures in preventing or reducing environmental effects, of in-design mitigation measures. ("In-design" mitigation measures are features included in the Project design for the purpose of pre-empting possible environmental effects, based on good practice and OPG experience).

Specific assessment criteria were developed and applied individually for each environmental component as the framework within which to judge likely environmental effects (i.e., to evaluate whether a measurable change represents an environmental effect). Assessment criteria vary from among the environmental components and they are described as they were established for each component in the appropriate sections of Chapter 5.

Each likely environmental effect was identified and described as either beneficial or adverse. Where the likely effect was determined to be beneficial, no further assessment was conducted[1].

[1] Although beneficial effects were not assessed for significance, their positive contribution to the environment is recognized and documented in the appropriate subsections of Chapter 5. The beneficial effects are largely represented in the Socio-economic Environment (see Section 5.11) and although not explicitly stated, further enhancement of these beneficial effects of the Project can be expected to result from associated, ongoing OPG initiatives in the local community including, for example, corporate sponsorships, support for learning and training opportunities, environmental stewardship and leadership both on and off the DN site.

Similarly, where the likely adverse effect was determined to be measurable, however so small that it was clearly not of concern, no further assessment was conducted. A rationale was provided in each case where further assessment was not conducted. All other likely adverse environmental effects were carried forward for consideration of mitigation measures.

Where relevant, the predicted environmental effects were evaluated further with regard for the possible influence of climate change. The objective was to consider if the effect (e.g., extent, magnitude) and the confidence (e.g., degree of uncertainty) of the prediction, were likely to be exacerbated by possible consequences of climate change. This consideration of the possible influence of climate change on predicted effects complements the evaluation of climate change as a potential effect of the environment on the Project (see Section 6.4).

Consideration of Mitigation and Determination of Likely Residual Effects

Section 2(1) of the *CEAA* defines mitigation as:

> *"… the elimination, reduction or control of the adverse environmental effects of the project, and includes restitution for any damage to the environment caused by such effects through replacement, restoration, compensation or other means."*

As noted above, in-design mitigation measures were considered for their benefit in initially preventing environmental effects. In situations, however, where adverse environmental effects (other than those clearly of no concern[2]), were determined likely regardless of the in-design mitigation measures, additional mitigation measures deemed technically and economically feasible, were identified for further addressing the adverse effect. Each further mitigated effect was re-evaluated to determine the residual effect (i.e., the effect that remains after all mitigation measures are considered).

By advancing through the assessment in the methodical manner described above, the wider range of potential Project-environment interactions identified at the beginning of the process was progressively screened and evaluated to result in a narrower range of residual adverse effects identified as likely at the end of the process. This progression from potential interactions through to likely residual adverse effects is an important aspect of the overall assessment methodology used, especially as it relates to the subsequent determination of significance of the likely residual adverse effects (Section 3.2.11).

[2] Although the EIS Guidelines (Section 4.2d) proposed that mitigation measures be considered for "significant adverse environmental effects", mitigation measures were in fact, considered to both pre-empt possible environmental effect (in-design mitigation) and to address all adverse effects without regard for significance, except for those that were clearly of no concern. The significance of adverse environmental effects (see Section 9) was determined for residual effects (i.e., those that remained following mitigation).

The mitigation measures, both "in-design" measures and further measures based on EA findings, were identified considering a number of factors, chief among which were:

- Technical feasibility – was determined through professional judgement of the Project team (including both EA and design planning); and consideration of the record of application of the mitigation measure in similar situations. For example, many of the proposed mitigation measures represent Good Industry Management Practices that are well-established and recognized within their respective industries (e.g., construction). Other measures have a proven record of application in directly-relevant situations, including at the DNGS, which represents many years of operational success; and

- Economic feasibility – was also determined largely through the professional experience of the Project team and consideration of the record of successful application of the proposed measure. All mitigation measures are presented as commitments of OPG, and in anticipation of the commitment, the conceptual cost basis for all such measures was determined.

As Project planning and design continues, the Good Industry Management Practices included as in-design mitigation measures will be integrated into a comprehensive Environmental Management Plan (EMP) as discussed in Section 2.9.1. In developing the EMP, appropriate and applicable standards and protocols will be considered, including but not limited to, the *Environmental Codes of Practice for Steam Electric Power Generation – Construction Phase* (Environment Canada 1989).

All mitigation measures are proposed with the confidence that they will be effective in ameliorating potential environmental effects. As appropriate, mitigation measures are proposed in combination (e.g., multiple measures are proposed to mitigate the loss of Bank Swallow nesting habitat, see Section 5.5.6.2) to ensure effectiveness. As noted in Chapter 11, an important element of this EA is a follow-up program whose primary function will be to determine the effectiveness of mitigation measures, and if or where they may not be fully effective, to identify new mitigation strategies.

A preliminary description of possible mitigation measures was presented to the public during the second round of key stakeholder dialogue sessions in the fall of 2008 and they were invited to comment on those suggested and offer others that may be appropriate in the circumstances. The mitigation measures as they ultimately evolved reflect public and other stakeholder feedback, as further described in Section 10.3.1.4. As the proponent of the Project, OPG will be responsible for implementation of the mitigation measures and for carrying out the follow-up program.

3.2.6 Assessment of Effects of the Project on Sustainability

The Guidelines require that the EA consider the capacity of renewable resources that are likely to be affected by the Project to meet the needs of the present and future generations. This requirement is consistent with the United Nations World Commission on Environment and Development's definition of sustainable development as *"…economic development that meets the needs of the present without comprising the ability of future generations to meet their own needs"* (UN WCED 1987a).

The CEA Agency's *Sustainable Development Strategy 20-year Vision* (CEA Agency 2006) acknowledges that *"a project EA is a vital step in implementing sustainable development"*. Further, the Strategy acknowledges that *"EA is an effective tool for addressing local environmental concerns associated with a specific development; it is not designed for debating broader environmental regional or policy issues"*. As such, it is reasonably concluded that an individual project EA, such as this one, is not expected to address or resolve broad-based environmental policy issues.

The purpose of the sustainability assessment included in this EIS for the NND Project was to consider, in an integrated manner, the net ecological, economic and social benefits to society and the overall extent to which the Project is supportive of sustainable development. Specifically, as required by the Guidelines, the assessment was to consider:

- The extent to which biological diversity may be affected by the Project; and
- The capacity of renewable resources that are likely to be significantly affected by the Project.

In considering sustainability, each of the above-noted evaluation pillars (ecological, economic, social) was correlated to a set of sustainable development considerations (or visions) synthesized from the stated objectives of the Region of Durham, the Municipality of Clarington and the City of Oshawa. Goals and objectives were defined and a sustainability scorecard completed to evaluate actions or progress towards sustainability that considered the likely interactions between the sustainability visions and the Project. These interactions were measured within three levels; diminish, maintain and enhance allowing a collective judgement of sustainability.

A full discussion of sustainability, including the approach taken to the assessment of potential effects on sustainability, is presented in Section 6.1.

3.2.7 Adherence to the Precautionary Principle

The EA activities were completed under a Quality Management System. This system has been certified to be in conformance with the requirements of ISO 9001:2008. In addition, assignment-specific quality steps were implemented. Key elements included:

- A Quality Coordinator was assigned to the EA assignment;
- A non-conformance and corrective action process was implemented to identify, isolate and correct any deficiencies;
- A specialist with expertise in EAs and the specific environmental discipline was assigned to lead the preparation of each TSD;
- Peer reviews were completed by independent specialists on the technical studies and the TSDs;
- Technical reviews were performed by independent personnel at OPG; and
- An acceptance review of the final EA documentation was performed by OPG.

The Guidelines require that the EA consider the Project through application of a "careful and precautionary manner" in order to ensure that it does not cause significant adverse environmental effects. The Guidelines refer to the document entitled *A Framework for the Application of Precaution in Science-based Decision Making About Risk* (CPC 2003). As indicated in the framework, its purpose is to set out precautionary principles to guide decision-making where there is an absence of full scientific certainty.

The EIS and the studies that it represents have been completed with regard for this "precautionary principle" such that sufficiently confident decisions can be made to protect society's values and priorities. Key themes relative to this principle and which are carried throughout the EIS include that:

- Qualified professionals fully experienced in their fields performed the work within a structured, organized approach;

- Industry standards and best practices, including peer review of technical programs were applied;

- Uncertainties inherent in the use of computer models were compensated through routine application of conservative Project design assumptions and model input parameters;

- The use of bounding conditions for assessment of effects purposes will routinely result in over-estimates of likely effects with associated confidence that the likely effects are lower than those predicted; and

- The EA program will conclude with a comprehensive follow-up and monitoring program, including adaptive management as a key feature to respond to scientific uncertainty and provide for informed decisions and actions going forward.

The Guidelines also require that the proponent indicate how the precautionary principle was considered in the design of the Project in at least the following ways (Guidelines requirement is written in italicized font and is followed by the EIS response to the requirement in normal font):

1. *Demonstrate that all aspects of the Project have been examined and planned in a careful and precautionary manner in order to ensure that they do not cause serious or irreversible damage to the environment and/or the human health of current or future generations*;
   The key aspect of this requirement of the precautionary principle is the assurance that the Project being assessed is fully understood and that all of its appropriate elements are considered in the EA. In the case of the NND Project, this requirement is addressed in several ways. First, the Project has been defined in a bounding framework, as described in Section 2.1. This results in a conservative description of the Project and ensures that the full reasonable range of all of its variables is bracketed within the envelope of possibilities (e.g., in terms of radioactive emission, the EA considers the aggregated maximum concentration of released radionuclides from all the AC-1000, EPR and AP1000 reactors to create a hypothetical hybrid of the three).

   Secondly, for purposes of the assessment of effects, the Project is defined in terms of its individual works and activities, with each being described in a manner that allows the assessment team to determine if and how each would interact with, and potentially affect the individual subcomponents of the environment (see Sections 2.5 and 2.6). Each Project-environment interaction then serves as a focus for evaluating the environmental consequences of the interaction.

   Thirdly, the EA methodology provides for an ecosystem approach to the assessment of effects rather than one that is constrained within the individual environmental components. The ecosystem approach is facilitated by the selection of VECs which acknowledge the connections among the environmental components and supports the consideration of possible synergistic effects among the components. For example, several VECs (e.g., within the Atmospheric, Surface Water, and Geological and Hydrogeological Environments) represent pathways by which environmental change and effects may be transferred to other components. Changes in these pathways (e.g., increased contaminants in air) were subsequently considered within other appropriate environmental components to determine if the changes would affect VECs in the receiving environment (e.g., the effect of increased contaminants in air on human and non-human biota).

2. *Outline and justify the assumptions made about the effects of all aspects of the Project and the approaches to minimize these effects*;

   Because an EA is typically conducted as early as possible in the planning stages, full design details of the project are often not available. As has been noted, this is the case for the NND Project EIS; therefore, some degree of assumption was necessary to conduct the assessment. The primary technique applied to reduce uncertainty of the assessment as a result of assumptions made was the use of the bounding envelope approach to describe the Project. This resulted in a conservative bounding envelope forming the boundaries for assessment in the knowledge that the Project as ultimately defined is likely to be well within the bounded parameters.

   Also to facilitate the assessment of effects in the absence of a detailed design for the Project, additional assumptions concerning design features, predictive modelling parameters and mitigation measures were also made, as appropriate. These assumptions are described in the respective sections of this EIS describing the assessment of effects (i.e., Sections 5.2 through 5.14). All modelling parameter assumptions have been deemed as appropriate and valid based on the extensive experience and knowledge base relevant to construction and operation of nuclear facilities. Mitigation measures considered in the assessment include "in-design" measures which are inherent aspects of design and will be integrated as such into the Project. Additional mitigation measures were identified through this EA process. These are included as EA-related commitments and will be tracked as such through the EA follow-up program (see Chapter 11). As noted in Section 11.5, the concept of adaptive management is inherent in the design and implementation of the EA follow-up and monitoring (and related) programs.

3. *Alternative means of carrying out the Project are evaluated and compared in light of risk avoidance, adaptive management capacity and preparation for surprise;*

   The alternative means of implementing the Project that were deemed reasonable have been evaluated and are included in the EIS (see Section 2.2). As with all aspects of the EA, the approach taken for consideration of alternative means was conservative and fully compliant with the precautionary principle. Specifically, as described in Section 2.3, the alternative means considered were incorporated within the Project bounding envelope assessed. In this way, therefore, the potential environmental effects associated with all variations of the Project were evaluated collectively.

The conclusion of this EIS (as stated in Section 13.3), that the NND Project will not result in any significant adverse environmental effects considers the Project as implemented in any of its variations. To the extent feasible, the alternative means of implementing the Project have been compared in Chapter 13.

4. *In designing and operating the Project, priority has been and will be given to strategies that avoid the creation of adverse impacts*;

   The Project is early in its planning and design stages. This EIS and the studies that support it have been carried out early in the evolution of the Project and will serve to support the design, construction and operating phases in terms of environmental effects management. As noted under point 2 above, in-design mitigation measures have been identified and endorsed in this EIS as commitments of the proponent; as have additional EA-related measures to further mitigate effects. Many of the mitigation measures are elements of Good Industry Management Practice that will be applied as a design and operational standard throughout the Project. All mitigation measures will be subjects of the EA follow-up program to ensure they are appropriate and effective.

5. *Contingency plans must explicitly address worst-case scenarios and include risk assessments and evaluations of the degree of uncertainty*;

   The use of the bounding envelope approach ensures that reasonable "worst case conditions" are considered inherently in the assessment of effects. Subsequent stages of Project design will include development of an environmental management plan (EMP) that will consolidate the strategic-level program for managing, through pro-active and pre-emptive means, the environmental effects of the Project. The EMP will include contingency measures to address conventional (non-radiological) upset conditions; and specific security and safety programs typical of current practice at operating nuclear facilities will be in place to address radiological hazards, including as a result of upset conditions. Finally, Chapter 7 of this EIS presents the assessment of the possible consequences of malfunctions, accidents and malevolent acts, including the preventative and contingency measures in place to consider such events.

6. *Identify any proposed follow-up and monitoring activities, particularly in areas where scientific uncertainty exists in the prediction of effects;*

   The Guidelines require that the EIS include a framework upon which environmental effects monitoring and follow-up actions will be based throughout the life of the Project. The framework for the follow-up and monitoring program is provided in Chapter 11.

This is a preliminary outline of the program and on-going planning and design of the Project will include corresponding refinement of the follow-up plan. For implementation, the individual monitoring requirements for each of the environmental components will be combined to form a single, integrated program that will address all aspects of EA follow-up.

7. *Present public views on the acceptability of all of the above;*

The NND Project Communications and Consultation Program was designed to meet the requirements of the *CEAA* and the *NSCA* for consultation. It has afforded the public and other stakeholders full opportunity to follow the progress of the EA studies and the NND Project as a whole, and to contribute to the EIS. A number of the communications and consultation events included information concerning the above-noted features of the Project and the EIS which have been highlighted as relevant to the precautionary principle as applied for this EIS (e.g., bounding envelope, alternative means, environmental effects and mitigation measures, follow-up monitoring). The program details and the input received from the public and others are provided in Chapter 10 of this EIS.

3.2.8 Assessment of Effects of the Environment on the Project

Natural hazards or conditions in the environment that are likely to affect the Project were identified based on past experience at the DN site and professional judgement of the specialists conducting the EA. These natural hazards and conditions are described in Chapter 6 and include severe weather, related flooding, seismicity and climate change. Assessment of the latter is guided by the document, *Incorporating Climate Change Considerations in Environmental Assessment: General Guidance for Practitioners,* issued by the Federal-Provincial-Territorial Committee on Climate Change and Environmental Assessment (FPTCCCEA, 2003).

Potential interactions between the environmental conditions and events and the Project were determined and for each hazard or condition, the design and contingency measures incorporated into the Project to mitigate the effect of the hazard or condition were identified and their effectiveness judged. The changes to the Project likely to result from the interactions notwithstanding the mitigation measures were determined and evaluated; and the consequential effects on the environment as a result of the changes to the Project were identified and evaluated.

3.2.9 Assessment of Credible Malfunctions, Accidents and Malevolent Acts

The potential interactions between Project works and activities and the existing environment were also identified with respect to credible malfunction and accident scenarios and malevolent acts. These scenarios are described in Chapter 7 and include:

- Conventional malfunctions and accidents - by definition involve no radiological substances and, therefore, have no potential for release of radioactivity;
- Radiological malfunctions and accidents - events that involve radioactive substances and components (e.g., processing, handling and storing of nuclear wastes; removal and preparation of steam generators for transportation) and therefore have the potential for release of radioactivity;
- Transportation accidents - those malfunctions and accidents related to the off-site transportation of low and intermediate-level radioactive wastes;
- Nuclear accidents - events that involve the operation of the reactor and associated systems, and may involve damage to fuel in the reactor core and, therefore, could result in an acute release of radioactivity to the environment;
- Out-of-core criticality - events that involve criticality outside the reactor core resulting from improper spacing or moderation of nuclear fuel enriched in uranium and that may result in an acute release of radioactivity to the environment; and
- Malevolent acts - events that are initiated by an intentional or deliberate act intended to cause damage.

The focus of this aspect of the assessment is on those events that are considered credible in the context of the Project. It is not the intent of the EA to address all conceivable abnormal occurrences, but rather to address only those that have a reasonable probability of occurring. For conventional and radiological malfunctions and accidents (i.e., excluding nuclear accidents), a “credible event” is defined as one that has a reasonable probability of occurrence based on professional judgement in a context of project-specific conditions. For consideration in an EA, the threshold identified by the CNSC for credibility of a nuclear accident scenario is that it has a one in one million (1×10^{-6}) or greater chance of occurring in any year

The assessment recognized that malfunctions and accidents may be precipitated by external factors, either natural or anthropogenic (i.e., human-made), in addition to those potentially arising from Project works and activities. In the context of this assessment, external factors that could lead to abnormal or upset conditions were considered "initiating events". Examples of such initiating events include lightning strikes, extreme weather, or human activities. It is noted that security events were not specifically considered as initiating events for purposes of this EA study.

Each malfunction and accident scenario was screened to determine whether an environmental effect (consequence) would be possible and whether further assessment was required. From this screening, bounding scenarios were determined. In general, the assessment and mitigation of potential effects from malfunction and accident scenarios followed a method similar to that outlined in the foregoing steps for normal Project construction and operation.

3.2.10 Assessment of Cumulative Environmental Effects

A cumulative environmental effect is a residual adverse environmental effect of the Project in combination with similar effects of other past, present or foreseeable projects. To be cumulative, the Project-related effect and the effect associated with the "other" projects or activities must be of a similar nature and overlap in both time and space.

Cumulative effects were assessed as follows:

- Project-related residual adverse effects were identified;
- Descriptions of other past, present or future projects and activities with potential to produce similar effects within the same timeframe and spatial boundaries as the Project, were developed. A preliminary list of such projects was developed and shared with the public and other stakeholders and they were requested to suggest others that they felt were important to consider from a cumulative perspective;
- The "other" projects and activities were considered individually in a context of each relevant environmental component to determine if potential effects associated with them would be likely to coincide in time and space with similar residual effects of the Project;
- If potential cumulative effects were suggested, additional mitigation measures with possible application to the Project were identified and the potential cumulative effect reconsidered to determine the likely residual cumulative effect; and

- The significance of any residual cumulative effects was evaluated in a context of the applicable VECs.

The cumulative effects assessment did not consider the effects of malfunctions and accidents because these events are hypothetical and have a low probability of occurrence. This is consistent with the CEA Agency's *Cumulative Effects Assessment Practitioners Guide* (CEA Agency 1999) which acknowledges that such events (i.e., malfunctions and accidents) are "rare" and should be assessed as "unique scenarios", as their potential effects are too extreme to be assessed together with those caused by normal operational activities.

3.2.11 Evaluation of Significance of Residual Environmental Effects

The significance of each adverse residual effect of the Project on the environment; of the environment on the Project; of malfunctions, accidents and malevolent acts; and of other projects and activities that could cause cumulative effects, was established within a framework of significance criteria and effect levels. Possible criteria for assessing significance were presented to the public in the second round of key stakeholder dialogue sessions in the fall of 2008 where participants were encouraged to provide feedback especially considering local knowledge as it related to the assessment of significance. The public was also asked to comment on the approach proposed to be used for determining significance at community information sessions held in Spring 2009 (see further discussion in Section 10.3.1.7).

The significance evaluation criteria as they were applied for the NND Project include magnitude, geographic extent, duration, frequency or probability, reversibility, physical and psychosocial human health, ecological importance, societal value and sustainability. Existing regulatory and industry standards and guidelines were used as points of reference; however, professional expertise and judgement are also important considerations in the assignment of significance.

Both the definitions and the parameters for the effects level within each criterion vary by environmental component to recognize that the units and range of measurement are distinct for each.

3.2.12 Communications and Consultation Program

The Communications and Consultation Program developed for the NND Project sought to ensure that all those potentially affected, or with a potential interest in, the Project were notified and had the opportunity to share their views about the Project through the following general steps:

- Communicate – inform stakeholders and share information;

- Consult – provide opportunities for information exchange and issue identification;
- Respond – ensure comments/concerns are dispositioned and publicly available; and
- Document – processes, process outcomes, issues, concerns and responses.

At the outset of the Project, a detailed plan was prepared to guide the Communications and Consultation Program. This plan reflected a commitment to conform with and exceed the consultation requirements of the *CEAA* and the Guidelines as well as the *NSCA* and the CNSC Regulatory Requirements for new nuclear power plants. The Communications and Consultation Program provided a broad range of opportunities for stakeholders to obtain information, ask questions, provide comments, data and input to the EA, and to identify and discuss any concerns they had with the Project. It also included a process to identify, document and address stakeholder issues as they arose during the EA.

Given the requirements and the community context, the following key principles were developed for the Communications and Consultation Program:

- Integration of the program at all times with OPG's communication activities, particularly those related to the DN site, while at the same time maintaining a distinct NND Project focus;
- Inclusion of all interested stakeholders and members of the public at a level of involvement suitable to their needs and interests;
- Flexibility to respond to unanticipated issues and stakeholder input throughout the study period; and
- Incorporation of issues, concerns, comments and perspectives brought forward in planning the Project and compiling the EIS.

The objectives of the Communications and Consultation Program were to:

- Communicate plans and activities to stakeholders and share information with them;
- Seek informed views, perspectives, issues and concerns from stakeholders;
- Respond to and incorporate issues/concerns/questions/perspectives; and
- Meet the requirements of the CNSC and CEAA and provide documentation of activities undertaken and comments and issues received.

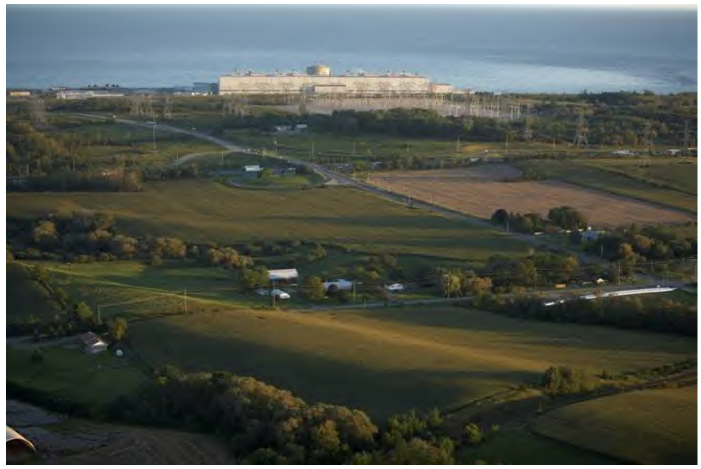
An important element of the Communications and Consultation Program was to ensure that the methodologies applied throughout the EA studies and reflected in the EIS were grounded in the perspectives of the community within which the Project will be implemented. Throughout the EA process, OPG sought community confirmation of the work carried out to date, and direction concerning the next steps. In particular, OPG requested, and received, community input to the following aspects of the EIS:

- Scope of the Project for EA Purposes;
- Selection of VECs;
- Determination of potential effects and possible mitigation measures;
- Development of criteria for determining significance of residual effects; and
- Identification of other projects for assessment of cumulative effects.

Complete details of community input sought and received in preparing this EIS are provided in Chapter 10.

4. DESCRIPTION OF THE EXISTING ENVIRONMENT

4.1 Introduction



The description of the existing environment focuses on those aspects of the environment that may potentially change as a result of the works and activities of the NND Project, including site preparation, construction, and continued operation and maintenance. This environmental baseline (i.e., the environment as it is now) is the basis for determining incremental changes and likely environmental effects associated with the Project.

Environmental studies have been conducted on and around the DN site since 1972. A large body of information on the physical, biological and social environments relative to the site and vicinity is available. The primary references for describing the existing environment on and around the site for this EIS are the TSDs that have been prepared for that purpose for each environmental component.

The conditions in the existing environment (i.e., baseline conditions) are described in a framework of each of the environmental components introduced in Section 3.2.3. The descriptions for each environmental component are generally organized according to the study area boundaries defined in Section 3.1.3. Typically, baseline conditions across the RSA are presented first, then the conditions in the LSA and finally, those in the SSA. Presenting RSA conditions first provides context for the more localized conditions in the LSA and the SSA. The baseline descriptions for each environmental component are presented in separate sections of this chapter and each description concludes with the identification of the VECs selected as relevant for that environmental component, considering the baseline conditions.

Consistent with typical EA practice, the focus of the baseline characterization programs for each environmental component was on those aspects of the environment that were likely to interact with, and be affected by, the Project. In this manner, those aspects of the environment most relevant in a Project-specific sense were the subjects of more detailed study than were those aspects that were unlikely to be affected, or only marginally affected, by the Project.

4.2 Atmospheric Environment

This Section provides an overview description of the existing Atmospheric Environment. The detailed baseline characterisation of the Atmospheric Environment is contained in the *Atmospheric Environment – Existing Environmental Conditions Technical Support Document, New Nuclear - Darlington Environmental Assessment*. The description is presented in the context of the following environmental sub-components:

- Air Quality: the physical (climate and meteorology) and chemical characteristics (non-radiological only) of the airshed in the vicinity of the DN site (radioactivity in air is addressed in Section 4.7); and
- Noise: sound level characteristics in the vicinity of the DN site.

4.2.1 Study Areas

The study areas described in Section 3.1.3 were considered for specific application for the Atmospheric Environment with modifications made as appropriate. The study areas as applied are described below.

<u>Regional Study Area</u>

The RSA applied for the Atmospheric Environment extends from Toronto in the west, to Belleville in the east, and north to Peterborough. It is noted that atmospheric conditions in the RSA are dominated by conditions in the Greater Toronto Area (GTA), the Golden Horseshoe and the Midwestern United States. Any changes in atmospheric conditions as a result of the Project are not expected to extend beyond the LSA and as such, Project-related effects in the RSA are not anticipated.

<u>Local Study Area</u>

The LSA was adopted generally without change from the generic LSA. It extends approximately 10 km from the DN site and includes the sensitive receptors identified for considering potential environmental effects in the Atmospheric Environment; and other sources of emission in the general vicinity (e.g., St. Marys Cement and Highway 401) that will contribute to the existing conditions.

Site Study Area

The SSA was adopted generally without change from the generic SSA. It includes the DN site and extends approximately 1 km into Lake Ontario.

4.2.2 Climate and Meteorological Conditions

Climate and meteorological conditions are the primary factors affecting contaminant transport (dispersion) in the atmosphere. For example, the direction and speed of the wind determine the location and distance that a pollutant may travel; several factors including atmospheric stability and mixing height, influence contaminant mixing in the atmosphere; and contaminants in the air may be washed out by precipitation.

Climate normals (or climate averages) are arithmetic calculations based on observed climate values for a given location over a specific time period (typically 30 years with compilation every 10 years). The descriptions that follow were developed from the 1971-2000 data sets from meteorological stations in the RSA and at Pearson International Airport and from local meteorological data consisting of temperature, wind speed, wind direction and variability of wind direction for the period 1996-2000 collected at the DN site meteorological station located south of the Highway 401 at Holt Road.

4.2.2.1 Regional and Local Climate

Temperature

Temperature data have been collected on-site during the period of 1996-2000. Over this time, the mean daily temperature was 8°C. The mean daily temperatures were below 0°C in December, January, February and March. The coldest month was January, with mean daily temperatures in the vicinity of -5.5°C. Summer temperatures averaged 17.7°C, or higher. The highest daily mean temperature recorded was 20.0°C, which occurred in July. The 1996-2000 on-site temperatures were also representative of the regional data.

Precipitation

The Bowmanville climate station is the closest to the DN site and most typical of conditions in the SSA. That station reported an average annual precipitation of approximately 858 mm of which less than 11% was snowfall (1 cm of snow = 1 mm of rain) during the 1971-2000 period. Stations throughout the LSA and RSA reported annual total precipitation of approximately 800-900 mm during the same period.

In the regional area, average annual precipitation was approximately 793 mm at Toronto's Pearson International Airport (1971 to 2000), 878 mm at the Oshawa station (1971 to 2000), 832 mm at the Port Hope station (1971 to 1992) and 858 mm at the Bowmanville Mostert Station (1971 to 2000).

Fog

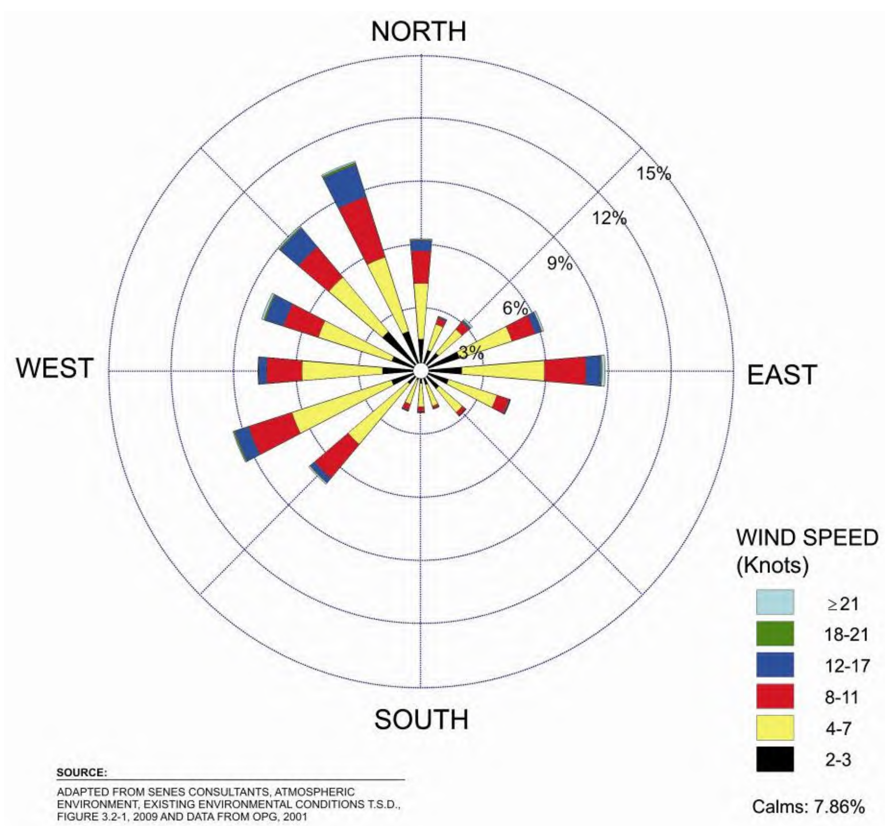
An average of 34 days of fog per year at Pearson International Airport was recorded during the period 1960-1990 (EC 1993). The average days per month with fog during this time ranged from four days to two days. At Trenton Airport, an average of 27 days of fog per year was recorded during the same period, typically with two days with fog per month. During the 1970-2000 period, the average number of days of fog per year at Pearson International Airport decreased to 27 and to 26 days at Trenton Airport (EC 2008c).

4.2.2.2 Regional and Local Meteorology

Wind

Wind data for the DN site meteorological station for the period 1996-2000 are presented in Figure 4.2-1 as a wind rose (a graphical representation of the frequency of winds from each direction). The average measured wind speed was approximately 2.6 m/s and calms were reported 8.9% of the time. The prevailing winds were from the northwest quarter (28% of the time), the west-southwest (10% of the time) and the east (9% of the time). Based on a review of wind patterns reported at Pearson International Airport, the distribution of winds in the RSA is generally similar to that at the DN site.

FIGURE 4.2-1
Wind Rose at DN Site (1996-2000)
(Source: OPG 2001)



4.2.3 Air Quality (non-radiological)

4.2.3.1 Regional Study Area

The ambient air quality in the RSA can generally be characterised by the monitoring data collected by Ontario Ministry of the Environment (MOE) throughout the GTA and southern Ontario. MOE air data from a number of monitoring stations in and beyond the RSA from 2000 through 2007 were examined, although with a focus on the stations in Oshawa, Peterborough and Belleville since they are considered to best reflect actual conditions in the RSA. For each contaminant, the reported data from the representative stations were averaged on a year-by-year basis and the maximum year within the period was selected to illustrate background concentrations. The maxima of the eight years for Oshawa, Peterborough and Belleville stations are summarised in Table 4.2-1.

TABLE 4.2-1
Background Air Concentrations (2000-2007) in the RSA
(Oshawa, Peterborough, Belleville)

Parameter	Averaging Time (hours)	MOE Standard (µg/m³)	50th Percentile (µg/m³)	90th Percentile (µg/m³)	Maximum (µg/m³)	MOE Annual Standard (µg/m³)	Annual Average (µg/m³)
Nitrogen Oxides (NO_x)	1	-	32	96	599	-	32
	24	-	37	87	223		
Nitrogen Dioxide (NO_2)	1	400	24	57	133	100[1]	20.9
	24	200	26	49	85		
Suspended Particulate Matter (SPM)[2]	24	120	-	-	-	60	-
Inhalable Particulate (PM_{10})	24	50	12	28	42	-	14.2
Respirable Particles ($PM_{2.5}$)	24	30	6	19	65	-	7.4
Carbon Monoxide (CO)	1	36,200	927	1568	3811	-	682
	8	15,700			2632	-	
Sulphur Dioxide (SO_2)	1	690	3	10	73	55	2.8
	24	275	2	9	29		

Notes
[1] Federal Maximum Acceptable Level (MAL) annual standard (no MOE standard).
[2] No measurements over this time frame.
Source: (MOE 2001a, 2003c, 2003b, 2004, 2006b, 2006a, 2007, 2008d).

The constituents in air at the monitoring stations in the RSA site are not substantially different from the general air quality reported in southern Ontario within the Quebec to Windsor corridor and the GTA. The substances that combine to produce smog or acid rain dominate air quality impacts. These include: carbon monoxide (CO), nitrogen oxides (NO_x – total of nitrogen dioxide, NO_2 and nitrogen oxide, NO), volatile organic compounds (VOCs), sulphur dioxide (SO_2) and particulate matter (SPM, PM_{10} and $PM_{2.5}$).

4.2.3.2 Local and Site Study Areas

The closest MOE air quality monitoring station to the DN site is located in Oshawa, approximately 10 km to the west. As such, MOE quality data alone are not adequate for effectively characterising air quality in the LSA and SSA. For this reason, the EA studies included a specific air quality monitoring program within the SSA and adjacent areas. Data from that program and information from other sources, including from the program associated with the Durham/York Residual Waste Study (Genivar and Jacques Whitford 2008a,b) and monitoring conducted by OPG during the EA studies carried out in 2001-2002 for the Darlington Waste Management Facility (DWMF), have been considered in characterising air quality in the LSA and SSA.

A summary of the air quality in the LSA and SSA in terms of parameters relevant to the NND Project and potential emissions associated with its implementation, is presented below.

Particulate Matter (SPM, PM_{10} and $PM_{2.5}$)

The DN site is located immediately west of the St. Marys Cement plant and the surrounding area is largely rural and operating farmland. Both of these uses contribute to seasonally elevated local particulate matter concentrations in air.

The 90^{th} percentile of the 24-hour average concentration of Suspended Particulate Matter (SPM) measured at three on-site locations during the EA studies ranged from 53 to 146 $\mu g/m^3$. The higher concentrations were at the monitoring station on the DN site east boundary, bordering the St. Marys Cement property and one of its main on-site haul roads. The 90^{th} percentile of the 24-hour average concentration of $PM_{2.5}$ at the same locations ranged from 18 to 34 $\mu g/m^3$ with the higher values also at the station near the St. Marys property. The measured SPM and $PM_{2.5}$ concentrations are generally similar to than MOE background concentrations with the exception of the sampling station near St. Marys, which is expectedly higher.

$PM_{2.5}$ monitoring associated with the Durham/York Residual Waste Study (conducted at a location approximately 1.5 km to the south of Highway 401 off Courtice Road) indicated a 90^{th} percentile concentration comparable to the regional level, while the 90^{th} percentile concentration of SPM was much lower. SPM concentration data collected for the DWMF EA indicated a 90th percentile concentration of 47 µg/m^3, which is significantly less than the regional level. (Because it is likely that the SPM levels in this vicinity are influenced by local traffic (e.g., on Highway 401 and area roads) it is speculated that the lower concentration observed during that campaign was a result of the siting of the monitor at some distance from public roadways and other potential sources).

Criteria Contaminants (NO_x, SO_2, CO)

Local concentrations of NO_x, SO_2 and CO were also measured as part of the Durham/York Residual Waste Study. Based on those measurements, the local 90th percentile levels of NO_x at 62.7 µg/m^3 averaged over 24 hours; and CO at 250 µg/m^3 averaged over 8 hours were lower than those elsewhere in the RSA; while the 90th percentile and maximum concentrations of SO_2 averaged over 24 hours, were higher than the Regional data set likely due to local sources of SO_2, including at the St. Marys Cement plant and testing of emergency equipment at DNGS.

Metals in Particulate

Collected particulate samples were analysed for metals content. All metals with MOE Annual Average Quality Criteria (AAQCs) were well below their respective limits. The metals that do not have AAQCs were compared to MOE Jurisdictional Screening Levels (JSLs). With the exception of magnesium, all quarterly metals analyses were below their respective JSLs. Magnesium is ubiquitous in nature and is also a nutritional component in agricultural soils. Its presence at the measured concentrations is not unexpected.

Trace Volatile Organic Compounds (VOCs), Polyaromatic Hydrocarbons (PAHs)

Several VOCs and PAHs are released during the combustion of fuel (i.e., in internal combustion engines). A conservative screening approach was used to determine the most restrictive constituent among these for evaluation purposes. Acrolein was found to be the most restrictive contaminant and was assessed as a surrogate for the other VOC and PAH constituents.

Acrolein concentrations are measured at various locations across Canada by Environment Canada. A monitoring station at Simcoe, Ontario was deemed appropriately representative of conditions in the LSA and SSA. The average acrolein concentration at the Simcoe monitoring station is approximately 0.04 µg/m^3, with a 90th percentile of approximately 0.06 µg/m^3. The MOE AAQC for acrolein is 0.08 µg/m^3 (24 hour average). It is not unusual for measured acrolein concentrations in Ontario, particularly at urban locations and adjacent to large highways, to exceed this value.

4.2.4 Air Dispersion Modelling

Dispersion modelling was carried out to characterise current emissions from sources in the SSA and immediately-surrounding portions of the LSA. The parameters modeled included steam generator chemicals (associated with current operations at DNGS) and combustion products associated with testing of back-up power systems and vehicle emissions, including particulate (e.g., SPM, PM_{10} and $PM_{2.5}$). Emission sources included DNGS, St. Marys Cement and vehicle traffic on the local roads. The dispersion model used was the U.S. EPA AERMOD-PRIME model (AERMOD) (U.S. EPA 2004).

A number of specific receptors were selected to represent potentially sensitive areas for the Air Quality Assessment and the modelling results were expressed as concentrations at these locations. As applicable, the receptor locations and the modeled results were also applied for considering air quality related effects in the Human Health, Terrestrial and Socio-economic environmental components. Receptor locations are illustrated on Figure 4.2-2.

Figure 4.2-2
Receptors Locations

LEGEND:

+ Receptors Location

SOURCE:
ADAPTED FROM SENES CONSULTANTS, ATMOSPHERIC ENVIRONMENT, EXISTING ENVIRONMENTAL CONDITIONS T.S.D., FIGURE 4.2-1, 2009

Date: September 2009

Project: 34500

ONTARIO POWER GENERATION

The primary sources of emissions to air from the DNGS facility are related to combustion equipment (nitrogen oxides, suspended particulate matter, sulphur dioxide and carbon monoxide) for testing emergency and back-up power equipment, and emissions of treatment chemicals from the steam generators (acetic acid, ammonia, formic acid, glycolic acid and hydrazine). Table 4.2-2 presents the estimated maximum ½ hour average emission rate for each constituent along with their respective MOE ½-hour Point of Impingement (POI) limits, where available. To create an effective baseline condition, the existing conditions as represented in the table were included in the model.

TABLE 4.2-2
Estimated Maximum ½-hour Average Concentrations for Existing Conditions at DN Site Boundary from Primary Emission Sources

Chemical Parameter	Max ½ Hour Emission Rate (g/s)[1]	Maximum ½ Hour POI Concentration (µg/m³)	MOE Criteria (µg/m³)	Percentage of Criteria
Steam Generator Treatment Chemicals				
Acetic acid	0.03	0.355	2500	0.01%
Ammonia	20.35	241	300	80.3%
Formic acid	0.00014	0.039	1500	<0.01%
Glycolic acid	0.023	0.027	0.3	9%
Hydrazine	0.214	1	1[2]	NA
Combustion Sources[1]				
Nitrogen oxides	22.5	440	500	88%
Suspended particulate matter	1.66	35	100	35%
Sulphur dioxide	0.95	38.3	830	4.6%
Carbon monoxide	4.19	86.17	6000	1.44%

Source: (OPG 2008)

[1] O. Reg. 346 does not apply to emissions from road traffic; emissions from vehicular movement on and off-site are not included in this calculation.
[2] There is no ½ hour POI criteria for hydrazine. This value is an MOE agreed upon site specific ½ hour concentration for hydrazine. Note that the ESDM describes an emission scenario, in which the maximum possible hydrazine emission rate was applied.

As well as on-site sources, the modelling also considered the larger sources in the immediate area which contribute to the local air quality, namely local roads including Highway 401 and St. Marys cement plant. Emission estimates of CO, NO_x, SO_2, and SPM from all combustion sources were calculated based on data from the application for existing Certificate of Approval (C of A) for air emissions from DNGS. PM_{10} and $PM_{2.5}$ for all combustion sources were derived from the emission factors also cited in the C of A.

Source inputs to the model included vehicle emissions (i.e., road dust and tailpipe exhaust) from employee traffic and delivery vehicles and various contaminants from on-going maintenance and operational activities at DNGS (e.g., laboratories, maintenance welding, painting etc.). Most, including operation of the ventilation systems, contribute only trace levels of substances to the

LSA and RSA and did not warrant further consideration. Others (e.g., testing of standby generators) were included in the assessment.

So as to establish baseline air quality of relevance in the vicinity of the DN site, the current emissions from the St. Marys Cement plant which is located directly east of the DN Site, were also considered. These included particulate matter (SPM, PM_{10} and $PM_{2.5}$), NO_x, SO_2 and CO.

Detailed modelling parameters and results are provided in the *Existing Environmental Conditions, Atmospheric Environment Technical Support Document*. In summary, however, on the basis of the dispersion modelling, for steam generator chemicals, the predicted concentrations in air at the closest sensitive receptors for all modelled parameters are less than 60% of their respective 24-hour criteria, and less than 4% of their respective derived annual criteria.

The other conventional air quality parameters are products of fuel combustion largely attributable to traffic associated with Highway 401 and surrounding local roads. The predicted concentrations of NO_2, SO_2 and CO are below their applicable criteria for all time frames. With the exception of receptors in close proximity to Highway 401, the predicted air concentrations for SPM, PM_{10}, $PM_{2.5}$ and acrolein are below their applicable criteria. The maximum predicted 24-hour average SPM and acrolein concentrations are infrequently (less than 0.2% of the time) predicted to exceed the 24-hour average criteria at one residential receptor location in close proximity to Highway 401. This finding is consistent with observations at locations in close proximity to heavily travelled roads.

4.2.5 Ambient Noise Conditions

The noise environment in the vicinity of DN site is typical of an urban setting and is influenced by several noise sources including DNGS, traffic on Highway 401 and local roads, the CN rail line and the St. Marys Cement plant. The DN site is bounded by Lake Ontario to the south and as a result, shoreline wind and wave noise also contribute to the background noise. In addition, other sounds of nature such as rustling leaves and chirping birds influence the existing noise environment. Based on the existing sound environment at the DN site and the applicable receptors, the SSA is defined as a “Class 1 Area” under Ontario regulation (MOE 1995b). A "Class 1 Area" is defined as “an area with an acoustical environment typical of a major population centre, where the background sound level is dominated by the urban hum.”

Continuous sound level monitoring was conducted at two of the closest residential receptors to the west and north of the DN site (R15, R23 on Figure 4.2-2). The sound environment at both locations is dominated by road traffic from Highway 401 and to a lesser degree from local roads. The measured minimum background sound levels (hourly energy equivalent - L_{eq}) at these receptor locations were 44.7 dBA and 46.2 dBA, respectively. The measured maximum background sound levels were 63.4 dBA and 62.3 dBA, respectively. No significant difference was observed between average daytime and night-time sound levels at either location. Daytime and night-time sound levels exceeded 50 dBA approximately 80% of the time at receptor location R15 and over 90% of the monitoring time at receptor location R23. The range and distribution of sound levels at these locations indicated that the sound environments are typical of a Class 1 Area.

On-site spot sound measurements were taken at 50 locations on the DN site during the EA studies to identify the presence of any steady on-site noise sources containing tonal components. Overall, with a few exceptions (e.g., in the vicinity of the on-site transformers), the sound levels on the DN site do not include strong tonal components.

Predictive modelling was carried out to establish the sound levels at other receptor locations selected for assessment in the EA, including as they may be applicable for consideration of effects in other environmental components (e.g., Human Health, Socio-economic). The modeling considered current noise associated with the SSA and vicinity (i.e., from DNGS, St. Marys Cement, traffic). The receptor locations are illustrated on Figure 4.2-2. Modelled daytime average conditions ranged from a low of 46.5 dBA (receptor location R2) to a high of 68.8 dBA (receptor location R20). Modelled night-time average conditions ranged from a low of 40.3 dBA (receptor location R2) to a high of 64.3 dBA (receptor location R20).

A separate modelling program was carried out to establish a baseline sound condition more directly relevant to the Terrestrial Environment. This modeling was completed on a 24-hour basis and included rail noise as a component of the background condition. Rail noise is typically not included when establishing background sound levels because the irregular frequency and duration of train passes creates noise that is considered intrusive and a receptor is unlikely to become acclimatised to it due to its unsteady nature). The modelling included a prediction of sound levels at each of the above-noted receptor locations as well as at a series of additional receptors identified specifically for the Terrestrial Environment. The predicted 24-hour equivalent sound levels ranged from 47.4 dBA to 67.6 dBA.

4.2.6 Valued Ecosystem Components

Changes in atmospheric conditions as a result of constructing and operating the Project may contribute to effects on human health, on non-human biota health and on VECs in other environmental components. Accordingly, changes to the Atmospheric Environment will be considered within other environmental components so as to evaluate the potential environmental effects on appropriate receptors (i.e., VECs) in those components. As such, Air Quality and

Noise are considered pathways to effects in other environmental components and VECs specific for the Atmospheric Environment have not been identified.

VECs as pathways from the Atmospheric Environment are summarised in Table 4.2-3.

TABLE 4.2-3
VECs (as Pathways) for the Atmospheric Environment

Sub-Component	VECs as Pathways	Rationale
• Air Quality • Noise	Pathway to human health	The effects on humans associated with changes in atmospheric conditions (air quality and sound levels) will be considered in the Human Health component.
	Pathway to non-human biota health	The effects on non-human biota associated with changes in atmospheric conditions (air quality and sound levels) will be considered in the Non-Human Health and Terrestrial components.
	Pathway to VECs in other environmental components	The effects on VECs in other environmental components associated with changes in atmospheric conditions will be considered in the applicable environmental components. These will include effects on Aquatic Environment Non-Human Health and Terrestrial Environment VECs as a result of changes in air quality and other physical parameters (e.g., sound levels).

The process of selecting VECs has been described in Section 3.2.4 and as indicated, consideration of input from the public and other stakeholders was an important aspect of finalizing those to be used. Stakeholder contribution to the VEC selection program is summarized in Section 10.3.1.3. A key aspect of stakeholder input to the overall EA program not acknowledged to this point, however, was the responses by interested parties to the draft EIS Guidelines published for comment by the CEA Agency. All responses with respect to suggested VECs were reviewed by the EA team. Suggested VECs relating to the Atmospheric Environment were resolved as follows:

- Add Air – Radiation as a VEC: radiation and radioactivity, including in air and other media, is included as a pathway for effects on VECs in other environmental components (see Section 4.7.9).

4.3 Surface Water Environment

This Section provides an overview description of the existing Surface Water Environment. The detailed baseline characterisation of this environmental component is contained in the *Surface Water Environment – Existing Environmental Conditions Technical Support Document, New Nuclear – Darlington Environmental Assessment*. The description is presented in the context of the following environmental sub-components:

- Lake Circulation: lake-wide circulation characteristics; near-shore lake current direction and velocity; water velocities and directions in the vicinity of cooling water intakes and discharges; and cooling water withdrawal volumes and rates;

- Lake Water Temperature: lake-wide thermal regime; and nearshore mean temporal and spatial temperature variations;

- Site Drainage and Water Quality: stormwater and liquid effluents from the site and the resultant receiving water quality; and

- Shoreline Processes: processes that affect the nearshore conditions in the vicinity of the DN site (e.g., geomorphic setting and bathymetry; sediments; Lake Ontario water levels; wave conditions; and ice behaviour); sediment transport and deposition (the chemical characteristics of sediment are considered in Sections 4.14 and 5.14 in terms of associated effects on non-biota).

4.3.1 Study Areas

The generic study areas described in Section 3.1.3 were considered for specific application for the Surface Water Environment with modifications made as appropriate. The study areas as applied are described below.

Regional Study Area

The RSA for the Surface Water Environment includes the portion of Lake Ontario where there may be some potential for cumulative effect on water quality, currents, temperature or substrates. This area extends generally from the Pickering-Toronto municipal boundary in the west to the Town of Cobourg in the east and into the lake a distance of 5 km from shore. The on-land portion of the RSA includes the watersheds for all tributary streams that flow into Lake Ontario along the length of the shoreline for the lake portion of the RSA.

Local Study Area

The Lake Ontario portion of the LSA for the Surface Water Environment is generally consistent with the generic LSA. It extends approximately 7 and 9 km both east and west of the DN site, respectively, and approximately 3 km from the shoreline. This area encompasses the expected maximum extent of the measurable thermal plume from the Project as defined by the area that may experience a temperature difference of 2°C above ambient conditions less than 1% of the time. The on-land portion of the LSA extends considerably further inland than does the generic LSA and includes the watersheds for any streams that flow into Lake Ontario within the LSA. Although there is no reasonable potential for a direct surface water effect on drainage basins outside of the SSA, these watersheds are included since they, in fact, may affect the water quality in the LSA.

Site Study Area

The SSA for the Surface Water Environment is generally consistent with the generic SSA in that its on-land portion is defined by the DN site. However, the Lake Ontario portion of the SSA has been extended approximately 2 to 3 km from the DN site boundaries in both directions along the shoreline and into the lake from the shoreline to account for the potential range of locations for the cooling water intake and outfall diffuser(s).

4.3.2 Lake Circulation

4.3.2.1 Lake-Wide Circulation

Circulation patterns in the RSA are generally reflective of those at the lake-wide level. The primary meteorological and hydrological influences on Lake Ontario's circulation are the eastward flows from the Niagara River coupled with the discharge to the St. Lawrence River, as well as wind shear. These influences and, to a lesser degree, the effects of the Earth's Coriolis Force, result in a counter clockwise movement of currents along the eastern shore and within the sub-basins of the main lake. Although there is very little net flow along the northern shore, the dominant counter-clockwise gyre within the central and eastern portions of the lake results in a considerably weaker clockwise gyre in the northwest with local wind conditions determining the direction of flow along the northern shore. Reversals of the nearshore current direction along the northern shore are common following brief patterns of strong winds exerting stress at the water surface. However, the response takes time and there is generally a temporal lag between shifts in wind and current direction.

During the winter months, wind stress drives the entire depth of water in the longshore component of the wind direction. In spring, more rapid warming of nearshore than offshore waters creates pressure gradients due to density differences and results in warmer water being pushed offshore. This horizontal circulation can persist for over a month until thermal stratification has stabilised throughout the entire lake. During summer and fall, buoyancy associated with thermal stratification has some effect on the lake circulation pattern, although lake circulation is still predominantly driven by winds.

4.3.2.2 Nearshore Circulation

Conditions in the LSA and SSA are primarily a function of nearshore circulation patterns. A direct comparison of historic (pre-operational) and existing (operational) nearshore conditions has established that nearshore currents in the vicinity of the DN site have been affected by the DNGS discharge (Ontario Hydro 1997a, Armstrong and Burchat 1999). The discharge essentially forms a barrier to longshore water movement during low energy periods and that this effect is reduced as current speeds increase. During low current speeds, the diffuser discharge deflects longshore currents offshore, with higher current speeds, although penetrating the diffuser mixing zone, being reduced on the lee side of the diffuser. Over the period from 1997 to 2007, the average easterly and westerly current speeds were found to be approximately 9 cm/s.

4.3.2.3 Water Withdrawals and Discharges

Existing withdrawals of water from Lake Ontario by DNGS occur via a deepwater intake with discharges made through a diffuser manifold. Currently, DNGS withdraws and discharges water at a maximum design rate of approximately 144 m^3/s with four units in operation (Ontario Hydro 1997a).

Water is drawn from the lake via an 85-m diameter (approximately) porous bottom, submerged intake located at a distance of 700 m from the shoreline at a depth of 10 m. The intake is designed to minimize the impingement and entrainment of fish and the drawdown of cooling water (i.e., the maximum height above the intake from which water is drawn). As a result of the reduced intake velocities (compared to traditional intakes), the drawdown effects of the intake are limited to 5 m above the intake. Disruptions in the thermal regime are limited to a distance of approximately 250 m from the intake (Ontario Hydro 1997b).

The design objectives of the diffuser (with respect to environmental effects mitigation) were to minimize thermal and flow effects of the cooling water discharge by dispersing the water over a large area. Accordingly, the entire structure extends 1,600 m into Lake Ontario with a diffuser length of 900 m. The first pipe segment from shore to about 700 m offshore is a tunnel beneath the lake bottom. The second diffuser segment, from about 700 to 1,600 m, has exit ports that sit on the lake bottom at depth contours of 10 to 12 m. There are 90 ports over the entire length of the diffuser.

The localised effects of the diffuser ports have been studied (Armstrong and Burchat 1999). The discharge jet was evident at all times (at a depth of 6-8 m) at a distance of 6 m from the port, although this effect was substantially reduced at a distance of 12 m, with the discharge jet only evident about 50% of the time (during a limited period of observation between April 10-18, 1995).

4.3.3 Lake Water Temperature

4.3.3.1 Lake-Wide Thermal Regime

Lake water temperatures in the RSA are generally reflective of those at the lake-wide level. As with most large lakes in Canada, Lake Ontario is dimictic, meaning that it stratifies and mixes twice each year, typically in June and September. Horizontal patterns in water temperature typically occur in the spring when the nearshore waters warm faster than the offshore areas. The division between the warmer near-shore waters and the cooler off-shore waters is referred to as a thermal bar. The thermal bar generally forms close to the shoreline (e.g. within 1 km) in April. The thermal bar slowly migrates offshore during April, May and June and usually dissipated in mid-June as the lake-wide thermal stratification occurs.

Lake-wide surface temperatures range from freezing in the winter to approximately 20ºC in the summer (Beak 1990). Ice formation in the winter is typically limited to the nearshore areas and within the Kingston Basin at the eastern end of the lake.

4.3.3.2 Near Shore Thermal Regime

Conditions in the LSA and SSA reflect the near-shore thermal regime. OPG (and formerly Ontario Hydro) has collected detailed temperature data in the vicinity of the DN site since 1984 at up to 34 locations. The mean monthly ambient water temperatures in the nearshore areas averaged between 1ºC in January to 18 ºC in August over the monitoring period. Temperatures were quite variable in the summer (July to September) with the maximum mean monthly temperature ranging from 15.6 ºC to 20.3 ºC, while there was little variation in winter months (January and February).

During normal operation, the water temperature increases between the intake temperature and the discharge temperature averaged approximately 11.5ºC+ (based on data from 1993 to 1998 with all four units operating).

Ontario Hydro completed several detailed studies to determine the effectiveness of the diffuser in dissipating the thermal plume. Two types of plumes were measured during the studies. A warm plume exists when the temperature of the water discharged at the bottom of the lake is higher than the ambient surface water temperature. The warm plumes tend to be positively buoyant and spread on the surface. In contrast, a cold plume exists when the discharge temperature is less than the ambient surface water temperature. Cold plumes are only possible when the plant intake is drawing water that is below the thermal stratification layer. Cold plumes are infrequent and, at DNGS, it is more common that the discharge is mixed with cooler bottom water due to the depth of the diffuser and the frequency of upwelling events.

The maximum areal extents and the corresponding distances travelled alongshore to the east and west for both warm water and cold water plumes are indicated in Table 4.3-1. The areal extents presented in the table represent the area that contains all the plumes measured during the surveys. The area reported for any of the temperature increases are significantly larger than any of the individual plumes measured. The extent of the 1ºC differential (above or below ambient surface temperature) was measured to extend up to 6.9 km to the west and up to 3.5 km to the east.

TABLE 4.3-1
Maximum Surface Thermal Plume Extents

Temperature Increase (ºC)	Maximum Areal Extent (ha)[1]	Alongshore Length (km)[2]	
		West	East
Warm Water Plume[3]			
1.0	2,200	6.7	3.5
1.5	660	2.0	1.4
2.0	2.8	<0.1	<0.1
Cold Water Plume[4]			
-1.0	1,800	6.9	1.3
-2.0	560	2.3	0.2
-2.5	110	1.2[5]	0[5]
-3.0	87	1.0[5]	0[5]
-4.0	48	1.2[5]	0[5]

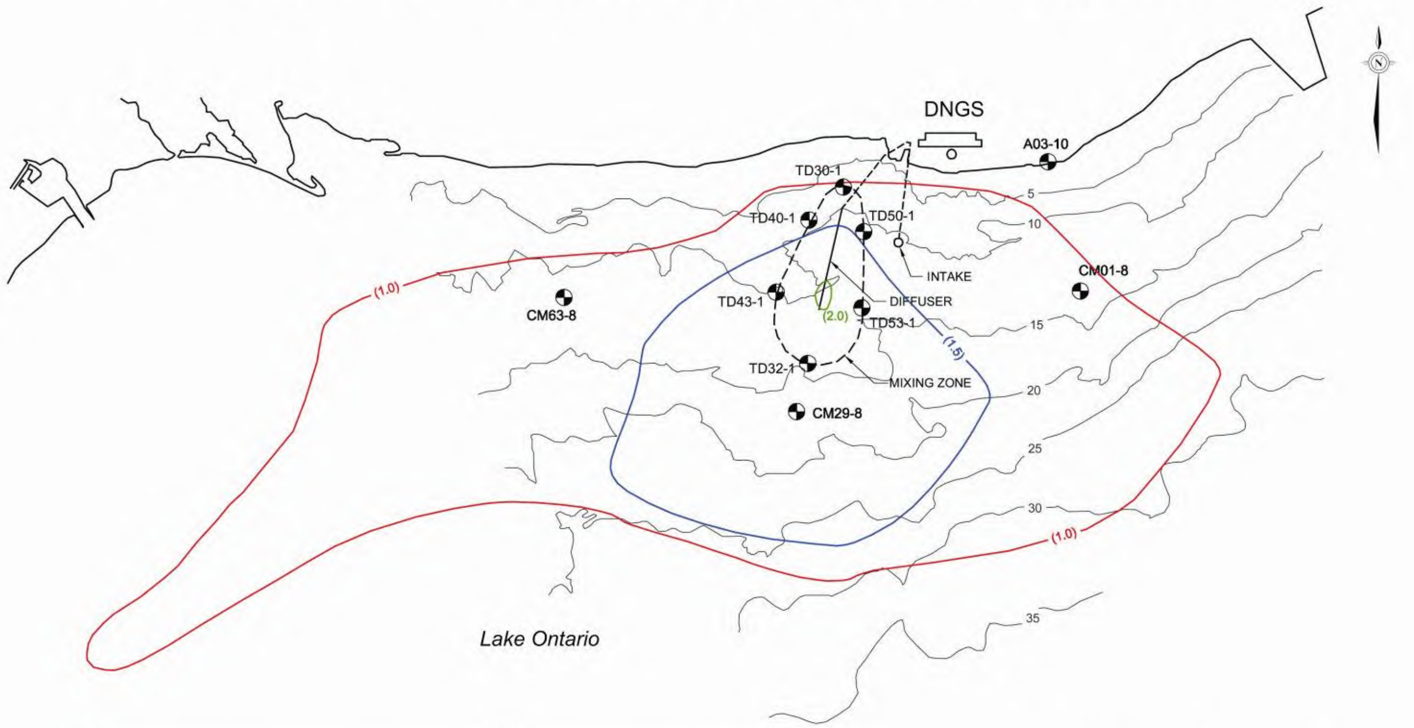
Notes:
1) Maximum area estimated to contain the thermal plumes measured during 31 studies.
2) Maximum along shore extent measured from existing diffuser
3) Conditions where discharge temperature is warmer than the ambient surface water.
4) Conditions where discharge temperature is cooler than the ambient surface water.
5) Surface plume temperatures greater than ±2ºC occur infrequently and maximum extents could not be accurately delineated.

The existing thermal plume has minimal recirculation to the intake and minimal effects in the temperature of the intake. The in-situ measurements indicated that the intake temperatures exceeded the ambient temperature by 2ºC less than 1% of the time (Burchat and Romanchuk 1997).

The nearest municipal intakes are located at Oshawa to the west and Bowmanville to the east, at distances of approximately 7.2 km and 7 km, respectively, from the DNGS site diffuser. Considering that the alongshore distance of the 1ºC above or below ambient plume was measured to extend up to 6.9 km to the west and up to 3.5 km to the east (Figures 4.3-1 and 4.3-2) it is expected that the effects of the existing thermal plume on the water temperatures are minimal at both of the intakes.

Figure 4.3-1

Historical Maximum Extents of Thermal Plume - Temperature Above Ambient



LEGEND:

- (1.0) ISOTHERM TEMPERATURE ABOVE AMBIENT (°C)
- 15 CONTOUR DEPTH (m)
- SAMPLING LOCATION

NOTES:

1. PLUMES WITH TEMPERATURE DIFFERENCES GREATER THAN 2°C (EG -2.5°C, 3.0°C, 4.0°C) OCCUR INFREQUENTLY AND COULD NOT BE ACCURATELY MAPPED
2. TH THERMAL PLUME EXTENTS WERE APPROXIMATED FROM THE IMAGES OF THERMAL PLUME STUDY CARRIED OUT BY ONTARIO HYDRO HYDROELECTRIC (DECEMBER 1997) AND DOCUMENTED IN REPORT NO. NK38-REP-02740-004-R00

800 0 800 1600
METRES

SOURCE:

ADAPTED FROM GOLDER ASSOCIATES, SURFACE WATER, EXISTING ENVIRONMENTAL CONDITIONS T.S.D., FIGURE 4.2-6, 2009

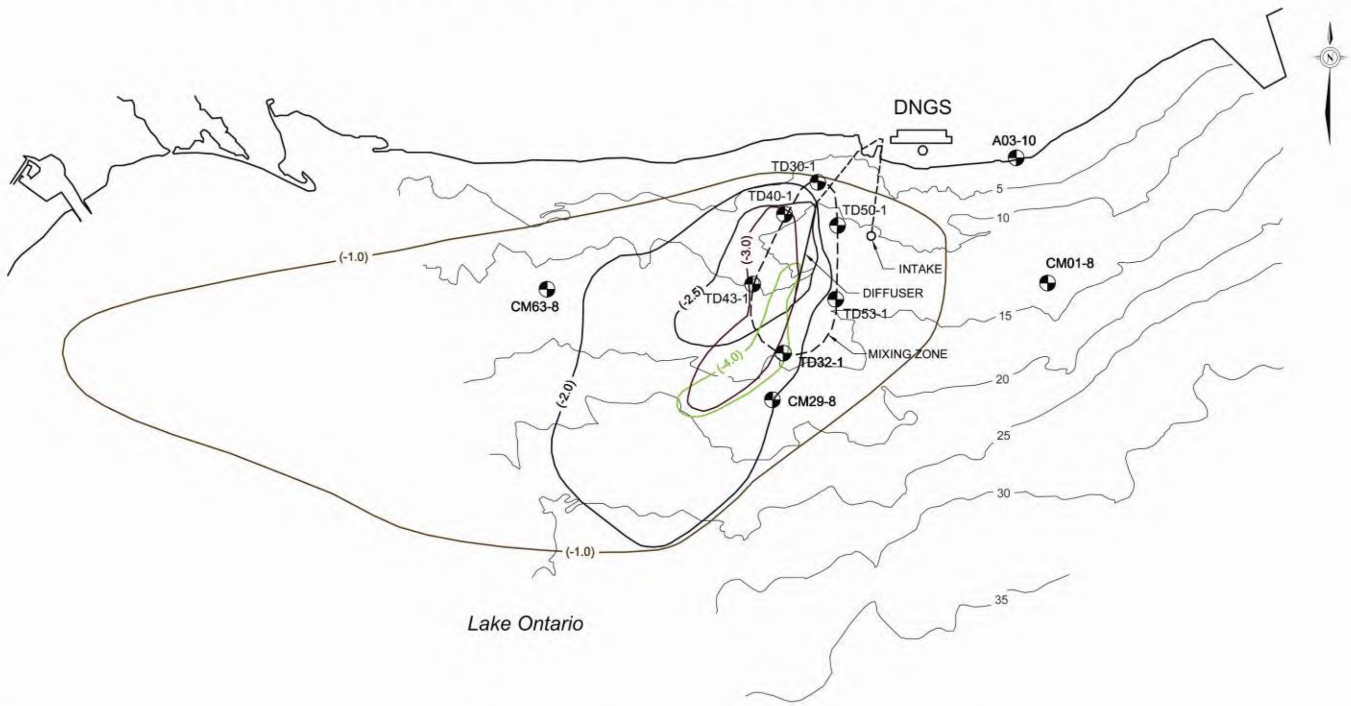
Date: September 2009

Project: 34500

ONTARIO POWER GENERATION

Figure 4.3-2

Historical Maximum Extents of Thermal Plume - Temperature Below Ambient



LEGEND:

- (-1.0) — ISOTHERM TEMPERATURE BELOW AMBIENT (°C)
- 15 — CONTOUR DEPTH (m)
- SAMPLING LOCATION

NOTES:

1. PLUMES WITH TEMPERATURE DIFFERENCES GREATER THAN 2°C (EG -2.5°C, 3.0°C, 4.0°C) OCCUR INFREQUENTLY AND COULD NOT BE ACCURATELY MAPPED
2. TH THERMAL PLUME EXTENTS WERE APPROXIMATED FROM THE IMAGES OF THERMAL PLUME STUDY CARRIED OUT BY ONTARIO HYDRO HYDROELECTRIC (DECEMBER 1997) AND DOCUMENTED IN REPORT NO. NK38-REP-02740-004-R00

800 0 800 1600
METRES

SOURCE:

ADAPTED FROM GOLDER ASSOCIATES, SURFACE WATER, EXISTING ENVIRONMENTAL CONDITIONS T.S.D., FIGURE 4.2-7, 2009

Date: September 2009

Project: 34500

ONTARIO POWER GENERATION

4.3.4 Site Drainage and Water Quality

4.3.4.1 Watersheds in the LSA

Watersheds in the LSA that discharge into Lake Ontario are shown on Figure 4.3-3. The main LSA watersheds to the east of the DN site include the Bowmanville-Soper Creek, Westside Creek and Darlington Creek. Watersheds west of the DN site include Tooley Creek, Black/Harmony/Farewell Creek, Oshawa Creek, Corbett Creek, Pringle Creek and Lynde Creek. These watersheds range in size from 57 ha (Robinson Creek) to over 16,000 ha (Bowmanville/Soper Creek). The average annual volume of water flowing into Lake Ontario along the shoreline from Bowman/Soper Creek to Lynde Creek is approximately 200 million m^3.

4.3.4.2 Drainage in the SSA

The DN site is approximately 480 ha in area, bisected into north-south sectors by the CN railway tracks. The general topography of the southern sector is relatively flat to gently sloping toward Lake Ontario. North of the railway tracks and east of the Holt Road, the site slopes toward the east.

Eighteen drainage areas were identified on the DN site with an estimated average annual runoff of about 2 million m^3 (Sharma 2002). Stormwater drains from the site though at least 22 outfalls, with 18 directly discharging to Lake Ontario, 11 of which are conduits discharging below the lake water level with the others outletting to swales, ditches or culverts. The four remaining drainage areas discharge to swales or streams on neighbouring properties to the east and west and ultimately to Lake Ontario.

The two natural water courses in the vicinity of the DN site that flow toward Lake Ontario are Darlington Creek on the northeast side and Tooley Creek on the northwest side of the DN site. Based on historical flooding, information collected from the local conservation authority and a review of the proposed works and activities in the vicinity of Darlington Creek, potential flooding issues relative to the new build due to Darlington Creek and Tooley Creek are considered negligible (see Section 6.2.1)

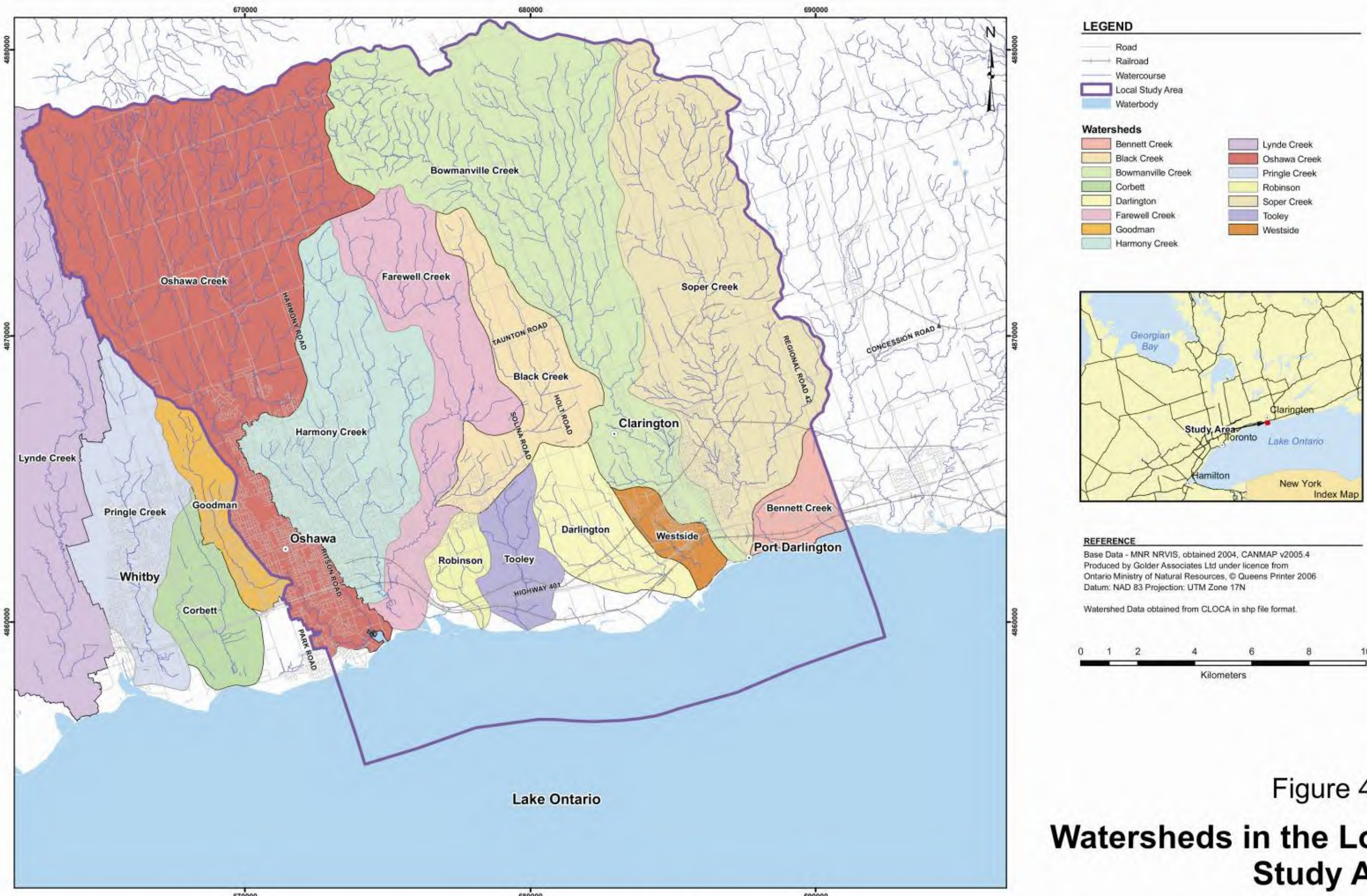


Figure 4.3-3

Watersheds in the Local Study Area

Date: September 2009

Project: 34500

SOURCE:
ADAPTED FROM GOLDER ASSOCIATES, SURFACE WATER, EXISTING ENVIRONMENTAL CONDITIONS T.S.D., FIGURE 4.3-1, 2009

ONTARIO POWER GENERATION

4.3.4.3 Stormwater Quality in the SSA

In 1995 and 1996, Ontario Hydro conducted a Stormwater Control Study at the DN site (Sharma 2002) following which a two-phase Stormwater Control Plan (Dunstall 2000) was initiated. Phase 1 of the plan consisted of remediation activities to reduce loadings of suspended solids and improve the quality of stormwater discharging to Lake Ontario. The second phase was an evaluation study, carried out in 2001 to assess the effectiveness of the work performed (Dunstall 2002). Phase 2 sampling was focused at four outfall locations. The results of the stormwater quality samples collected during the 1996 and 2001 studies are discussed below.

TSS concentrations observed at the DN site are usually within the range of typical urban stormwater concentrations, although some samples collected both in 1996 and 2001 exceeded the Durham Sewer Use By-Law limit. One of four composite samples analysed for PCBs in 2001 indicated a concentration of 0.1 µg/L (no PCBs were detected in 1996). Petroleum hydrocarbons were detected in the stormwater runoff both in 1996 and 2001. Concentrations of aluminum, iron, zinc, lead copper and cadmium were elevated in some of the samples collected in 2001. However, with the exception of zinc, observed metals concentrations were usually within the range of typical urban stormwater concentrations for these metals. In the 1996 study, samples collected at four outfall locations failed acute lethality tests for rainbow trout and for *Daphnia magna*. In the 2001 study, only one sample failed acute lethality testing. The cause of mortality in this sample was attributed to the interaction of low water hardness and elevated concentrations of zinc and copper.

4.3.4.4 On-site Surface Water Quality

A surface water quality monitoring program was carried out as an element of the EA baseline characterisation studies during 2007/2008. Four on-site surface water bodies were included in the program: Darlington Creek upstream of the St. Marys Cement property; a stormwater management (SWM) pond located in the operating DNGS area which receives runoff from adjacent buildings and parking lots; Treefrog Pond, a man-made pond with no visible outlet located north of the railroad tracks in the eastern portion of the DN site; and a man-made pond (Coot's Pond) south of the Northwest Landfill Area designed to receive runoff (and potentially leachate) from the existing landfill. The water quality at these locations is summarised as follows:

The water in Coot's Pond, Treefrog Pond and Darlington Creek exhibits elevated levels of phosphorus (compared to the SWM pond). The nitrate levels in Coot's Pond, Treefrog Pond and the SWM pond are typically low. However, samples from Darlington Creek in summer 2008 were elevated, possibly as a result of the use of fertilisers and manure in its watershed. The total suspended solids (TSS) concentrations at Coot's Pond and Treefrog Pond are higher than the SWM pond and Darlington Creek; and concentrations of aluminum, boron, cobalt, iron and zirconium were elevated at some or all of these locations (i.e., exceeded the Provincial Water Quality Objective (PWQO)/Interim PWQO guidelines). Elevated levels of conductivity and sodium were observed in the SWM pond during spring 2008, probably as a result of the use of road salt in the vicinity.

Quarterly monitoring in Coot's Pond has been conducted since 1999 as a requirement of the construction landfill CofA. A review of the annual landfill reports indicated an overall rising trend for concentration of 5-day Biochemical Oxygen Demand (BOD_5) and TSS while a downward trend was observed for chloride and Dissolved Organic Carbon (DOC).

4.3.4.5 Lake Water Quality

Prior to the addition of excess phosphorous in the 1960s and 1970s, Lake Ontario was considered oligotrophic (low or poor in dissolved nutrients such as nitrogen and phosphorus, hence with relatively low organic productivity such as algae and usually rich in dissolved oxygen). As lake-wide phosphorous levels increased to over 20 µg/L, Lake Ontario became mesotrophic (relatively moderate amounts of nutrients). Higher phosphorous concentrations also led to eutrophic conditions (high in nutrients and high in organic (biological) production) in the nearshore areas. However, the implementation of phosphorous controls in the 1970s has led to lake wide phosphorous concentrations below 10 µg/L. In recent years, Lake Ontario has again been classified as oligotrophic. Lake Ontario has been reported with spring phosphorous concentrations generally less than 8 µg/L which is typical of all the Great Lakes except Lake Erie. The average measured phosphorous concentrations in the SSA, LSA and RSA for lake water samples collected from Spring 2008 to Fall 2008 as part of the EA baseline characterization study was 6 µg/L.

Lake Ontario has the highest average nitrate concentrations of all the Great Lakes at approximately 400 µg/L. Similarly, with a chloride concentration of 22 mg/L, Lake Ontario has the highest chloride concentration of all the Great Lakes. Lake Ontario water has a hardness of approximately 137 mg/L expressed as calcium carbonate.

The EA baseline characterisation studies conducted in 2007/2008 also included a comprehensive water quality monitoring program in Lake Ontario. The quality data were generally consistent with historical water quality data. Although occasional individual sample exceedances were noted as a result of natural variation or anthropogenic influences, most of the lake water quality in the RSA, LSA and SSA meets the MOE PWQOs and Canadian Council of Ministers for the Environment (CCME) Canadian Environmental Quality Guidelines (CEQG) limits (CCME

2007). Accordingly, it can be implied that the water quality is generally protective of aquatic habitat, although area specific concerns may occasionally occur and other factors, such as invasive species or water temperature can affect aquatic habitat.

4.3.5 Shoreline Processes

4.3.5.1 Geomorphic Setting

Lake Ontario is the lowest of the Great Lakes, second smallest by volume and smallest in terms of surface area. On average, the lake contains approximately 1,640 km^3 of water and covers an area of about 18,960 km^2. Its maximum dimensions are 311 km east to west and 85 km north to south, and its coastline measures approximately 1,150 km in length. With an average and maximum depth of 86 m and 244 m respectively, Lake Ontario is the second deepest of the Great Lakes after Lake Superior.

The DN site is located on the northern shore of Lake Ontario approximately halfway between Oshawa and Clarington, and approximately 70 km east of Toronto. The shoreline orientation within the LSA is predominantly ESE to WNW, although the DN site foreshore and a small stretch to the east exhibit a direct east to west alignment.

The shoreline west of the DN site (from Scarborough Bluffs to Raby Head) consists primarily of glacial till bluffs (low to moderate in height), with sand collected in embayments and updrift of man-made structures to form pockets of beaches (Boyd 1981). Erosion rates along this frontage are generally low and tend to be dominated by wave-induced toe erosion. From the DN site east to Port Hope, high glacial bluffs dominate the shoreline, with occurrence of massive upper slope failures resulting primarily from the piping of groundwater through sand layers in the bluffs. These slope failures appear to be of equal importance to wave induced toe erosion along this frontage (Sandwell Swan Wooster *et al*. 1990). The shoreline fronting DNGS is protected by armour stone fascia.

4.3.5.2 Shoreline Bathymetry

In general, the water depths are 10 m to 15 m at a distance of 1 km from the shoreline. At a distance of 10 km, the water depths are 60 m to 70 m. With the exception of the immediate nearshore areas, the bottom slope varies between 0.008 and 0.01 m/m (Beak 1990).

During the construction of DNGS, lake infilling occurred in the nearshore areas. This infilling replaced the natural beach and lake bottom gradient with an armour stone wall. The infilling extended to a water depth of approximately 5 m. The armour stone wall was constructed with large boulders at a slope of approximately 2:1 (horizontal:vertical).

Most of the DN site foreshore (and within the SSA) consists of either small sandy beaches or rock armour fronting relatively low-lying hinterlands. Beyond the immediate foreshore, a narrow shelf of less than 5-m depth follows the shoreline, gradually dropping off to a depth of 20 m within 2 km of the foreshore.

4.3.5.3 Lake Substrates

The lake bottom within the LSA generally consists of glacial till and ranges from clay to boulder size (Armstrong and Burchat 1996). The immediate nearshore zone is predominantly characterised by a combination of boulders and rock with infrequent patches of sediment sinks that appear to be closely associated to the presence of nearby watercourses. The boulders disappear as one moves further offshore beyond the 10-m depth contour and the substrate becomes predominantly mud, sediments and rock.

4.3.5.4 Sediment Supply, Transport and Deposition

The processes of sediment erosion, transport, accretion and re-suspension in the vicinity of the DN site are complex (Armstrong and Burchat 1997b) and are affected by a number of natural and anthropogenic influences. While the general direction of sediment transport is largely determined by the orientation of incoming waves to the shoreline, operations of the discharge diffuser at the DN site and the nearby St. Marys Cement wharf can inhibit the natural transport of sediments through current and wave action along the LSA.

In general, the sediment supply to the shoreline consists of materials eroded from shoreline features and materials brought down to the lake by tributary streams (Golder 2007b). It has been reported (Sandwell Swan Wooster *et al*. 1990) that the bluffs fronting the DN site east of DNGS to Darlington Creek recede at an annual average rate of 0.21 m/year and contribute an approximate annual average of 2,250 m^3 of sand to the local sediment budget. In contrast, Darlington Creek was cited as only contributing 90 m^3/year of sand. Recommendations regarding shoreline protection along this particular frontage state that protection would not be detrimental to adjacent shorelines because the frontage is situated at the downdrift end of its littoral cell. The geographic extents of the local sediment cell are further discussed below.

Sediment deposited at the nearshore lake bottom provides a continuous source of transport material when wave and current conditions are conducive to re-suspension. Remobilisation of fine sediments along the lake bed is continual in the littoral zone due to wave activity but decreases with increasing water depth (Burchat 1988). In water depths of less than 8 m, fine sediments are typically stirred up by wave action and transported out to deeper water. The net effect is a scattered accumulation of fine sediments at greater depths.

The nodal point of the sediment sub-cell along the DN site is located at Oshawa with sediment transport occurring to the east and west of this location (Rukavina 1976). It was more recently suggested (Armstrong and Burchat 1997b) that the limit of the sub-cell is actually located further west at Highland Creek. Both studies agree that sediment transport along the DN site is generally eastward. However, a net transport in longshore direction is not substantial.

Sediment flux is highly variable across the general DN site vicinity with total flux regardless of direction being approximately an order of magnitude greater along the St. Marys Cement foreshore (90.2 g/cm/day) than at the DN site (9.55 g/cm/day) (Armstrong and Burchat 1997b). This suggests that a substantial amount of sediment is deflected offshore into deeper water at St. Marys wharf, reducing the amount of sediment available along the DN site frontage. The existing DNGS cooling water intake was not considered to have a significant impact on sediment transport. However, it was stated that the discharge diffuser mixing zone appeared to deflect sediment in an onshore or offshore direction depending on the orientation of ambient currents and waves.

The amount of material capable of forming a stable beach in the SSA is limited (LGL 1992). Fine sediments such as fine sands and silts move into suspension under exposure to waves and are transported both alongshore and offshore under diffusive and advective processes. In the absence of processes to bring the fine grained materials back onshore and due to the limited supply from land, the fine grained materials are continually starved from the shoreline resulting in a sediment deficient shoreline.

4.3.5.5 Water Levels

The mean monthly water level for Lake Ontario between 1900 and present ranged from 73.76 to 75.78 m International Great Lakes Datum (IGLD). Since 1970, the average water level has been 74.85 m IGLD. During the same period there has been a downward trend in the monthly water level of approximately 3 mm/year.

The annual maximum daily average water levels at Toronto during the period 1908 to 1998 ranged from a low of 74.26 m IGLD (1935) to a high of 75.81 m IGLD (1952). At Cobourg, the annual maximum daily average water levels between 1956 (approximately the point in time in which Lake Ontario water levels became regulated due to the completion of the St. Lawrence Power Project) and 1998 ranged from a low of 74.64 m IGLD (1958) to a high of 75.76 m IGLD.

4.3.5.6 Wave Characteristics

The DN site is exposed to waves from a variety of directional sectors, ranging from the east to the west, although waves from the direct east or west become refracted in the nearshore zone as they become depth limited and therefore lose a significant amount of energy prior to runup.

Based on reported results (Ontario Hydro 1988) for Oshawa (deemed typical of the DN site) waves are most prevalent from the southwest. Waves from this sector were also shown to have the greatest significant wave height, reaching above 4.5 m on a few occasions, with wave periods of up to 9 seconds. Over the 20 years of January 1964 to December 1983, waves from the east occurred approximately 15% of the time, with waves in excess of 1.5 m occurring about 1.4% of the time. Waves from the southwest occurred about 40% of the time with waves in excess of 1.5 m occurring from that direction 3% of the time. Waves from the west occurred approximately 11.7 % of the time with waves in excess of 1.5 m occurring less than 1.6% of the time.

4.3.5.7 Ice Behaviour

Ice cover is rare on Lake Ontario. Limited aircraft and ground observations of the nearshore area of the lake in the vicinity of the DN site beginning in 1971 indicated that there is no extensive ice cover, rather, only shore and slush ice that have formed ridges extending up to 30 m offshore (OPG 2004). The potential effect of flooding, including due to ice, is further discussed in Section 6.3.2.

4.3.6 Valued Ecosystem Components

Changes in surface water conditions as a result of constructing and operating the Project may contribute to effects on human health, on non-human biota health and on VECs in other environmental components. Accordingly, changes in the Surface Water Environment will be considered within other environmental components so as to evaluate the potential environmental effects on appropriate receptors (i.e., VECs) in those components. As such, surface water is considered a pathway to effects in other environmental components and VECs specific for the Surface Water Environment have not been identified.

VECs as pathways from the Surface Water Environment are summarised in Table 4.3-2.

TABLE 4.3-2
VECs (as Pathways) for the Surface Water Environment

Sub-Component	VECs as Pathways	Rationale
• Lake Circulation • Lake Water Temperature • Site Drainage and Water Quality • Shoreline Process	Pathway to human health	The effects on humans associated with changes in surface water conditions will be considered in the Human Health component.
	Pathway to non-human biota health	The effects on non-human biota associated with changes in surface water conditions will be considered in the Non-Human Biota (Ecological Risk Assessment) component.
	Pathway to VECs in other environmental components	The effects on VECs in other environmental components associated with changes in surface water conditions will be considered in the applicable environmental components. These will include effects on Aquatic Environment and Terrestrial Environment VECs as a result of changes in water quality and other physical parameters.

The process of selecting VECs is described in Section 3.2.4 and as indicated, consideration of input from the public and other stakeholders was an important aspect of finalizing those to be used. The following specific suggestions concerning VECs in the Surface Water Environment were received as comments made on the draft EIS Guidelines. They were considered as noted in establishing the final VEC list:

- Add <u>Lake Ontario Shoreline</u> as a VEC: Surface Water is considered a pathway for potential effects on VECs in other environmental components. Shoreline Processes is included as a sub-component of the Surface Water Environment, therefore, any changes in shoreline processes are evaluated for their potential to result in effects in other environmental components. It is also to be noted, that physical changes to the on-land portion of the shoreline (e.g., removal of bluffs) are addressed within the Terrestrial Environment;

- Add <u>Areas of Groundwater Discharge into Lake Ontario</u> as a VEC: The groundwater flow regime, including its recharge and discharge characteristic, is addressed as a sub-component of the Geological and Hydrogeological Environment. Similar to the above, groundwater flow is a pathway to other environmental components, therefore, potential effects of groundwater discharge are evaluated within those other appropriate components (e.g., Aquatic Environment and Ecological Risk Assessment); and

- Add <u>On-site Surface Water Features</u> as VEC: As has been noted, the Surface Water Environment is treated as a pathway for transfer of potential effects to receptors in other components. Accordingly, any changes in surface water conditions, including on the DN site, are evaluated within other appropriate environmental components. These include the Terrestrial, Aquatic and Geological and Hydrogeological Environments which all consider their potential interactions with on-site surface water conditions.

4.4 Aquatic Environment

This Section provides an overview description of the existing Aquatic Environment. The detailed baseline characterisation of the Aquatic Environment is contained in the Aquatic *Environment – Existing Environmental Conditions Technical Support Document, New Nuclear - Darlington Environmental Assessment.* The description is presented in the context of the following environmental sub-components:

- Aquatic Habitat: includes tributary watercourses and ponds on the DN site, and the adjacent areas of Lake Ontario. Habitat is characterised by conditions of flow, current, bathymetry, temperature, substrates and water quality that influence its status with respect to the federal *Fisheries Act* (i.e., presence and types of fish habitat). Because the areas occupied by the existing DNGS intake forebay is artificially separated from Lake Ontario, it is not included in the assessment; and

- Aquatic Biota: includes the communities of underwater plants and animals that occupy the aquatic habitat defined above. These include, depending on habitat conditions, periphyton, aquatic macrophytes, phytoplankton, benthic invertebrates, zooplankton and fishes. Aquatic biota may also include rare, vulnerable, threatened and endangered aquatic species.

4.4.1 Study Areas

The generic study areas described in Section 3.1.3 were considered for specific application for the Aquatic Environment with modifications made as appropriate. The study areas as applied are described below:

Regional Study Area

The RSA is the area within which there is potential for population-level, cumulative or socio-economic effects and includes Lake Ontario and its watersheds. The RSA is large in order to address population-level effects on those aquatic species that have lake-wide distributions or are important to broader, basin-level conservation and socio-economic considerations.

Local Study Area

The LSA is identical to the Surface Water Environment LSA (see Section 4.3.1) and corresponds to those areas where there is reasonable potential for direct Project-related effects on Aquatic Habitat and Aquatic Biota outside the SSA. Examples of relevant pathways between the Project and LSA include thermal discharge dispersal in Lake Ontario and airborne dispersal of radionuclides or other compounds to adjacent waterbodies such as Darlington Creek and McLaughlin Bay.

Site Study Area

The SSA is identical to the Surface Water Environment SSA (see Section 4.3.1) and corresponds to the existing DN site property and approximately 3 km into Lake Ontario. The SSA is the area where direct effects on Aquatic Habitat and Biota are most likely and includes the area of onshore facilities, buildings and infrastructure and the offshore intake and diffuser areas of the proposed Project and existing DNGS facilities.

The description of the existing conditions in the Aquatic Environment is focused on the SSA since it is primarily this area that will be subject to potential effects of the Project. Discussion of the LSA and the RSA is more general and intended to provide the broader context for the description of existing conditions in the SSA.

4.4.2 Aquatic Habitat

Aquatic features on the DN site that are likely to be affected by the Project include:

- The main branch of Darlington Creek;
- The intermittent upper portions of tributaries to Darlington Creek;
- The artificially constructed Dragonfly, Treefrog and Pollywog Ponds;
- The intermittent upper portion of a tributary to Lake Ontario (at the eastern toe of the Northwest Landfill Area slope); and
- Coot's Pond (which functions as a settling pond).

These features are identified in Figure 4.4-1 and the existing physical and biological attributes of these habitats are summarised in the following sections.

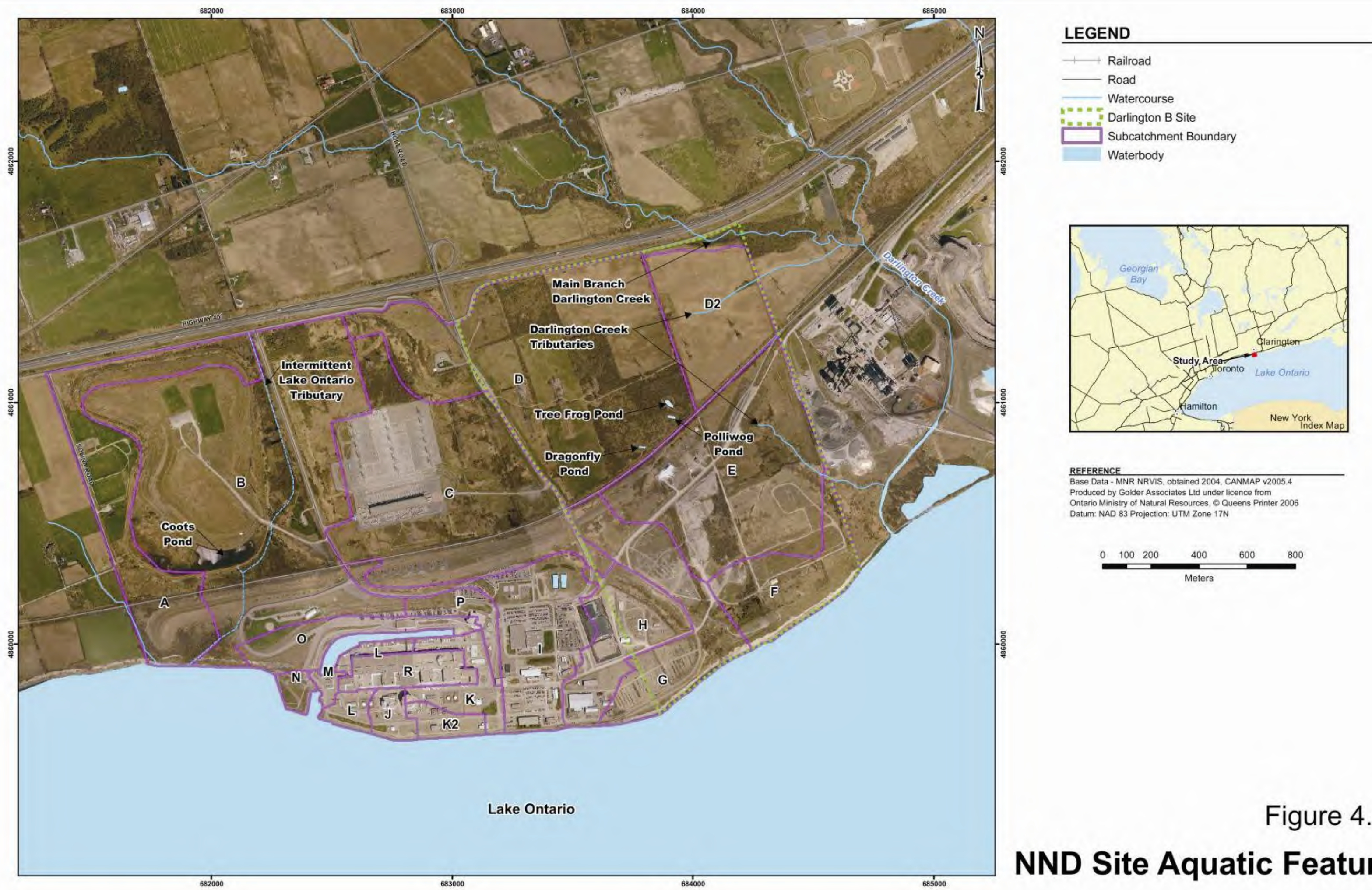


Figure 4.4-1

NND Site Aquatic Features

Date: September 2009

Project: 34500

SOURCE:

ADAPTED FROM GOLDER ASSOCIATES, AQUATIC, EXISTING ENVIRONMENTAL CONDITIONS T.S.D., FIGURE 3.1-1, 2009

ONTARIO POWER GENERATION

4.4.2.1 Darlington Creek

Darlington Creek enters the northeast corner of the DN site after emerging from concrete box culverts beneath the South Service Road and Highway 401. A reach of approximately 200 m of the creek crosses the site before entering the adjoining property. In this area, the creek is several metres wide and occupies a wooded ravine. The DN site reach is characterised by cobble and gravel substrates and riffle-pool morphology. During studies conducted in 1998, summer conditions were dry and by fall only isolated pools were observed and there was no flow. Electrofishing in the pools confirmed a warmwater fish community dominated by small-bodied fish including fathead minnow, brook stickleback, creek chub, white sucker, longnose dace, blacknose dace and bluntnose minnow. In the following spring, adult white sucker and rainbow trout were observed in the reach, presumably having migrated up the creek from Lake Ontario to spawn somewhere in the creek (Gartner Lee Ltd. 1999). Surveys conducted in the spring of 2009 as part of the baseline characterisation program confirmed the presence of both white sucker (young of the year) and rainbow trout in the upper reaches. The presence of white sucker in Darlington Creek is consistent with the capture of adult spawning white sucker also in the spring of 2009, between the proposed lake infill area and St. Marys Cement.

Darlington Creek was characterized within six ecologically distinct reaches, with the upper reaches representing much better quality stream habitat than the lower reaches. The upper reaches have clear water, cobble and gravel substrates and a mixture of riffle and straight run habitat as well as the occasional pool. The lower reaches are channelized and murky. Fish community observations in the creek included primarily warmwater fish but also the presence of rainbow trout. Large amounts of debris which have blocked or partially blocked the channel (depending on water levels) create partial barriers to upstream migration.

The lower reaches of Darlington Creek are highly altered, with an undifferentiated channel morphology and lack of complex habitat characteristics suggesting a primarily warmwater fish habitat function. The low gradient of the lower reaches of the creek, similar in elevation to Lake Ontario, suggests that a backwater effect extends a considerable distance upstream, with sluggish flow and depositional conditions occurring much of the time. The Darlington Creek mouth could be a relatively productive spawning and nursery area for some warmwater species. Although observations of rainbow trout in upstream areas confirm a migratory route, it seems unlikely that critical habitats for coldwater fish would occur in the sluggish lower reach of the creek. Survey results suggest that coldwater fish would only be present in the upper reaches.

4.4.2.2 Intermittent Tributaries to Darlington Creek

Two intermittent tributaries drain eastern portions of the DN site north and south of the CN rail line. Both of these tributaries are comprised primarily of marshy swales with cattail, reed canary grass and other emergent wetland species, but lack fully formed and permanent aquatic habitat and may be intermittent. The northern tributary drains the area of the (proposed) Northeast Landfill which is intended for surplus soil disposal and the southern tributary drains the vicinity of the proposed station building. Both tributaries are considered ephemeral and do not appear to constitute direct fish habitat but may be considered indirect fish habitat since they have identifiable watercourse features that convey flow to downstream fish habitat either in off-site downstream sections of the tributary or in the main branch of Darlington Creek.

4.4.2.3 Treefrog, Polliwog and Dragonfly Ponds

Treefrog, Polliwog and Dragonfly Ponds were created by OPG to provide wetland habitat at the DN site and are located in the northeast quadrant of the site, immediately north of the CN railway tracks. The ponds are not connected to each other and there are no direct connections to fish-bearing waters; and extended periods of dry weather conditions leave the ponds dry or nearly so. The ponds were not constructed to support fish and because they appear not to contain fish, they would not be considered direct fish habitat.

Because of their poor hydrological and biological connectivity to Darlington Creek, it is also unlikely that the ponds would be considered indirect fish habitat and they are not considered likely to fall under the fish habitat protection provisions of the federal *Fisheries Act*.

4.4.2.4 Intermittent Lake Ontario Tributary

This small watercourse is located between Park Road and the toe of the eastern slope of the Northwest Landfill Area. Near the landfill, the watercourse is intermittent; however, portions of it are currently permanently wetted due to the recent construction of a series of beaver dams and ponds.

The tributary reaches near the landfill are poorly connected to Lake Ontario, such that it is considered impossible for fish from Lake Ontario and lower reaches to migrate upstream to the landfill area. While the tributary is poorly connected to Coot's Pond, it is considered likely that the tributary has been colonised by northern redbelly dace and perhaps other fish species, since Coot's Pond supports an introduced population. The beaver ponds now offer refuge habitats in the otherwise intermittent system and this area of the tributary is considered to direct fish habitat.

4.4.2.5 Coot's Pond

Coot's Pond is a settling pond that was constructed by OPG to intercept drainage from the construction waste landfill (which is contained within the Northwest Landfill Area). In addition to those functions, management of the pond according to the DN site biodiversity program has resulted in a naturalised feature with open water near its eastern end and emergent wetland on the margins and dominating the western end. Although the pond was intended to be fish-free to encourage amphibian production, northern redbelly dace inadvertently became established and have become quite abundant. The pond still supports frog reproduction.

Coot's Pond is poorly connected to the adjacent intermittent tributary and Lake Ontario. Water may seep through its southern bank and can overflow from the pond through a culvert outfall, but fish and other aquatic species are not considered capable of migrating upstream into the pond. Since Coot's Pond is a settling pond, its aquatic habitat is not likely to represent significant aquatic conservation or *Fisheries Act* concerns. However, in the context of the DN site biodiversity objectives, in its naturalized state Coot's Pond provides valued aquatic habitat in addition to its wetland and terrestrial habitat contributions on the DN site.

4.4.2.6 Lake Ontario Nearshore Environment

The area of Lake Ontario directly adjacent to the DN site is similar to extensive stretches of the north shore and is not distinctive in terms of its physical habitat and biological community attributes. It has gently sloping bathymetry and is exposed to the effects of waves and currents which scour away fine sediments and leave behind relatively featureless flat rocky substrates. This open area offers only sparse physical cover for most invertebrate and fish species and is, therefore, utilised as permanent habitat by relatively few species. The nearshore area is essentially the barren rocky edge of the offshore or pelagic zone and as a result its use as habitat is heavily skewed toward seasonal and intermittent use by migratory Lake Ontario fish species. The nearshore is influenced to a limited extent by the seasonal presence of warmwater fish from nearby tributaries, bays and coastal marshes.

While this means that a wide range of species is considered as part of the assessment, it should not be construed that the affected areas represent sizeable proportions of critical habitat for any of these species. Fish community monitoring undertaken by OPG during the 1990s and catches in 2007-2009 during EA studies were characterised by consistently low numbers of captured fish, dominated by relatively few species.

Nearshore

The definition of the nearshore zone varies among references. Since the Project works and activities could involve construction of intake and diffuser structures out to the 10 to 20 m depth contours, the Lake Ontario nearshore is considered to be the receiving environment of interest for the assessment of Project-related effects in the Aquatic Environment.

Bathymetry and Substrates

The nearshore zone at the DN site slopes gradually, with an average depth of approximately 10 m at 1 km offshore. There are no drop-offs, distinct shoals or other specialised physical habitat features known within this area. Wave erosion acting on glacial deposits has created shoreline bluffs at the DN site and has deposited the eroded material on the beaches and in the lake. Darlington Creek meets Lake Ontario east of the bluffs.

Extensive stretches of the nearshore in this area are characterised by shallow gravel/cobble beaches. Underwater substrates are comprised of beds of clayey glacial till and further offshore, smaller areas of bedrock outcrop. Lag deposits of gravel, cobble and boulder are found on top of the till and bedrock, and are remnants of erosion of the bluffs and subsequent transport by wave and current action of the finer sediments away from the site. Finer sediments are patchy and thin, such that sandy substrates are limited to sporadic occurrences at the 3 to 4-m depth (Tarandus 1998).

The exposure of the north shoreline to wind, wave and current action creates a high-energy aquatic environment. The coarse substrates of gravel and cobbles near the beach are frequently displaced during storms. The underlying hard-packed clay till is exposed in many places and as noted in Section 4.3.5, fine sediments are transported to quieter depositional areas such as west of St. Marys Cement wharf or offshore beyond the influence of waves and currents.

Underwater video images at 27 locations in and immediately-adjacent to the proposed NND lake infill area were acquired in November 2008 during the EA studies. The images suggested that substrates in the area could be grouped into six major categories ranging from finer sediment (sand or silt) over bedrock to densely packed cobble and boulders. The western portion of the proposed infill area was dominated by rocky substrates. In the eastern portion of the area, rocky substrates tended to (with some exceptions) dominate the locations closest to shore, transitioning to more sandy substrates in deeper areas. Additionally, dead mussel shells could be seen throughout the infill area. Shell numbers were highest in the western portion of the potential infill area, reaching their highest densities at the eastern edge of the armoured shoreline, becoming almost non-existent in the easternmost area of the site. Substrate with greater proportions of dead mussel shells supported larger and more diverse benthic invertebrate communities.

Currents and Nearshore Water Temperature

Sediment transport conditions and deposition patterns have been influenced by both longshore currents and offshore currents that existed prior to development of the DNGS. Along the north shore of Lake Ontario, within the RSA, westerly longshore currents predominate. Current velocities between 1971 and 1990 at DNGS, excluding calm periods, ranged between approximately 8 to 15 cm/s (monthly average). Maximum monthly currents ranged from 28 to almost 56 cm/s. During low current speeds, the DNGS diffuser discharge deflects longshore currents offshore. With higher current speeds (up to 25 cm/s), the currents penetrate the diffuser mixing zone, but are reduced on the lee side of the DNGS diffuser (Ontario Hydro 1997a). Ambient currents are unaffected at speeds in excess of 25 cm/s with all four DNGS units in operation (Armstrong and Burchat 1999). However, the effects noted above are localized to the area of the diffuser and it is not believed that the operation of the DNGS since 1990 has had a meaningful change to average current directions and speeds in the SSA.

These currents carry phytoplankton and zooplankton around the lake. The relatively high average current velocities mean that these organisms tend to spend little time close to the DN site. Even at the relatively calm velocity of 3 cm/s, plankton at the DN site would be transported approximately 2.6 kilometres away within 24 hours. Also, plankton population dynamics follow an established seasonal succession with rapid changes in density and species composition in response to water temperature, nutrient availability and food web dynamics. As such, there is no resident plankton community.

Ambient nearshore temperature conditions are seasonal, but can be quite variable as a result of weather-induced currents, upwellings and downwellings. Temperatures within the SSA and LSA rose to a maximum of over 20º C by July/August, but fluctuations occurred during summer on the range of 10-15ºC due to upwelling and downwelling. Temperatures in the range of 0-4ºC characterize the November to April period. These conditions were considered to be similar to other north shore locations and representative of the broader RSA.

4.4.3 Aquatic Biota

4.4.3.1 Benthos

The nearshore environment is dynamic, making it generally unfavourable for aquatic plants and algae. Due to the hard substrates and high energy environment, it supports only a limited density and diversity of benthic invertebrate communities, with chironomids and amphipods being the major benthos components. The shallow areas (<35 m) support the highest densities, and amphipods in particular are most abundant inshore of the 10-m contour. DNGS entrainment studies listed the most abundant susceptible invertebrate taxa as copepods/cladocerans, followed by spiny water fleas, rotifers and amphipods. Since the mid-1990s the benthic community and benthic habitat have been altered by the invasion of exotic dreissenid mussels. Nearshore areas were rapidly colonised, first by zebra mussels and now, by the closely related quagga mussel, which has all but replaced the former. Mussels have had a significant impact on Lake Ontario including the nearshore environment of DNGS. They have altered nutrient flow, food webs and productivity in Lake Ontario, which have resulted in a proliferation of attached algae, notable Cladophora along the shoreline. They provide a food source for round goby, another invasive species, which is now very common fish species in the nearshore environment at DNGS. Predatory fish such as walleye, are expected to increase in abundance feeding on goby (which are feeding on mussels, and other aquatic life). Mussels are also linked to the collapse of Diporeia, a native amphipod that previously accounted for more than 80% of total benthic production in Lake Ontario and was a critical component of the diets most benthic fishes (GLFC 2007).

Low invertebrate densities collected in the proposed NND lake infill zone in November 2008 were typical of benthic communities in other high energy littoral zones of Lake Ontario where shifting substrates, limited interstitial space and little organic accumulation result in the presence of only relatively few, tolerant invertebrate species and populations.

Spring benthic sled sampling for larval fish in 2009 also indicated the presence of an additional invasive species, the bloody red shrimp. This species, endemic to Eastern Europe, was first reported in North America in 2006 in Lakes Michigan and Ontario. This is the first documented report of the bloody red shrimp in the DN area of Lake Ontario. This species has the potential to cause great ecological harm in Lake Ontario, as this highly adaptable omnivore feeds on key components of the food web.

4.4.3.2 Fish Community

The Lake Ontario nearshore fish community has been described as relatively sparse (Hoyle *et al*. 1999). The fish community monitoring conducted as part of the Darlington Environmental Effects Monitoring Program (DEEMP), as well as the recent catches associated with fish tissue sample collection for this EA, have been characterised by consistently low catches of most species, with only intermittent higher catches during spawning and inshore migrations by some species such as alewife and round whitefish. While the nearshore hosts a seasonally dynamic mix of resident and migratory fish species that are parts of both the benthic and pelagic food webs, these species tend to migrate over large foraging ranges and are not resident in SSA.

The recent catches associated with fish tissue collection in the 2007-2008 sampling program were similar to the DEEMP in that alewife dominated the catches in the experimental gillnets that were similar in design to the nets used in DNGS fish community monitoring. A total of 31 species was collected during this sampling period which involved sampling in November 2007, as well as during the May to November period in 2008. The catch of round goby, a recent invasive species, was also high relative to alewife; however specific effort was focused on goby collection for tissue samples using small-mesh gillnets. Nevertheless, goby numbers were present in relatively high numbers, and were not reported in the earlier fish surveys. A quantitative comparison of the recent data collection (tissue samples) and the earlier DEEMP fish collection was not possible since methodologies varied with respect to location, season, effort and gear used. The tissue collection methodology was also not designed to measure fish community structure. However, the catches were similar in terms of species observed, and the low numbers of most species captured. Higher catches were associated only with spawning and inshore migrations by some species such as alewife, round goby, and round whitefish.

During the spring 2009 fish community assessment, nine adult fish species were caught at six locations. Round goby was the most common species overall, at 80% of the total catch. White sucker was second most common at 9% of the total catch. The remaning 11% was composed of seven other fish: lake trout, round whitefish, walleye, sculpin, alewife, rainbow smelt and lake chub.

Fish from tributaries, coastal marshes and bays, venture into the lake when conditions are favourable, usually during the warmer seasons. Bass, bullheads, sunfish and northern pike can be found intermittently along shore during the spring, summer and autumn, and retreat to warmwater habitats during the winter.

Pelagic and bentho-pelagic fish include the nearshore in their seasonal spawning and feeding migrations, but retreat to offshore areas of Lake Ontario when nearshore temperatures rise between late spring and early autumn. Beach spawners such as alewife and emerald shiner, and shoal-spawning species like whitefish and lake trout, move inshore according to seasonal preferences and there has been evidence of activity by these species at the DN site and in the wider LSA and RSA. The habits and habitat requirements of these fish can bring them into close contact with the DN site, but there is nothing remarkable about the DN site nearshore habitat as a spawning or feeding area that is not shared by adjacent areas for many kilometres east and west of the site.

Resident benthic forage fish include slimy sculpin and, more recently, the exotic round goby which has spread across the lower Great Lakes and is currently abundant in the nearshore of Lake Ontario. Slimy sculpin feed on benthic insects and crustaceans, while the goby's diet is broad and also includes zebra and quagga mussels. Sculpin, although still present near the DN site, may have declined somewhat in competition with the round goby. Goby compete with other small fishes in this environment and are aggressive egg and fry predators in rocky habitats used for spawning by lake trout and lake whitefish. The Lake Ontario Management Unit (LOMU, 2007) has reported that the round goby population had been increasing in abundance in Lake Ontario. The round goby is now common in the diet of most fish predators which is likely affecting their abundance. Goby have been relatively abundant at rocky sites near the DN site.

Although much of the nearshore food web is based on benthic production, planktivorous fishes such as emerald shiner and alewife also occur in both the nearshore and pelagic zones foraging on plankton carried by the currents. Historically, alewife and emerald shiner are two of the most abundant fish species along the DN site shore.

Alewife spawn on shallow beaches from April to July over sandy or gravely bottom. Successive annual surveys have noted an abundance of alewife in the nearshore in mid-July and a decline in their numbers in the fall (Tarandus 1991, 1992, 1993, 1996). Larval studies in 1995 found alewife larvae to be the majority of larvae caught during summer months (Tarandus 1995). Alewife eggs have shown up in entrainment studies at DNGS. Alewife abundance in Lake Ontario has declined since the 1970s, when nutrient inputs supported a highly productive pelagic forage base and the alewife population had yet to come under the control of stocked trout and salmon. Vigorous phosphorus abatement and the introduction of dreissenid mussels have dramatically reduced pelagic productivity and alewife numbers declined steeply. It has been recently reported that alewife abundance has increased substantially from a low in 2005 (LOMU 2007), but a return to previous large population sizes seems unlikely under foreseeable conditions.

Schools of emerald shiner, particularly young-of-the-year, are prominent in shallow waters throughout spring, summer and fall, feeding on plankton, midges and microcrustaceans. They in turn are food for gulls, terns, cormorants and other fish including smallmouth bass, lake trout and other salmonids.

The most prevalent benthivorous fish species found year-round at the DN site is white sucker. Large adult white sucker forage on benthic invertebrates in the nearshore, but ascend tributary streams in the spring to spawn. Young white sucker feed and grow in these nursery streams before returning to the lake.

Round whitefish, a coldwater species, is also a benthivore that feeds on amphipods, snails and recently also on dreissenid mussels. Round whitefish are known to spawn in numerous areas along the north shore of Lake Ontario in the nearshore at depths generally less than 10 m. However, results of the 2009 spring larval survey indicated the presence of only a few round whitefish larvae, and only at 3 of 7 sites. Of 487 larval fish (including one egg) collected in the vicinity of the DN site, round goby dominated at all sites, comprising over 97% of the total larvae caught. Larval round whitefish relative abundance appears to be in decline similar to trends in adult round whitefish populations. At the DN site, round whitefish have been found to be most abundant in late November (Tarandus 1996).

Lake sturgeon is also known to be present in the area. The Lake Ontario sturgeon population remains low as a result of historical over fishing and dams and degradation of tributary spawning areas. The sturgeon is listed as “Threatened” by COSEWIC. Recent increased presence of juvenile sturgeon, such as those near the DN site, is evidence that population recovery may be occurring and that sturgeon may become more common in the DN site nearshore as part of their wider foraging ranges in the lake.

A diverse community of fish-eating or piscivorous fish species can be found at various times of the year in the nearshore. Species that prefer warmer water temperatures are often grouped as ‘warmwater’ fish. These include American eel, northern pike, walleye, yellow perch, white bass, white perch and smallmouth bass. Surveys have found relatively small numbers of these species near the DN site. However, it is notable that American eel, listed as ‘Special Concern’ federally by COSEWIC and on Schedule 3 (Transition-Species to be listed as Endangered Species) of the provincial *Endangered Species Act* (MNR 2007) was observed during nearshore electrofishing conducted at night at the DN site (in 1998). While the total number of American eels has increased in recent years, the overall abundance of eels is in the lake is low (LOMU 2007) and DFO in conjunction with OMNR has completed a Management Plan for the American eel. Northern pike, smallmouth bass and yellow perch have close associations with coastal marshes, shallow bays and tributary mouths, but do venture into the nearshore and have been observed in small numbers at the DN site and in the DNGS intake forebay. Large adult walleye will leave the Bay of Quinte and migrate widely throughout Lake Ontario, similar to trout and salmon, as they follow schools of forage fish, particularly alewife. Although walleye presence near the DN site has been incidental, a few large walleye have been caught in the SSA.

The nearshore is also part of the wider range of a number of coldwater predators that currently includes lake trout, Atlantic salmon, rainbow trout, brown trout, chinook salmon and coho salmon. These species were stocked in Lake Ontario and its tributaries to maintain the sport fishery and as an attempt to replace extirpated stocks of lake trout and Atlantic salmon. The trout and salmon are highly migratory and, as adults, are not residents in the area but migrate widely throughout the lake as they follow schools of forage fish and respond to seasonal temperature changes that encourage movement to deeper offshore areas during the summer. Although their numbers are maintained by stocking, limited natural reproduction occurs, with rainbow trout being particularly successful in some north shore tributaries. Numerous juvenile chinook salmon and juvenile rainbow trout were captured during electrofishing surveys along the armoured shoreline at DNGS (Tarandus 1998), indicating a nursery habitat function in the area for larger juveniles of these species. Of the trout and salmon, all but the lake trout are tributary spawners and are not expected to attempt to spawn at the DN site. Gravid lake trout were frequently captured in the autumn and early winter surveys at the DN site and, although there are no known distinct spawning shoals in the area, are thought likely to spawn in the general area, similar to the round whitefish, in small patches of suitable habitat where it occurs. The lake trout population has been maintained by stocking as reproduction has been extremely low in Lake Ontario, possibly due to the effects of thiaminase found in higher concentrations in alewife than in the lake trout's historical forage species.

Several attempts to reintroduce Atlantic salmon have failed to establish a significant population in Lake Ontario. Ongoing efforts remain experimental with only very small numbers of this species present in the lake and some of its tributaries. The trout and salmon are the focus of the local Lake Ontario recreational fishery, with Chinook salmon and rainbow trout being the primary targets, and the nearby harbours at Oshawa and Port Darlington are access points for this fishery. While recreational fishing does occur at the DN site, the site is not known to host concentrations of sport fish similar to the Pickering NGS and Bruce NGS, because the DNGS employs an offshore diffuser for cooling water discharge rather than a surface discharge channel. The diffuser prevents the formation of an extensive thermal plume, and therefore does not seem to be a fish attractant. Angling that occurs near the DN site is not generally focused on the site, but targets the general area.

Water from Lake Ontario flows from the intake tunnel into the DNGS forebay before being drawn into four pumphouses. The forebay is separated from Lake Ontario by the intake tunnel which is a barrier for fish to return to the lake. Because of the high flow conditions within the forebay, over time the majority of entrained fish in the forebay are assumed accounted for during impingement monitoring.

4.4.3.3 Fish Species at Risk

The fish community includes species that are the subject of conservation concern and, in some cases, management efforts aimed at their conservation. These include:

- Deepwater sculpin (COSEWIC): Special Concern; *Species at Risk Act (SARA)*: Special Concern, Schedule 1) (MNR 2007): extremely restricted numbers and distribution in Lake Ontario make it unlikely to interact with the DN site or the Project;
- Lake sturgeon (COSEWIC: Threatened; *SARA*: no status): large juveniles have been found near the DN site in previous monitoring suggesting general nearshore nursery/foraging habitat;
- Atlantic salmon (COSEWIC: Extirpated; *SARA*: no status): low abundance in Lake Ontario and reintroduction program remains experimental, but may need to be tracked in the future if reintroduction is more successful; and
- American eel (COSEWIC: Special Concern; *SARA*: no status, management plan in preparation): past studies demonstrated occurrence of adult eel in the nearshore at the DN site.

The SSA nearshore area does not seem to contain critical habitat for any of these species, and measurable interactions with the existing DNGS have not been detected in monitoring studies to date.

4.4.4 DNGS Interactions with Lake Ontario Nearshore Environment

4.4.4.1 DN Site Shoreline Alteration/Infilling

Site preparation for the DNGS included extension of the natural shoreline with approximately 11 ha of lake infill comprised of excavated fill from the site. Armour stone shoreline revetments were installed to stabilize the new shore. Underwater video observations and boat electrofishing surveys conducted (Tarandus, 1998) concluded that the use of the natural versus armoured shorelines differed to some extent in the species and life stages of fish that were discovered. This effect could be attributed to differences in depth, availability of interstitial space and other factors that could not be controlled during the study and form the physical basis of the differences between the habitats. The study further concluded that the armoured shoreline, although apparently different in its physical and fish community characteristics, remained a productive fish habitat for a variety of species.

Habitat conditions and fish community characteristics have been documented for the site shoreline, including portions of the DNGS lakefill and adjacent natural shorelines including the Raby Head shoreline at the NND site, and these are reflected in the foregoing description of existing conditions. In summary, the western portion of the proposed NND infill area is dominated by rocky substrates. In the eastern portion of the area, rocky substrates tended to dominate the locations closest to shore, transitioning to more sandy substrates in deeper areas. The proposed infilling area is characterized by low densities of benthic invertebrates and low species richness which is characteristic of such high energy, unstable environments. As a result, good fish habitat in this area is limited, and the fish community is comprised primarily of transient species (with the possible exception of the invasive species, round goby). In terms of the physical characteristics of the habitats, and the biota that make use of the area, the proposed infill area is similar to broad reaches of shoreline along the north shore of Lake Ontario.

4.4.4.2 DNGS Intake Performance

DNGS Intake Performance

DNGS was the first OPG station where fish protection principles were considered in the decision-making process for both design and shoreline location of the intake. The intake incorporates a porous concrete intake "field" that circumvents the impingement and entrainment problems associated with a more traditional velocity cap intake. For instance, flow near the intake was made heterogeneous and designed so that velocities did not exceed the swimming capacities of large schooling species such as alewife and rainbow smelt. The velocity design criterion for the intake was an average velocity of 0.15 m/s or less to minimize potential capture of the offshore migrating species. Fish protection principles were also deliberated in locating the intake structure with a considered depth of approximately 10 m selected for the intake. Still, alewife encounters with the porous intake do occur based on their onshore-offshore migratory movements.

Field investigations have been conducted to evaluate the performance of the intake. Studies conducted in the early 1990s using a range of monitoring methods (e.g., submersibles, underwater videos and diver observations) indicated that although fish were present in the vicinity of the intake, especially during the summer, impingement was minimal. Further intake performance studies conducted in 1995 suggested that the intake was performing as designed and fish tended to avoid impingement. A report prepared for the CNSC in 2006 documenting a review of thermal mitigation technologies for nuclear generating stations, concluded that the DNGS off-shore submerged intake and off-shore submerged multi-port diffuser employed best available technology (Golder 2006).

Impingement studies were conducted over the 1993-1996 period as well as more recent investigations in 2006-2007 (see Section 5.4.5). In the more recent impingement study only 8 species were impinged of which alewife and round goby contributed 85.9 and 8.5% of the total, respectively. Entrainment sampling conducted in both 2004 and 2006 indicated that alewife and smelt were the principal species entrained in 2004 whereas alewife, common carp and freshwater drum were the only species entrained in 2006. Overall, results indicated that both entrainment and impingement numbers were relatively low compared to lake populations.

4.4.4.3 Thermal Interactions at DNGS

In addition to the intake structure, mitigation measures were employed in the design and placement of the cooling water (thermal) discharge at DNGS. Surface discharge of heated effluent at other nuclear generating stations created extensive thermal plumes and many fish species were attracted to the warmer waters of the discharge channels and vicinity. In contrast, the DNGS diffuser is a submerged offshore structure, and consists of a single line of 90 diffuser ports that project from a lake bottom discharge pipe. The diffuser line is oriented roughly perpendicular to shore and offset from productive shallows. The diffuser ports are angled upward such that contact of heated water with the lake bottom is minimized and rapid mixing with the overlying water column is achieved. The minimal thermal effects of the DNGS observed over years of monitoring confirm the suitability of the site for the Project and provide a convenient and appropriate case study for the assessment.

4.4.5 Valued Ecosystem Components

VECs were selected to represent each of the sub-components of the Aquatic Environment. Each VEC was deemed to be an element of importance within the geographic extent of Project works and susceptible to change and effect as a result of Project-related activities. The selected VECs represent specific aquatic habitats and broad species groups (based on general trophic web structure). For purposes of the assessment, each VEC was further refined into specific VEC Indicators that allow a more focused assessment of the broader category.

The VECs and VEC Indicator species, and the rationale for their selection are described below in Table 4.4-1.

TABLE 4.4-1
VECs Selected for the Aquatic Environment

Environmental Sub-Component	VEC	VEC Indicator	Rationale
Aquatic Habitat	Darlington Creek and Intermittent Tributary to Darlington Creek	White Sucker	The selected VECs represent the specific habitat types that have been identified as relevant to the aquatic habitat within the applied study areas. Species (or groups of species) were selected as VEC Indicators because the Project will interact with Aquatic Habitat through the species that make use of these habitats. The condition and function of the habitat will be most effectively assessed by evaluating the species that use the habitat. The species groups selected as VECs for the Aquatic Environment represent the general trophic web groupings with ecological importance in the LSA and RSA. The rationale for the individual species selected as Indicators within these groups are provided below.
	Lake Ontario Nearshore	Benthic Invertebrates Round Goby Emerald Shiner Alewife White Sucker Round Whitefish Lake Sturgeon American Eel Lake Trout Salmonid Sport Fish	
Aquatic Biota	Forage Species	Benthic Invertebrates	Benthic invertebrates will be entrained, some benthic invertebrate habitat will be lost or altered; and these organisms were adopted as a VEC in the Darlington Used Fuel Dry Storage (DUFDS) EA with regard to construction-related effects on the nearshore. Important food source for benthivorous fish species.
		Round Goby	Most abundant nearshore benthic forage species and will be subject to mortality and habitat loss/alteration. Although an exotic species in Lake Ontario, this species needs to be considered due to its apparent ecological role in the aquatic community.
		Emerald Shiner	Numerically important nearshore schooling forage species, particularly in the proposed fill area, and will be subject to mortality and habitat loss/alteration. Emerald shiner was a VEC for the DUFDS EA related to effects on the nearshore due to construction.

TABLE 4.4-1 (Cont'd)
VECs Selected for the Aquatic Environment

Environmental Sub-Component	VEC	VEC Indicator	Rationale
Aquatic Biota	Forage Species	Alewife	Remains the most significant pelagic forage species in Lake Ontario, has been the focus of substantial work concerning fish losses to once-through cooling water systems; and has been a VEC for the Aquatic Environment component of most Great Lakes nuclear plant EAs.
	Benthivorous Fish	White Sucker	Common benthivorous fish of the nearshore, an important component of that community, the focus of radiological monitoring, potentially affected by loss/alteration of some nearshore habitat and was a VEC for the DUFDS EA.
		Round Whitefish	Has been a VEC for the Aquatic Environment component of most Great Lakes nuclear plant EAs due to potential thermal effects on nearshore spawning shoals and concerns surrounding entrainment of eggs and larvae. Recent round whitefish work has been completed at Darlington and both round whitefish larvae and adult populations are on the decline. This species may suffer some habitat loss with construction occurring in the nearshore.
		Lake Sturgeon	A species of conservation concern that is subject to recovery efforts in Lake Ontario. Catches of large juveniles in experimental gillnets and anecdotal evidence of angler catches of large juveniles in adjacent tributary mouths warrants consideration of this species in relation to effects on nearshore habitats and the potential for impingement losses (although sturgeon has yet to be recorded as impinged at DNGS). Sturgeon had been subject to fishery exploitation in the past, before population declines.
	Predatory Fish	American Eel	A species of conservation concern, subject to recovery efforts and ongoing studies related to Lake Ontario and other waterbodies. Eels were encountered during earlier boat electrofishing in the nearshore at the DNGS and may be affected by works and activities in the Lake Ontario nearshore. However, they were not impinged in recent sampling (2006-7).

TABLE 4.4-1 (Cont'd)
VECs Selected for the Aquatic Environment

Environmental Sub-Component	VEC	VEC Indicator	Rationale
Aquatic Biota	Predatory Fish	Lake Trout	Has been a VEC for the Aquatic Environment component of other nuclear plant EAs and was the most frequently captured salmonid in monitoring at the DNGS. Potential for spawning in the area, similar to whitefish, is cause for consideration of habitat effects and the susceptibility of lake trout to impingement/entrainment and attraction to thermal discharge.
		Salmonid Sport Fish	Multi-species category intended to capture the non-native salmonid fishery including chinook and coho salmon, rainbow trout and brown trout for discussion of potential concerns of Project-related changes to the sport fishery.

The process of selecting VECs is described in Section 3.2.4 and as indicated, consideration of input from the public and other stakeholders was an important aspect of finalizing those to be used. The following specific suggestions concerning VECs in the Aquatic Environment were received as comments made on the draft EIS Guidelines. They were considered as noted below in establishing the final VEC:

- Add Daphnia (i.e., planktonic crustaceans) as a VEC: A detailed rationale for not including planktonic organisms as a VEC is provided in the *Aquatic Environment Existing Environmental Conditions TSD.* In summary, because planktonic crustaceans drift with the current they do not actively make use of the habitat likely to be affected by the Project for a sufficient period of time to serve as a meaningful measure of effect. Their populations and patterns throughout the lake are highly variable and it would not be possible to evaluate if changes to these populations and patterns could be attributed to the Project. It is to be noted that zooplankton (i.e., Daphnia) was applied as one of several aquatic receptors for the assessment of effects on non-human biota (see Section 5.1);

- Add Submerged Aquatic Habitat as a VEC: Submerged habitat is not included as a separate VEC because it is inherently considered in the assessment of effects on the aquatic biota species, in which fish communities are evaluated, in part, based on loss of habitat for individual species. To add as a separate VEC would contribute to a double counting of an effect on aquatic habitat.

4.5 Terrestrial Environment

This Section provides an overview description of the existing Terrestrial Environment. The detailed baseline characterisation of the Terrestrial Environment is contained in the *Terrestrial Environment – Existing Environmental Conditions Technical Support Document, New Nuclear - Darlington Environmental Assessment*. The description is presented in the context of the following environmental sub-components:

- Vegetation Communities and Species: the basic habitat unit for many wildlife attributes and represents the most important element of ecosystem function;
- Insects: the Monarch butterfly, a species of conservation concern migrates through the DN site in numbers. In addition, many species of dragonflies and damselflies including provincially rare species have been attracted to the constructed and enhanced wetlands;
- Bird Communities and Species: these are commonly used as indicators for the assessment of potential effects. They are relatively easy to survey, their status and behaviour are relatively well-understood and they can act as useful surrogates for broader wildlife species that are more difficult to sample (e.g., secretive or nocturnal mammals);
- Amphibians and Reptiles: these are good indicators of the quality of wetland habitat as they often respond rapidly to changes in their environment. Ecologically, they represent an important link in the food chain and are also useful for measuring ecosystem health;
- Mammal Communities and Species: these are an important element of the food chain. They range from small herbivorous mammals taken as prey by other animals to carnivores; and
- Landscape Connectivity: this is represented by elements of the landscape that serve as corridors or linkages and support the movement and dispersal of flora and fauna.

4.5.1 Study Areas

The generic study areas described in Section 3.1.3 were considered for specific application for the Terrestrial Environment, with modifications made as appropriate. The study areas as applied are described below:

<u>Regional Study Area</u>

The RSA applied for the Terrestrial Environment was adopted without change from the generic RSA.

Local Study Area

The LSA applied for the Terrestrial Environment was adopted without change from the generic LSA.

Site Study Area

The SSA applied for the Terrestrial Environment was modified from the generic SSA to incorporate lands that, although beyond the DN site, are clearly associated with it as a result of biophysical connection. Specifically:

- A western extension along the Lake Ontario bluff to consider that the bluff in the off-site area is immediately adjacent to likely areas of NND-related construction, is contiguous with the same on-site bluff features, and that the associated Shrub Bluff vegetation community is rare in Durham Region;
- The boundary continues south along the eastern perimeter of the OPG property from the South Service Road but extends eastwards onto the St. Marys Cement property close to the lake to incorporate a cultural meadow, a small coastal wetland and portions of the Lake Ontario bluff; and
- For the purposes of considering the Bank Swallows colony only (see Section 4.5.4.3), a Bank Swallow Evaluation Area was established extending into the LSA along the shoreline only, to include the lakeshore from Oshawa Creek to Wilmot Creek. This Bank Swallow Evaluation Area is more meaningful for a species that has its breeding habitat more or less confined in this area of the Lake Ontario shoreline. The east-west extent was derived from examination of the surveyed colonies and professional judgement.

Existing conditions in the Terrestrial Environment are described in the sections that follow in a framework of the individual study areas. The description is primarily focused on the SSA since it is primarily this area that will be subject to potential effects of the Project. The descriptions of existing conditions in the LSA and the RSA are more general and intended to provide the broader context for the description of the SSA.

4.5.2 Regional Study Area

Significant Natural Heritage Resources

Life Science Areas of Natural and Scientific Interest (ANSIs) represent the full range of biological (life science) and geological (earth science) resources of a particular area. The ANSI program is led by the Ontario Ministry of Natural Resources (OMNR). A provincially significant life science ANSI is one of the best representations of the range of biological resources associated with that particular kind of feature within the Province of Ontario. A total of 31 Life Science ANSIs have been identified in the RSA, however other ANSIs include bluffs, forests, creek valleys and headwater areas.

Environmentally Significant Areas (ESAs) are identified by the Conservation Authorities. They represent important ecological areas and are also useful in characterizing potential effects at the RSA level. According to the OMNR approximately 64 ESAs have been designated by the six Conservation Authorities in the RSA.

Within the RSA, 35 Provincially Significant Wetlands (PSWs) have been identified, many of which are also designated ANSIs. Some of the wetlands are Great Lakes coastal wetlands; a unique wetland type that forms either at the mouths of streams and rivers where they empty into Lake Ontario, or in open or protected bays along the shoreline.

Vegetation Communities and Species

Much of the RSA has been cultivated over the past century and, accordingly, the dominant vegetation cover relates to agricultural use, including row crops and pasture land. Natural vegetation features also include valley lowlands associated with rivers and creeks and the Lake Ontario shoreline environment.

The natural forest vegetation is dominated by broadleaved deciduous trees such as American Beech, Sugar Maple, Basswood, Red Maple, White Oak and Bur Oak. Many of the wooded areas are associated with Life Science ANSIs such as the Durham Region Forest and the Long Sault Conservation Area. Land use change has eliminated most extensive forested areas; remaining or regenerating ones are located along the riparian corridors of Lynde Creek, Oshawa Creek, Bowmanville Creek and the smaller subwatersheds. Several Mixed Forest and Coniferous Forest units extend along these corridors. The dominant species in these units consist of species such as Eastern White Cedar, White Pine, Black Cherry, Green Ash and Sugar Maple.

Coastal wetlands are an important aspect of the vegetation communities and species in the RSA. These wetlands are located between the permanent water of Lake Ontario and adjacent upland areas. Examples of vegetation communities in coastal wetlands include the following: treed and thicket swamps, wet grass and sedge meadows and emergent marshes dominated by cattails and bulrushes. In addition, coastal wetlands often contain interspersed pockets of open water that support submerged and floating leafed plants such as pondweeds and water lilies. Coastal wetlands are important for migratory birds many of which make first land-fall during spring and fall migration.

Land use change has resulted in the propagation of numerous anthropogenic vegetation communities. Cultural woodland, plantations, thickets and meadow features are located both adjacent to natural vegetation communities and in isolated pockets.

Faunal Communities and Species

Common amphibian species known to be present in the RSA include Red-spotted Newt, Northern Redback Salamander, American Toad, Spring Peeper, Western Chorus Frog, Gray Treefrog, Wood Frog, Northern Leopard Frog and Green Frog, although some are uncommon in and/or may be declining (e.g., the Northern Leopard Frog and the Western Chorus Frog).

Native turtles reported in the RSA include the Common Snapping Turtle, Midland Painted Turtle, Map Turtle, Blanding’s Turtle and Spiny Softshell. In recent years the “Threatened” Blanding’s Turtle has been observed at Pumphouse Marsh in Oshawa, and one was seen on the beach near that marsh. There are only one or two older records for the “Threatened” Spiny Softshell Turtle or the Map Turtle in the RSA and they are unlikely to occur in the future, except as isolated reports.

Snake species that may be observed in the RSA species include: Eastern Gartersnake, Eastern Ribbonsnake, Northern Redbelly Snake, Dekay’s Brownsnake, Smooth Green Snake and Eastern Milksnake.

Over 350 bird species have been recorded in the RSA with the vast majority of these being migrants. Many millions of migrants (e.g., raptors, waterfowl, shorebirds, thrushes, warblers and finches) pass through the area in spring and fall each year. Some species with a more northern range distribution, also move into the RSA each winter according to weather conditions and food supplies and they remain for all or part of the winter period. This includes raptors such as Snowy Owl, Rough-legged Hawk, familiar winter birds such as Dark-eyed Junco and a variety of so-called “winter finches”. The number of regular breeding bird species within the RSA is approximately 140. These include “Threatened” species such as Least Bittern, Peregrine Falcon and Hooded Warbler as well as a wide range of common, uncommon, scarce and rare species.

Approximately 50 mammalian species occur within the RSA, varying from the tiny shrews to the Black Bear and even the occasional Moose. Some bat species are migrants, but most mammals are resident whether they hibernate, aestivate or simply remain active all year. Most uncommon mammals have now disappeared from the RSA (e.g., Timber Wolf) and the remaining species that are regular in occurrence are those that are more tolerant of human activities.

4.5.3 Local Study Area

Vegetation Communities and Species

The same broad-leaved deciduous trees that are characteristic of the RSA are also represented in the LSA. The ancient Lake Iroquois shoreline area plays a role in the context of the LSA in that this feature supports different plant communities on sandy and silty sandy soils which contrasts strongly with the fertile clay-based tills of the surrounding, now mostly agricultural (or urban) lands.

Many wetlands are also concentrated in the LSA including along the Lake Ontario shoreline environment where a number of coastal wetlands constitute important natural features. These include: Oshawa Second Marsh, McLaughlin Bay, Oshawa Creek Coastal Wetland, Pumphouse Marsh and Bowmanville Coastal Wetland. All of these have been designated PSWs. Other PSWs in the LSA include Harmony-Farewell Iroquois Beach Wetland Complex, Maple Grove Wetland Complex and West Clarington Iroquois Beach Wetland Complex. These are located in the north central portion of the LSA and together they form a substantial area of natural habitat.

Faunal Communities and Species

The wildlife community and species within LSA also reflect the assemblages discussed above for the RSA.

4.5.4 Site Study Area

The Terrestrial Environment in the SSA is described below in a framework of the individual environmental sub-components.

4.5.4.1 Vegetation Communities and Species

Vegetation communities within the DN site have been mapped and described following the Ecological Land Classification (ELC) system (Lee *et al*. 1998). ELC allows examination of the distribution and assemblages of plant species for the purpose of classifying observations according to ecosystem characteristics and processes. The classification was originally carried out in 1999 and 2002 and it was updated during this EA baseline characterization program.

The terrestrial community classes represented within the SSA are summarized below.

Beach: Approximately 1.5 ha (<1% of the total mapped area of 284.4 ha) is represented by Beach community. Beach Community Classes are characterized by their patchy vegetation cover. These areas are located above the seasonal high water mark and are often exposed to extremes in moisture and temperature. Beach areas are subject to active shoreline processes such as wave action, erosion, wind action and deposition.

Bluffs: Approximately 2.4 ha (<1% of total area) is represented by Bluffs. Bluff communities have less than or equal to 10% tree cover as tree invasions are often restricted by erosion related events. These erosion related events are a result of the bluffs having steep, sometimes near vertical faces that are more than 2 m in height, wave action and, in the case of the DN site, by the lateral movements of water within sand lenses, which are affected by freeze-thaw cycles.

Forest: Forest represents about 16.3 ha (3% of total area). Forest communities have more than 60% tree cover with variable substrate types and conditions. The ELC further breaks down the forested areas into coniferous, deciduous and mixed forest types.

Cultural: Collectively, Cultural communities consisting of Cultural Woodland, Thicket and Meadow represent 229.4 ha (46.7% of the total). This broad category includes plantations, cultural meadows and woodlands that generally result from or are maintained by cultural or anthropogenic disturbances.

Marsh: Marsh communities represent 13.5 ha (3% of the total). Marsh communities exhibit less than 25% tree and shrub cover and dominance (50% or more) by plant species that are adapted to wet conditions. Marshes typically have variable flooding regimes but the water depth does not exceed 2 m.

Open Aquatic: Open Aquatic communities represent 0.4 ha (<1% of the total), not including Lake Ontario. This class is identified by their lack of vegetation and a water depth in excess of 2 m. This small area is generally in the centre of Coot's Pond.

Submerged Aquatic: Submerged Aquatic communities represent 1.6 ha (<1% of the total). These classes are typified by submerged or floating-leaved wetland plants. These areas can have emergent plant species but are not dominated by them. Tree and shrub cover will not be present. They can have water depths up to 2 m and there is always standing water present.

Swamp: Swamp communities represent about 19.4 ha (3.9% of the total). This classification is applied to areas that have more than 25% tree and shrub cover and that are dominated by wetland trees and shrubs. These areas have variable flooding regimes and water depth less than 2 m. Standing water should comprise more than 20% of the groundcover.

Over 340 species of vascular plants have been identified for the DN site. Approximately 138 species of those recorded are non-native to Ontario. This relatively high percentage (40%) of non-native species is indicative of high levels of disturbance and often lower floristic quality. Certain highly invasive non-native species such as: Common Reed, Purple Loosestrife, Black Locust, Dog-strangling Vine and Common Buckthorn were recorded in a wide-range of vegetation community types and these species in particular affect biodiversity by limiting wildlife habitat opportunities and by displacing native species.

Two significant species have been recorded at the DN site: the provincially Endangered Butternut and the provincially Vulnerable Cup Plant. In addition, 45 locally or regionally rare or uncommon plant species (also referred to as *species of conservation concern*) have been identified on the DN site.

The vegetation communities in the eastern extension of the SSA onto St. Marys Cement property were also mapped following the ELC system. The general classes included Beach/Bar community extending parallel to the shoreline which provides an important physiographic function to the Shallow Marsh community to its north by serving as a barrier to water in the wetland thereby maintaining its hydrology. Much of the area north of the shoreline exists as a Wetland community with marsh adjacent to an open lagoon (i.e., Raby Head Marsh) and submerged aquatic and swamp ELC classifications.

4.5.4.2 Insects

Migrant Butterfly Stopover Area

To date, 29 species of butterflies have been recorded at the DN site. This number is modest for a location along the shore of Lake Ontario. The Monarch, which is a long-distance migrant, regularly uses the DN site. While many thousands of Monarchs pass through the DN site every fall on their southbound migrations, fall roosting sites (large sheltered conifers) are lacking and no large aggregations have been noted at the DN site in the past or in the fall of 2007. The ELC communities of Cultural Meadow and Cultural Thicket, which occupy over 180 ha on the site, provide excellent breeding habitat for these butterflies which require Common Milkweed as a caterpillar food plant. During the fall these same communities support many thousands of flowering asters, goldenrods and even the non-native Purple Loosestrife, all of which provide sources of nectar for the adults as they continue on their long journey south.

Dragonflies and Damselflies

Nine of the 41 dragonfly and damselfly species observed on the DN site are considered Vulnerable under the provincial ranking system. The DN site ponds (Coot's, Treefrog, Polliwog and Dragonfly) attract these insects and the site is on a dragonfly migration pathway. One of the species seen breeding by amateur Odonatists in 1997 was the Red-mantled Saddlebag, which became perhaps the first known breeding record in Ontario. The recent arrival of northern redbelly dace (a fish species) in Coot's Pond may be detrimental to the dragonfly community and in recent years the community has appeared to be less diverse.

Moths

In 2003, a three-evening moth inventory undertaken at the DN site yielded 208 recorded species. One additional species has since been added. For the effort employed, the moth list is typical of what would be expected in an area that includes large expanses of regenerating old field habitat. Forest and wetland species were almost absent. Many of the moths recorded were generalists on grasses and tree species that are usually regarded as pioneer species (e.g., poplars, birches, hawthorns, cherries, willows and ash).

4.5.4.3 Bird Communities and Species

Breeding Birds

Around Coot's Pond and in other moist or wet thicket areas, Yellow Warbler was by far the most dominant species of the Wetland Breeding Bird Community. Associated species included Common Yellowthroat, Willow Flycatcher, Eastern Kingbird and Red-winged Blackbird. Yellow Warblers are one of the most common species on the site and their numbers have been increasing, whereas the kingbird has declined, likely due to factors outside of the DN site as indicated by evidence of more widespread declines across its range. Pied-billed Grebe and Virginia Rail were present in 2007, for the second consecutive year, at Coot's Pond, as was a "Threatened" Least Bittern and Black Terns, a species of "Special Concern" in Ontario, were seen prospecting for a nest site.

Species such as American Woodcock, Willow Flycatcher, Gray Catbird, Brown Thrasher, American Robin, Cedar Waxwing, Yellow Warbler, Common Yellowthroat, Northern Cardinal, Indigo Bunting, Song Sparrow and Red-winged Blackbird typified the Upland Successional

Breeding Bird Community. Less common species were also present such as Alder Flycatcher, Black-billed Cuckoo, Orchard Oriole and Northern Mockingbird.

Woodland associated species continued to expand and their increases may not be reflected by the original annual transects which by and large do not intersect with new woodlands. These species included: Downy Woodpecker, Eastern Wood Peewee, Black-capped Chickadee, Warbling Vireo, Red-eyed Vireo and American Redstart. Less common species included Cooper's Hawk and Blue-gray Gnatcatcher.

The Upland Cultural Meadow Breeding Bird community was dominated by Savannah Sparrow, Song Sparrow and American Goldfinch. There were also occasional Red-winged Blackbirds and many pairs of Tree Swallows that frequented the nest-boxes provided by OPG. Other species in this community included several pairs of Field Sparrow, the declining Bobolink and Eastern Meadowlarks.

In the eastern extension of the SSA onto the St. Marys Cement property, 57 species of probable or confirmed breeding bird species were recorded including habitat generalists, shoreline species, waterfowl and other wetland habitat species. The Least Bittern, a provincially "Threatened" species was observed in the central marsh unit. A nesting pair of Peregrine Falcons (provincially "Threatened") with one fully grown offspring were observed in the St. Marys Cement quarry (although not within the SSA). There is also a large Ring-billed Gull nesting colony located to the southeast of the area that was investigated.

Migrant Songbirds

A total of 213 different species of birds has been observed at the DN site and almost all have occurred as migrants, even if they breed on the property. The few exceptions are species such as Rock Dove, which are truly resident.

The total area of higher quality habitat for migrant songbirds is approximately 125 ha. Some of the higher quality migrant bird habitat at the DN site appears to be in a woody vegetation area (Bunting Thicket) in the eastern portion of the site, just north of the CN railway which includes Treefrog, Polliwog and Dragonfly ponds. Large numbers of migrant birds have been recorded in that vicinity during the spring and less during the fall. Bunting Thicket is the largest patch of woody vegetation on the site and the ponds offer additional forage and shelter potential making this thicket attractive to a wider range of bird species.

Bank Swallow

Bank Swallows have been known to nest at the DN site for many years. In 1997, 1,450 nest burrows were surveyed along the Lake Ontario shoreline, including lands both on and off-site (Henshaw 1997). In 1999, approximately 600 nests were counted during a shoreline survey along the western part of the site alone (Henshaw 1999a), where today virtually no burrows are located.

The EA field program included a 2007 survey of the entire Durham Region Lake Ontario shoreline to provide context for the Bank Swallow nesting burrows found on the DN site. Following the survey protocols, 86 colonies were identified with a sum of 12,759 burrows. The smallest colony size, found at three separate locations, had seven nesting burrows while the largest single colony in Durham Region contained 840 burrows. The average colony size was 148 nesting burrows.

In the fall of 2008, the Bank Swallow Monitoring Program (BSMP) was initiated. The BSMP comprises a periodic survey of the Bank Swallow colonies along the Lake Ontario shoreline from Darlington Provincial Park to the mouth of Darlington Creek. To date, three surveys have taken place; in October 2008, in April 2009 and in June 2009. The results of these surveys and comparative data obtained from the 2007 Durham Region Shoreline Survey indicate that nesting habitat for approximately 1,300 burrows exists in the area of the DN site likely to be directly affected by the Project.

Currently, the Bank Swallow is common, even abundant in some areas, and it is not designated for a special level of protection in Canada or in Ontario. Most concerns over the protection of colonies relate to the vulnerability of colonial species in general. At the Regional level, it is unknown whether or not the colonies at the DN site could be described as important. Although it is likely that the colonies associated with the Great Lakes are important source populations in the province.

Waterfowl Staging Areas and Winter Habitat

The level of waterfowl use of staging areas and winter habitat appears to be robust in the vicinity of the DN site. A series of eight counts conducted at Coot's Pond and throughout an approximately 5-km length of Lake Ontario shoreline in the vicinity of the DN site during 2007/2008 identified 23 species of waterfowl. Coot's Pond supported up to 345 Ring-necked Ducks in the spring of 2007, which is a high number for any location within the RSA. A number of other migrant waterfowl was noted there in both spring and fall 2007. On Lake Ontario, large numbers and a wide-variety of species were associated with the outfall area and with the physical structures (e.g., docks) in the adjacent shoreline at St. Marys Cement.

Winter Raptor Feeding and Roosting Areas

During winter 2007/2008, one American Kestrel, one male Northern Harrier and up to two Red-tailed Hawks were observed, but not all at the same time. The low use of the site by raptors was thought to be due to a cyclical low in Meadow Vole numbers. During periods when Meadow Voles are numerous, the site is known to support numerous other raptors during winter. Typically, several American Kestrels, Rough-legged Hawks, Red-tailed Hawks and one or two Northern Harriers can be anticipated. Much less frequent visitors are Snowy Owls, Great Gray Owls and Northern Saw-whet Owl. In recent years, winter roosts of the scarce Long-eared Owls have been reported at the DN site.

Bird Strikes

Thirteen bird strike surveys were carried out within the Protected Area of DNGS during the spring/fall of 2007 and the spring of 2008. During 10 of these surveys dead, injured and/or dazed birds were observed in the vicinity of the buildings. Compared to the hundreds of birds that can be found at lighted buildings in waterfront cities such as Toronto, a very low number were found distressed or dead during the surveys (32 individual birds). In addition, there was evidence that some of the dead birds were local breeding European Starlings having fallen from, or been predated at, nests or were birds predated by other bird species (e.g., Common Grackles, American Crows and Racoons).

4.5.4.4 Amphibians and Reptiles

Over the past 10 years, six species of amphibians have been recorded calling during the breeding season at the DN site. These were the Green Frog, American Toad, Northern Leopard Frog, Wood Frog, Western Chorus Frog and Gray Treefrog. The latter three species have been represented only by single calling males and have probably not bred successfully at the DN site over the past decade. The other three species are annual breeders and have been quick to colonize the three ponds that have been constructed (Treefrog Pond, Polliwog Pond and Dragonfly Pond). The toads strongly prefer the ephemeral Polliwog Pond. In general the toads and Green Frogs appear more abundant at the small ponds compared to Coot's Pond (especially when considering the much larger area of marsh habitat at Coot's Pond, while Northern Leopard Frogs prefer Coot's Pond. In 2008, Green Frogs did return to the small ponds which had dried out during the previous year.

Only four species of reptiles are known for the DN site: the Common Snapping Turtle, Midland Painted Turtle, Red-eared Slider and Eastern Gartersnake. The turtles are relatively recent arrivals and although three Midland Painted Turtles were once seen at Treefrog Pond, all other records are from Coot's Pond. Some of these turtles may have been released here particularly the non-native Red-eared Slider. Both the Common Snapping Turtles and the Midland Painted Turtles have been successfully breeding around Coot's Pond in recent years.

The Raby Head Marsh (on the St. Marys Cement property) appears to be relatively productive for breeding amphibians and is probably the source for the same three species that have colonized the DN site. It is also probably an important breeding area for local amphibian populations south of Hwy. 401, which represents a formidable barrier for these species, especially for the more terrestrial American Toad and Northern Leopard Frog.

4.5.4.5 Mammal Communities and Species

Accounts of 30 mammal species at the DN site have been compiled as a result of incidental observations during field investigations conducted for other purposes since 1997. None of these species is considered to be at risk in Ontario. Some are uncommon or poorly known in the RSA such as Pygmy Shrew and Long-tailed Weasel. A Black Bear was observed traversing the site by OPG security staff in 2003. Generally similar species were recorded for the studied area of the St. Marys Cement property.

Winter tracks observed in the winter of 2006 - 2007 show a low level of use by a range of common winter-active species such as White-tailed Deer, Coyote, Red Fox, Eastern Cottontail and Striped Skunk. The highest densities of tracks were associated with areas where some cover was present or slopes provided shelter, such as the south-eastern area of the property. Generally winter cover for wildlife is poorly developed at the DN site.

4.5.4.6 Landscape Connectivity

The northern half (approximately) of the DN site represents approximately 200 ha of more or less contiguous wildlife habitat. To the west is the Oshawa Second Marsh - McLaughlin Bay Wildlife Reserve – Darlington Provincial Park complex, which constitutes a regional core habitat, beyond which are the Harmony Creek and Farewell-Black Creek systems. To the east, the Provincially Significant Westside Marsh and two creek systems (Darlington Creek and Soper Creek) are located. Efforts have already been made to maintain east - west connectivity through this area as part of the expansion of the St. Marys Cement quarry operations.

Within the DN site, most connectivity for wildlife currently exists north of the railway line. For some species that are able to avoid collisions with trains, the CN railway enhances this connectivity. Small and medium sized mammals, insects and seed dispersal for certain flora may benefit from the connectivity opportunity afforded by the railway right-of-way. This east - west connectivity includes small nodes associated with the ponds or other features on the site either directly on the corridor or somewhat removed.

Another local pathway potentially exists for some species between the Raby Head Marsh located on the St. Marys Cement property and three of the four constructed ponds (Treefrog, Dragonfly, and Polliwog ponds) and associated natural features on the DN site.

The influence of the Hwy. 401 compromises north – south connectivity between the LSA and the SSA.

4.5.5 Valued Ecosystem Components

VECs were selected to represent each of the biophysical sub-components of the Terrestrial Environment. Each VEC was deemed to be an element of importance within the geographic extent of Project works and susceptible to change and effect as a result of Project-related activities. The VECs and their rationale for selection are described in Table 4.5-1

TABLE 4.5-1
VECs Selected for the Terrestrial Environment

Environmental Sub-Component	VEC	VEC Indicator	Rationale
Vegetation Communities and Species	Cultural Meadow and Thicket Ecosystem	Cultural Meadow Cultural Thicket	Vegetation communities are the basic habitat unit for many wildlife attributes. The four primary ecosystem elements at the DN site are: cultural meadow and thickets, shrub bluff, wetland and woodland. These provide habitat for a wide range of flora and fauna species both as breeding habitat and in some cases as habitat for migrant songbirds. Meadow and thicket were selected as VEC Indicators as they are directly relevant to the maintenance of biodiversity, may be directly affected by the Project through removal, and are readily measurable by area following the protocols of the Ecological Land Classification system.
	Shrub Bluff Ecosystem	Grass of Parnassus	The Grass of Parnassus reflects groundwater seepage and associated flora and fauna, and the dynamic nature of the bluff community, one of only a handful of locations in the Region where this species is found.
Vegetation Communities and Species	Wetland Ecosystem	Bur-reed	The Bur-reed, an emergent wetland plant, is heavily used by wildlife and is found in the wetland ponds at the DN site. It also represents shallow water marsh habitat and is not in wetlands that are dry for much of the year.
	Woodland Ecosystem	Sugar Maple Woodland (Cultural Woodland, Forest, Swamp Forest	The Sugar Maple is a typical deciduous tree species and is an important element in woodland ecosystems. Woodland cover is directly relevant to the maintenance of biodiversity, may be directly affected by the Project through removal, and is readily measurable by area following the protocols of the Ecological Land Classification system.

TABLE 4.5-1 (Cont'd)
VECs Selected for the Terrestrial Environment

Environmental Sub-Component	VEC	VEC Indicator	Rationale
Insects	Dragonflies and Damselflies	Eastern Amberwing	Insects are a critical component of ecosystem function and at the DN site some insect groups have been investigated. Many species of dragonflies, damselflies and butterflies have been attracted to the on-site constructed and enhanced wetlands. The Eastern Amberwing, was selected as a dragonfly indicator as it is scarce in the Region and is a recent arrival at the DN site, it is also readily identifiable for monitoring purposes.
	Migrant Butterfly Stopover Area	Area of habitat for the Monarch	Migrant insects are a feature of the north shore of Lake Ontario and the DN site represents a site where there is extensive habitat for migrant butterflies. The Monarch butterfly is an unusual long-distance migrant. It is a species of conservation concern that attract a high level of attention from the public.
Bird Communities and Species	Breeding Birds	Yellow Warbler Red-eyed Vireo Bank Swallow	Breeding Birds (including the Bank Swallow colony) are relevant to the maintenance of biodiversity and are a readily monitored surrogate for broader ecosystem function. They are also a good indicator of overall ecosystem health. The Yellow Warbler complements the cultural ecosystem that is dominated by thicket and meadow, and is a common insectivore at the DN site. The Red-eyed Vireo, while less common, is an insectivore that is confined to treed habitats (woodland of various types) and it complements the selection of woodland ecosystem as a VEC. The DN site has nesting habitat that supports a substantial colony of Bank Swallows (approximately 1,300 burrows). This species has highly specific nest site requirements. It is also a member of a guild of birds (aerial insectivores) that are of conservation concern.
	Waterfowl Staging Areas and Winter Habitat	Bufflehead Mallard	Studies carried out in the DN site vicinity have indicated a significant presence of waterfowl, and waterfowl are valued to the general public. Staging areas and winter habitat are essential to the viability of the waterfowl population and these could be affected by activities at the lake

TABLE 4.5-1 (Cont'd)
VECs Selected for the Terrestrial Environment

Environmental Sub-Component	VEC	VEC Indicator	Rationale
			and at Coot's Pond. The Mallard and Bufflehead are species that use both Coot's Pond and the inshore environment of the Lake Ontario waterfront, and that represented both diving and dabbling waterfowl guilds.
	Migrant Songbirds and their Habitat	Area of woody habitat Bird strikes	Migrant songbirds are known to concentrate along the north shore of Lake Ontario and are a matter of federal interest. Woody habitat is the most-used habitat for migrant songbirds and is readily measured. Bird strikes were considered an indicator because of concerns over migrant birds striking large structures along the Lake Ontario shoreline.
	Winter Raptor Feeding and Roosting Areas	Long-eared Owl	The DN site is known to harbour winter raptors, including owl roosts, during years of high vole populations. Habitat for these birds is limited and some species are sensitive to disturbance. The Long-eared Owl was selected as the VEC Indicator.
Amphibians and Reptiles	Breeding and Key Summer Habitat	Green Frog Midland Painted Turtle	While there are other habitat elements important to amphibians, consideration of Breeding and key Summer habitats as a VEC ensures that the populations at the DN site are fully considered in the EA. The Green Frog is found in all ponds on the property and is an important component of the wetland ecosystems on the site. The Midland Painted Turtle is one of only two common reptiles at the DN Site and the population is centred at Coot's Pond.
Mammal Communities and Species	Breeding Mammals	Muskrat Meadow Vole	Breeding mammals were selected as the VEC because they are present year-round and are more likely to be affected by the Project. They are also an important element of site biodiversity. Meadow Vole is common and (when abundant) is easily sampled. It is also an important element of the food chain for other VECs. Few aquatic mammals are present at the DN site and only the Muskrat is a regular breeder, mostly at Coot's Pond.

TABLE 4.5-1 (Cont'd)
VECs Selected for the Terrestrial Environment

Environmental Sub-Component	VEC	VEC Indicator	Rationale
Landscape Connectivity	Wildlife Corridors	Connectivity across DN site	Landscape connectivity, including the concept of wildlife corridors, has become recognized as an important part of natural heritage planning. The wildlife corridor crossing the site in an east-west direction has been recognised by other stakeholders and OPG. The VEC Indicator is the extent to which connectivity across the site is maintained.

The process of selecting VECs is described in Section 3.2.4 and as indicated, consideration of input from the public and other stakeholders was an important aspect of finalizing those to be used. The following specific suggestions concerning VECs in the Terrestrial Environment were received as comments made on the draft EIS Guidelines. They were considered as noted below in establishing the final VEC list:

- Add Expanded List of Species under Vegetation and Habitat, Birds, Amphibians, Mammals, Aquatic/Fish Community: As described in Section 3.2.4, depending on circumstances and the nature of the evaluation, the VEC may be defined at a species level or in broader context in which case individual species may be applied as VEC Indicators to support a more focused assessment of the broader category. The VECs for both the Terrestrial and the Aquatic Environments were established at the broader level, however, both also included detailed lists of VEC Indicators at the species level (see Tables 4.4-1 and 4.5-1) and these will be applied as the basis for the assessment of effects; and

- Add Reptiles as an environmental (sub)-component and develop a List of Species: As indicated above, Amphibians and Reptiles is included as an individual environmental sub-component. The relevant VEC is Breeding and Key Summer Habitat and species have been identified at the VEC Indicator level.

4.6 Geological and Hydrogeological Environment

This Section provides an overview description of the existing Geological and Hydrogeological Environment. The detailed baseline characterisation of this environmental component is contained in the *Geological and Hydrogeological Environment – Existing Environmental Conditions Technical Support Document, New Nuclear - Darlington Environmental Assessment*. The description is presented in the context of the following environmental sub-components:

- Soil Quality: the physical and chemical characteristics of the surface and subsurface materials;

- Groundwater Flow: the rate of flow and volume of groundwater; and

- Groundwater Quality: the chemical characteristics of the groundwater system.

4.6.1 Study Areas

The generic study areas described in Section 3.1.3 were considered for specific application for the Geological and Hydrogeological Environment with modifications made as appropriate. The study areas as applied are described below.

Regional Study Area

The RSA extends to the north to include the southern part of the Oak Ridges Moraine, an important geological feature of significance to the geological and hydrogeological interpretation of the DN site. The RSA extends to the west to include the Pickering NGS and a generally equal distance to the east. In a regional context, groundwater flow is directed from the Oak Ridges Moraine to the south to discharge into Lake Ontario.

Local Study Area

The LSA encompasses portions of Oshawa and Clarington generally bounded by (and including) the Oshawa Creek and Soper Creek watersheds to the west and east respectively, the southern part of the Oak Ridges Moraine to the north and Lake Ontario to the south. While geological and hydrogeological effects of the Project are not expected to extend into the LSA in any meaningful way, the LSA contributes groundwater to the SSA through groundwater flow.

Site Study Area

The SSA applied for the Geological and Hydrogeological Environment was adopted generally without change from the generic SSA, although it does not include the Lake Ontario portion of the generic SSA. The SSA includes the facilities, buildings and infrastructure of the proposed Project and it is within this area that the Geological and Hydrogeological Environment will be most affected by the Project.

4.6.2 Physical Setting

Characterisation of the existing geological and hydrogeological conditions was developed in the context of a conceptual model. A "Conceptual Model" is generally described as the basic idea or construct of how a system behaves or operates. A geological and hydrogeological model is a general description of the basic processes that define, control or influence the geological and hydrogeological setting. In general, geological and hydrogeological models are described by summarising the relevant details of the geological and hydrogeological setting. The geological and hydrogeological conceptual model in the study areas relevant to the DN site is summarised in the following sections.

4.6.2.1 Topography and Drainage

The highest elevation in the RSA is in the Oak Ridges Moraine with elevations on the order of 350 m above sea level (masl). The topography drops to the south towards Lake Ontario. Typical lake elevations are on the order 74.78 masl (five-year average). The St. Marys Cement quarry is a significant topographical feature in the LSA. The quarry has been excavated to an elevation of about 64 m below lake level.

The watershed area for Darlington Creek which is located immediately east of the DN site includes the northeastern portion of the site and there is direct runoff to the creek in this area. Darlington Creek drains through St. Marys Cement property in a channelized stream discharging into Lake Ontario. A small un-named creek is located in the area of the proposed Project and drains east into Darlington Creek and from there to Lake Ontario. This stream is ephemeral, containing water only in the wet seasons; it receives groundwater in the spring and likely in the fall. Another tributary to Darlington Creek is located in the northeastern corner as a perennial stream that drains rural lands to the north of the site. Most of the DN site drains to the south directly to Lake Ontario. In the RSA, Harmony Creek and Tooley Creek are located to the west of the DN site.

The highest elevation on the DN site is the Northwest Landfill at an elevation of about 133 masl, dropping to about 105 masl at the base of its slope. The DNGS Protected Area is at an elevation of 78 to 80 masl. The portion of the DN site generally east of Holt Road is adjacent to a high bluff of land with elevations on the order of 95 to 105 masl with the land dropping steeply to the south to Lake Ontario and more gently to the east. The CN railway tracks are recessed into the ground through the central portion of the site with elevations differences of 5 to 10 m between the railway tracks and the adjacent land.

4.6.2.2 Geology and Hydrogeology

On a regional and local level, the bedrock is completely covered by Quaternary deposits and bedrock outcrops are found only in local quarries and other man-made excavations. The Oak Ridges Moraine is a major geologic/hydrogeologic feature in Southern Ontario. It is a ridge of high land separating drainage to the north to Lake Simcoe and drainage to the south to Lake Ontario. Consisting of interbedded layers of glacial till and sand and gravel, the moraine is a major source of groundwater recharge and a large number of creeks and rivers are derived from groundwater discharge from it. South of the moraine, the 8 to 12-km wide Iroquois Plain extends to Lake Ontario. Shoreline deposits and glaciolacustrine sediments are found in this area overlying the glacial tills. The shoreline deposits include sand and gravel bars and beach terraces as well as some deltas from former rivers and creeks flowing into Lake Iroquois. In the area of the DN site, the Iroquois Plain contains drumlins with a southeast orientation indicating the northwest glacial advance. Overburden thickness varies from over 200 m in the Oak Ridges Moraine to about 10 m at the Lake Ontario shoreline. (Note that Lake Ontario coastal (i.e., shoreline) processes are discussed in Section 4.3.5).

Surficial geology in the SSA consists of fill materials in places at surface, underlain by upper and lower till units with interglacial deposits in between. The overburden overlies shale or limestone bedrock. The fill materials are variable in thickness and composition. The limestone sequence has been found to extend to approximately 180 to 190 m in thickness. From surface to depth, the bedrock at the DN site consists of the shale and limestone of the Blue Mountain Formation, Lindsay Formation, Verulam Formation, Bobcaygeon Formation and Gull River Formation. The Shadow Lake Formation, a sandstone and shale unit, lies nonconformably on the Precambrian Basement. The Lindsay Formation is exposed at the surface in the St. Marys Cement quarry adjacent to the DN site. Rock quality is noted to be good to excellent with few breaks or fractures. There is no evidence of karstic features in the local bedrock.

The St. Marys Cement quarry, located immediately east of the SSA is a source of limestone for cement manufacture. The quarry has been developed in a series of four benches with the base of the quarry currently at an elevation of about 11 masl. The current quarry permit allows for development to an elevation of 116 m below sea level (mbsl).

Geotechnical and seismic characteristics relative to the DN site are described in Section 6.3.

In general, groundwater flows from the Oak Ridges Moraine to the south with discharge to local streams or to Lake Ontario. A number of creeks (e.g., Harmony, Bowmanville and Soper Creek) in the RSA have their headwaters in the moraine. The bedrock is of low permeability and does not yield appreciable amounts of groundwater for water supply. However, the upper fractured surface of the bedrock when in contact with more permeable overburden materials may yield sufficient water for domestic water supplies. South of the moraine, the Interglacial Deposits lying between the till layers represent the primary source of water supply. Rural areas north of the DN site rely on groundwater for domestic water supply while urban areas to the east (Bowmanville) and west (Courtice) rely on municipal water supply from a Lake Ontario-based source.

Within the SSA, the till units with relatively lower hydraulic conductivities will act as aquitards, or confining layers, and restrict groundwater movement. Groundwater flow in these units is expected to be primarily vertically downward. The Interglacial Deposits between till units have moderate hydraulic conductivities and act as aquifers and transmit groundwater. Where till is encountered at surface, the recharge of precipitation is expected to be low and most precipitation will runoff to surface water ditches or yard drainage features. Till or clay-rich layers act as confining layers for the Interglacial Deposits and restrict recharge to depth. Consequently, groundwater flow in the Interglacial Deposits is primarily horizontal. Where the Interglacial Deposits are exposed at surface, such as in the northeast of the DN site, a significant groundwater recharge is likely as a result. There may be an upward flow component from the bedrock into the lower till unit. The intact bedrock is generally considered to be of low permeability and will transmit very little water.

Seepage water and precipitation into the St. Marys quarry collects in a sump from where it is pumped to Darlington Creek (by permit). The permit allows a maximum pumping rate of 4,132 L/minute (5,950 m^3/day). The average daily pumping rate for the quarry in 2007 was approximately 1,500 m^3 but varied from no flow to about 4,100 m^3. The low flows in the dry months of the year indicate that there is very little groundwater seepage to the quarry and most of the accumulation in the quarry is the result of precipitation.

4.6.3 Soil Quality

Soil Quality is discussed in a context of the SSA since it is only within this area that soils will be handled or managed. Soil samples collected on the DN site during the EA studies were compared to *Ontario Ministry of the Environment Table 3 Full Depth Generic Site Condition Standards in a Non-Potable Groundwater Condition* of the *Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act*. Table 3 as an assessment standard is applicable for the DN site since it is an industrial site with no potable groundwater use between the site and the point of groundwater discharge (i.e., Lake Ontario).

Generally, the metals analyses indicated concentrations within the assessment criteria for non-potable groundwater conditions. Beryllium and barium were found in most of the soil samples and the consistent distribution between soil layers across the site suggests natural occurrence. Cesium 137 (Cs-137) and the naturally occurring potassium 40 (K-40) were found in concentrations consistent with the results of the DNGS Radiological Environmental Monitoring Program (REMP) indicating that the concentrations are representative of background conditions. Tritium was detected in some soil samples typically at concentrations consistent with those in the groundwater at the same locations. Carbon 14 (C-14) was detected above the method detection level at two of five sampled locations.

4.6.4 Groundwater Flow

Groundwater Flow in a context of the RSA and LSA is summarised above in Section 4.6.2.2. The description that follows is specific to the SSA. It is within this area (and its immediate vicinity) that conditions are most likely to be affected by the Project.

4.6.4.1 Groundwater Table Flow

The water table will generally represent a subdued reflection of the surface topography and therefore can be quite variable. In general, although there are considerable topographic elevation changes across the DN site, groundwater flow below the water table is from the north to the south for the western half of the DN site with eventual groundwater discharge into Lake Ontario, while the eastern half of the site has a component of flow directed to the east towards Darlington Creek. The highest water level elevations in the water table are found in the north centre of the site and beneath the Northwest Landfill Area with water table elevations of about 120 masl. The lowest water levels on the site are in the DNGS Protected Area, on the order of 76 masl, a few metres above lake level. Away from DNGS, the next lowest water table levels are found on the east side of the site, with elevation on the order of 84 masl.

The following are notable in terms of groundwater flows in the water table:

- Groundwater is mounded in the vicinity of the Northwest Landfill Area and as a result, flows radially away from the landfill and generally south towards Lake Ontario with some discharging into the adjacent settling pond (Coot's Pond) and wetlands areas. The water level beneath the centre of the landfill is on the order of 15 m higher than the water levels on the east and west sides;

- The Switchyard may be an area of groundwater recharge because of its granular surface. The recharge will generally flow to the south. However, there is a slight hydraulic gradient to the west that results in a westerly component of flow;

- The east-west railway line intercepts shallow groundwater flow and directs it down-gradient as surface water flow. These flows eventually discharge into Darlington Creek in the east. There are also other outlets from the railroad ditch located south of Coot's Pond and southeast of the Switchyard with the drainage flowing eventually to Lake Ontario;

- In the Protected Area, the shallow groundwater is likely controlled by the yard drainage system and underground utility and service trenches. Shallow groundwater may seep into the storm sewers and drain to Lake Ontario;

- In the northeastern and eastern areas of the DN site, shallow groundwater flows to the east in response to the topographic lows of Darlington Creek and the low lying areas on the St. Marys Cement property. Shallow intermittent creeks drain surface water and shallow groundwater flow to Darlington Creek to the east; and

- In the NND Project portion of the DN site, a water table mound occurs in an area of exposed soil at surface (i.e., no vegetation cover), piles of granular fill and a depression that likely results in higher recharge. The higher recharge creates an elevated water table and somewhat radial flow to the east, south and southwest.

4.6.4.2 Intermediate and Deep Groundwater Flow

Groundwater Flow in the Interglacial Deposits is generally similar to that in the water table, although with some difference. The highest water level elevation is in the northwest corner of the site, with flows to the southeast. On the eastern side of the site, groundwater flows to the east and southeast, and is lowest in the southeast corner of the site. The railway cut does not appear to have a significant impact on flow in the Interglacial Deposits. Close to DNGS, groundwater flows towards the Forebay Channel from the north. Inside the DNGS Protected Area, water levels are relatively flat.

Shallow bedrock water levels in the east are lower than in the Interglacial Deposits by more than 10 m. This may be influenced, as noted above, by the dewatering effects of St. Marys Cement quarry operations. In other areas of the site, the shallow bedrock and Interglacial Deposits water levels are comparable, indicating predominantly horizontal flow, although with downward gradients. Water levels in the bedrock are slow to recover due to the low permeability of the units. Monitoring is ongoing to confirm hydraulic gradients in the bedrock.

4.6.4.3 DNGS Protected Area Groundwater Flow

Groundwater Flow in the vicinity of the DNGS Protected Area is influenced by several factors which introduce a degree of uncertainty concerning flows in the area. The Forebay Channel is cut into bedrock, with a water level slightly below lake level, resulting in a groundwater sink effect, as groundwater levels in the vicinity of this channel are similar to lake level. Groundwater flows from the north into the Forebay Channel and may flow into it from the south as well. The reactors and other large structures are built with deep foundations on excavated bedrock and foundation walls may re-direct groundwater flow patterns. A foundation drain system lies on the excavated bedrock surface under the base floor slabs of major structures to collect groundwater seepage and direct it to sumps. Also, permeable backfill around foundations and underground utility corridors, as well as the variable nature of the permeability of the existing lake infilled area contribute to influence groundwater flow patterns around DNGS. Further studies are continuing to better define the nature of the Groundwater Flow around DNGS.

4.6.4.4 Vertical Gradients

Vertical hydraulic gradients between the water table and Interglacial Deposits are typically downward, indicating recharge conditions, with the exception of the area adjacent to the Darlington Creek tributary cutting into the DN site which indicated an upward gradient. This upward gradient would result in groundwater discharge from the Interglacial Deposits to the tributary.

The downward gradients indicate recharge conditions over most of the DN site. The downward gradients in the eastern area of the site are likely the result of the bluff at Raby Head where the open seepage face at the bluff acts to drain the Interglacial Deposits effectively lowering the head in the these deposits as compared to the water table. Enhanced infiltration under the recharge conditions will occur in areas where the Interglacial Deposits are exposed at surface or where the Upper Till is relatively thin (i.e., in areas such as the Switchyard, east of Holt Road and in the East Complex).

The bedrock water levels are typically much lower than the water levels in the Interglacial Deposits, indicating downward gradients.

4.6.5 Groundwater Quality

The interpretation of Groundwater Quality is presented in terms of historical water quality data derived from previous sampling programs conducted at the DN site, including annual groundwater monitoring programs; and current water quality data collected from the new monitoring well network installed during the current EA studies.

Historical Groundwater Quality Sampling

The historical groundwater monitoring results indicate few concerns with respect to Groundwater Quality. However, the historical monitoring well network is generally around the perimeter of the DNGS Protected Area or in undeveloped areas of the DN site.

Generally, the overburden groundwater is considered to be an active zone of fresh water typical of shallow groundwater recharge areas and its chemical characteristics (i.e., elevated concentrations of bicarbonate, calcium, magnesium and hardness) are reflective of the geological composition of the overburden (high proportion of limestone and dolomite materials). The bedrock groundwater is considered to be old groundwater, high in mineral content and typical of stagnant groundwater flow (i.e., high total dissolved solids including elevated concentrations of chloride, sodium and in some cases, sulphate).

Current Groundwater Quality Sampling

In general, the Groundwater Quality as characterised by the current EA studies is generally similar to that determined by the historical monitoring programs, although the new monitoring network includes areas of the DN site not represented by the historical monitoring well network. Overburden groundwater is typically high in bicarbonate, calcium and magnesium. Chloride and sulphate concentrations are typically low with concentrations less than 50 mg/L. The overburden groundwater is hard with concentrations exceeding 100 mg/L $CaCO_3$. The overburden groundwater is representative of the active flushing zone consistent with the downward gradient and recharge conditions across the site. Total dissolved solids are relatively low.

By comparison, the bedrock Groundwater Quality is markedly different. It is often brackish (Total Dissolved Solids greater than 1,000 mg/L and less than 10,000 mg/L) and occasionally saline. It is high in chloride with some wells exceeding 1,000 mg/L and one well exceeding 10,000 mg/L. Similarly, sodium concentrations in the bedrock are often greater than 100 mg/L. The bedrock is representative of sluggish groundwater flow resulting from low hydraulic conductivities. Groundwater in the bedrock is expected to increase in age with depth below the bedrock surface.

In terms of groundwater quality, the highest tritium concentrations are found in the shallow groundwater in proximity to the DNGS Protected Area. Concentrations surrounding the Protected Area are on the order of 100's of Bq/L. In general, there is a low concentration "halo" around the Protected Area with concentrations decreasing with distance away from the Protected Area. Concentrations below the water table are typically at the Method Detection Limit of 15 Bq/L although a few wells in the Interglacial Deposits have detectable concentrations. Other radionuclides were generally not found above the method detection limits.

Nitrate was detected in a number of monitoring wells located in or down gradient from agricultural areas currently planted with corn. Nitrate in groundwater is typically associated with the use of fertilisers on the farm fields. Concentrations of Base/Neutral/Acid Extractables were compliant with the Ontario Drinking Water Standards with two exceptions, 2,4-Dichlorophenol and Benzo(a)pyrene. However, neither of these compounds, nor any others in this analytical group, were detected at or above the applicable standards for the DN site.

The bedrock groundwater was found to contain trace levels of benzene, toluene, ethylbenzene and xylenes (BTEX) which are believed to be naturally occurring because of the petroliferous (petroleum-bearing) bedrock. None of the groundwater concentrations exceeded the applied non-potable water criteria. Petroleum hydrocarbons were detected occasionally at concentrations less than *Ontario Ministry of the Environment Table 2 Full Depth Generic Site Condition Standards in a Potable Groundwater Condition* of the *Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act*..

4.6.6 Valued Ecosystem Components

Changes in geological and hydrogeological conditions as a result of constructing and operating the Project may contribute to effects on human health, on non-human biota health and on VECs in other environmental components. Accordingly, changes in the Geological and Hydrogeological Environment will be considered within other environmental components so as to evaluate the potential environmental effects on appropriate receptors (i.e., VECs) in those components. As such, the geology and hydrogeology component is considered a pathway to effects in other environmental components and VECs specific for the Geological and Hydrogeological Environment have not been identified.

VECs as pathways from the Geological and Hydrogeological Environment are summarised in Table 4.6-1.

TABLE 4.6-1
VECs (as Pathways) for the Geological and Hydrogeological Environment

Sub-Component	VECs as Pathways	Rationale
• Soil Quality • Groundwater Flow • Groundwater Quality	Pathway to human health	The effects on humans associated with changes in geological and hydrogeological conditions will be considered in the Human Health component.
	Pathway to non-human biota health	The effects on non-human biota associated with changes in geological and hydrogeological conditions will be considered in the Non-Human Biota (Ecological Risk Assessment) component.
	Pathway to VECs in other environmental components	The effects on VECs in other environmental components associated with changes in geological and hydrogeological conditions will be considered in the applicable environmental components. These will include effects on Surface Water Environment, Aquatic Environment and Terrestrial Environment VECs as a result of changes in soil conditions and groundwater flow, quality and other physical parameters.

4.7 Radiation and Radioactivity Environment

This Section provides an overview description of the existing Radiation and Radioactivity Environment. The detailed baseline characterisation of this environmental component is contained in the *Radiation and Radioactivity Environment – Existing Environmental Conditions Technical Support Document, New Nuclear - Darlington Environmental Assessment*. The description is presented in the context of the following environmental sub-components:

- Radioactivity in the Atmospheric Environment: including gaseous radioactivity, radioactive particulate and gamma dose rate in air;
- Radioactivity in the Terrestrial Environment: including gamma radiation, and radioactivity in soil, vegetation (including animal feed) and in animal products;
- Radioactivity in the Surface Water and Aquatic Environments: including radioactivity in surface water, sediment, beach sand and in fish;
- Radioactivity in the Geological and Hydrogeological Environment: comprising radioactivity in groundwater; and
- Radiation dose to Humans: including doses to members of the public and workers.

The following description of existing conditions in the Radiation and Radioactivity Environment is primarily derived from data collected during OPG's routine radiological monitoring program associated with the DN site, monitoring conducted across by others across the province and nationally and supplemental measurements conducted during the EA studies.

The routine monitoring performed by OPG in the vicinity of the DN site is called the Radiological Environmental Monitoring Program (REMP). REMP includes the regular measurement of concentrations of selected radionuclides in various media at designated locations in the study areas. The locations of the REMP 2007 monitoring stations are illustrated in Figure 4.7-1.

In addition to REMP, OPG also conducts a monitoring program at various locations throughout Ontario which provides background radiation levels away from the influence of the nuclear station emissions. The results of the monitoring program are reported in OPG's annual radiological environmental monitoring program summary report (OPG 2008b). The Ontario Ministry of Labour (MoL) Radiation Protection Monitoring Service also monitors the environment for radioactivity around Ontario's three nuclear power generating facilities at Bruce, Darlington and Pickering and in the vicinity of the Chalk River Nuclear Laboratories.

Air, precipitation, drinking water, atmospheric water vapour, vegetable and milk samples are collected for radioactivity analysis and external gamma dose is monitored (MoL 2008).

A nation-wide radiological monitoring program called "Canadian Radiological Monitoring Network" (CRMN) has also been established by Health Canada (HC) as a network of monitoring stations that routinely collect air and atmospheric water vapour samples for radioactivity analysis and conducts external gamma dose monitoring. There are 26 environmental monitoring stations across Canada, plus additional sites in the vicinity of nuclear reactor locations (HC 2008). However, there are no monitoring stations in the vicinity of the DN site. There is one monitoring station in the vicinity of the Pickering NGS site (west of the site) and one monitoring station in Toronto.

In the discussion of existing conditions in terms of radiation and radioactivity, the data are compared to regulatory limits or standards where they are available and applicable. In cases where reference values are not available, the measured concentrations in the various media are limited implicitly by the regulatory limits on annual dose to the average member of the most highly exposed group in the public.

4.7.1 Study Areas

The generic study areas described in Section 3.1.3 were considered for specific application for the Radiation and Radioactivity Environment. The study areas as applied are described below.

Regional Study Area

The RSA was adopted without change from the generic RSA. This area includes the lands, communities and portions of Lake Ontario around the DN site that may be affected by the off-site transport of radioactivity from the Project by air and water.

Local Study Area

The LSA was adopted without change from the generic LSA. It includes the DN site and immediate vicinity, generally corresponding to the 10-km emergency planning zone centred on the DN site as identified by Emergency Management Ontario.

Site Study Area

The SSA was adopted without change from the generic SSA. It covers the entire DN site, including all facilities, buildings and infrastructure of DNGS and lands and portions of Lake Ontario under the care and control of OPG.

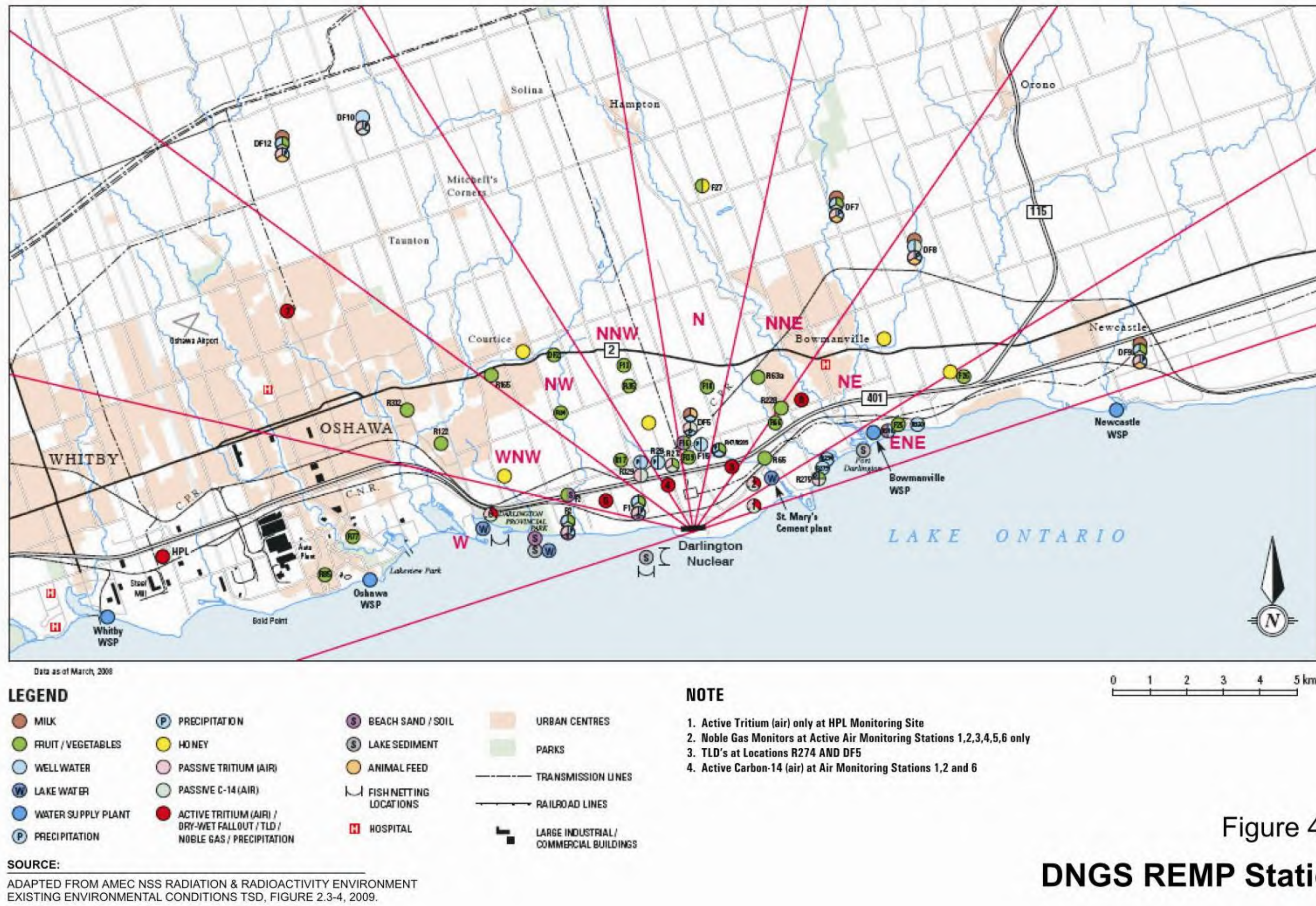


Figure 4.7-1

DNGS REMP Stations

Date: September 2009

Project: 34500

ONTARIO POWER GENERATION

4.7.2 Radiation and Dose from Background Sources

Most of the types of radionuclides released from nuclear generating stations, including DNGS, such as tritium, Carbon-14 (C-14), radioactive particulate in air and gross beta in water, are already present in the environment due to natural and/or anthropogenic processes. Radioactive iodine (most commonly I-131) is not naturally occurring, but may be readily detected (e.g., in sewage systems) due to its widespread usage in medical diagnosis and treatment of thyroid disease. Detectable amounts of these radionuclides may also be associated with the operation of nuclear generating stations and other nuclear facilities.

Natural and anthropogenic sources of radioactivity are discussed below and estimates of the dose to humans are provided. The background level of tritium and C-14 from natural and other sources is discussed and background levels that are typical of Canadian locations are provided. The discussion is based on data from locations well-removed from influences of DNGS emissions. However, these background levels are considered representative of the background levels in the RSA, LSA and SSA.

4.7.2.1 Natural Radiation Background and Non-NGS Originating Doses

Naturally-occurring radioactivity and anthropogenic sources are primarily associated with ionizing radiation from cosmic rays; naturally occurring radionuclides in air, water and food; and gamma radiation from radioactive material in soil, rocks and building materials. In addition, people are exposed to anthropogenic sources of background radiation from medical and dental procedures, and from commercial/industrial processes. The average annual dose from cosmic radiation in Canada is approximately 318 µSv/a (Grasty 2002, 2004). Naturally occurring radionuclides present in soils, rocks and building materials contribute a further estimated 219 µSv/a (Grasty 2002, 2004) to the external gamma radiation dose. Therefore, the total external gamma dose from cosmic rays and radionuclides on the Earth's surface is about 537 µSv/a in Canada (Grasty 2002, 2004). However, the dose is highly variable nationally because of differences across the country including in climate (e.g. rainfall, barometric pressure) and the geological composition of soils and rock.

Uranium and thorium series radionuclides and the radioactive potassium isotope, K-40, can be transferred naturally into vegetation and terrestrial and aquatic animals and subsequently ingested by humans. The annual internal dose in Canada is estimated at 306µSv (Grasty 2002, 2004).

The annual dose from radon gas and its radioactive decay products indoors is often responsible for the highest contribution to annual dose from naturally occurring radioactivity. The annual inhalation dose in Canada was estimated at about 926 μSv in 2002 and is mostly due to radon. This dose also is highly variable and it was estimated at approximately 565 μSv/a in the vicinity of the DN site (Grasty 2002, 2004).

The total annual dose from natural background sources is estimated at 1,840 μSv on average in Canada, including approximately 70 μSv/a from anthropogenic sources (e.g., nuclear weapon test fallout, exposures from technological processes and consumer products and services) (Grasty 2002, 2004, Aldrich 1997). However, as noted above this is highly variable and a wide range of annual doses is observed and is reported by Health Canada (HC 2000) as 1,200 to 3,200 μSv/a. In addition, the average dose to Canadians was estimated to be 1,100 μSv/a from medical sources.

4.7.2.2 Background Levels of Tritium

Tritium is produced at high altitudes in the atmosphere by the interaction of cosmic radiation and elements in the atmosphere. Tritium is also present in the environment as a result of fallout from atmospheric nuclear testing and as a by-product of nuclear power generation.

Tritium concentrations in precipitation have been measured in the Ottawa Valley since 1953. They peaked in 1963 at a value of almost 350 Bq/L (Letourneau *et al.* 1994) and have gradually decreased over time. Measurements in the early 1990s were in the range of 2.6 to 4.6 Bq/L. In 2007, sampling of tritium in precipitation at locations in Calgary, Fredericton and Saskatoon was ended because the concentrations, which had trended downwards over time, were below the method detection limit of 3.7 Bq/L (OPG 2007b). The background levels of tritium in precipitation are expected to be representative of the background tritium concentrations in surface water and shallow groundwater systems that are rapidly recharged with precipitation.

Tritium is also routinely monitored in air at various locations. The concentrations of airborne tritium at provincial background locations sampled since 2004 have consistently been below detection limits.

4.7.2.3 Background Levels of Carbon-14

C-14 is present in air as a constituent of carbon dioxide, which is incorporated into all living tissues (i.e., plants, terrestrial organisms and aquatic organisms) as a result of photosynthetic uptake by plants and transfer through the food chain to animals. Transfer directly to animals via inhalation represents an almost insignificant pathway of uptake.

C-14 was also released to the atmosphere as a by-product of past nuclear weapons testing in the early 1960s. The background C-14 measurements have been trending downwards with time and in 2007, the annual average C-14 in background vegetation was 226 Bq/kg-C which was essentially the same as pre-atmospheric weapons test concentrations.

4.7.3 Radioactive Releases from Existing Facilities

Radioactive emissions from DNGS and supporting facilities have been and remain well below the station Derived Release Limits (DRLs). These limits represent radionuclide release rates that correspond to critical group exposure at the public dose limit. The airborne and waterborne emissions from DNGS over the 10 year period ending in 2007 are summarised in Table 4.7-1.

TABLE 4.7-1
DNGS Emissions 1998 - 2007

	Annual Emissions (Bq) [1]									
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Air										
Tritium Oxide	2.0×10^{14}	2.2×10^{14}	2.3×10^{14}	2.4×10^{14}	1.9×10^{14}	1.7×10^{14}	2.8×10^{14}	1.3×10^{14}	1.3×10^{14}	1.6×10^{14}
Elemental Tritium [2]	7.2×10^{13}	2.4×10^{13}	1.0×10^{14}	1.8×10^{14}	5.6×10^{13}	6.6×10^{13}	7.5×10^{14}	7.9×10^{14}	9.5×10^{13}	1.3×10^{14}
Noble Gas [3]	3.5×10^{14}	3.4×10^{14}	1.5×10^{14}	1.8×10^{13}	1.5×10^{13}	1.3×10^{13}	1.9×10^{13}	1.7×10^{13}	1.4×10^{13}	1.5×10^{13}
I-131	2.1×10^{7}	3.2×10^{7}	7.5×10^{7}	1.3×10^{8}	1.5×10^{8}	1.4×10^{8}	1.3×10^{8}	1.2×10^{8}	1.2×10^{8}	1.2×10^{8}
Particulates	6.5×10^{7}	8.2×10^{7}	8.6×10^{7}	5.6×10^{7}	8.7×10^{7}	6.9×10^{7}	8.0×10^{7}	7.8×10^{7}	6.3×10^{7}	5.9×10^{7}
C-14	NM	NM	2.8×10^{12}	2.6×10^{12}	2.7×10^{12}	3.5×10^{12}	1.9×10^{12}	1.6×10^{12}	1.2×10^{12}	1.3×10^{12}
Water										
Tritium Oxide	7.5×10^{13}	8.9×10^{13}	1.1×10^{14}	9.4×10^{13}	6.9×10^{13}	1.0×10^{14}	1.6×10^{14}	2.2×10^{14}	1.9×10^{14}	3.5×10^{14}
Gross Beta/Gamma	3.8×10^{9}	1.4×10^{10}	1.3×10^{10}	5.6×10^{9}	8.5×10^{9}	7.3×10^{9}	5.7×10^{9}	7.8×10^{9}	4.8×10^{9}	4.5×10^{9}
C-14	NM	NM	2.7×10^{9}	3.0×10^{9}	1.6×10^{9}	1.2×10^{9}	4.3×10^{8}	2.8×10^{8}	5.9×10^{8}	7.6×10^{8}

NM = Not Measured
1 OPG 2008b, 2007b, 2006c, 2005a, 2004b, 2003b, 2002a, 2001c, 2000b, 1999
2 Emissions from Darlington Tritium Removal Facility
3 Units for noble gas emissions are γBq-MeV

All 2007 emissions from DNGS were significantly less than the corresponding annual DRLs, as shown by Table 4.7-2.

TABLE 4.7-2
DNGS 2007 Emissions as a Percentage of the DRLs

Release Category	% of DRL released in 2007
Air	
Tritium Gas	0.016
Tritium Oxide	0.373
C-14	0.074
Noble Gases	0.038
Particulate	0.003
I-131	0.003
Water	
Tritium Oxide	0.008
C-14	<0.001
Gross beta-gamma	0.006
Gross Alpha	<0.001

OPG 2008b

Although emissions of tritium gas (i.e. elemental tritium) are monitored, elemental tritium is not monitored in the environment. The inhalation pathway is the only direct pathway to humans resulting in dose from elemental tritium. Concentrations of elemental tritium in air around the DN site are modeled from emissions data and the atmospheric dispersion factor measured from tritium oxide data (OPG 2008a). Elemental tritium converts into tritium oxide through interaction with microbes in the soil. The resultant tritium oxide is routinely measured in air and local biota around the DN site.

4.7.4 Radioactivity in the Atmospheric Environment

The following sections summarise radioactivity in the Atmospheric Environment in terms of gaseous radioactivity, radioactive particulate and gamma dose rate in air.

4.7.4.1 Tritium in Air

Airborne tritium occurs as a gaseous tritium oxide, HTO, which is chemically equivalent to water. Tritium in air represents potential exposure pathways to humans and all non-human biota. There are no specific regulatory limits on tritium concentrations in air.

In the RSA, the annual averages of the measured tritium concentrations in 2007 ranged from 0.2 to 0.6 Bq/m^3. This value is higher than the annual average concentrations measured in 2007 at the provincial background locations outside of the study areas of <0.3 Bq/m^3.

The annual average airborne tritium concentrations measured at locations within the LSA in 2007 ranged from <0.3 to 1.1 Bq/m^3, also higher than the 2007 annual average concentrations measured at the provincial background locations (<0.3 Bq/m^3). The MoL measure tritium in air in the LSA, and their reported median for 2007 was 0.45 Bq/m^3. The higher concentrations in the LSA and the distribution of the data indicate that the airborne tritium concentrations decrease with increasing distance from the DN site and vary with direction from it (i.e., wind direction).

In the SSA, the annual average airborne tritium concentrations measured in 2007 ranged from 0.6 to 3.7 Bq/m^3, which is higher than the 2007 annual average concentrations measured at the provincial background locations.

4.7.4.2 Carbon-14 in Air

C-14 as $^{14}CO_2$ in air represents potential exposure pathways to humans and non-human biota. There are no specific regulatory limits on C-14 concentrations in air against which the measured data can be compared.

The measured annual average C-14 concentrations in air in the RSA in 2007 at two monitoring locations were 238 and 251 Bq/kg-C, which is within the range of provincial background annual average measurements during 2007 of 224 to 254 Bq/kg-C.

The measured annual average C-14 concentrations in air at monitoring locations in the LSA in 2007 ranged from 224 to 268 Bq/kg-C, which is slightly higher than the annual average provincial background range of measurements.

The annual average concentrations at the monitoring locations in the SSA ranged from 282 to 290 Bq/kg-C, which is higher than the range of annual average provincial background measurements (224 to 254 Bq/kg-C).

Note that the C-14 concentrations above do not take into account the level of uncertainty in analytical methods; the RSA, LSA and SSA ranges may be congruent with the provincial background measurements if uncertainties are included.

4.7.4.3 Radioactive Particulate in Air

Radioactive particulates in air represent a potential exposure pathway to humans and all nonhuman biota as a component of internal doses from inhalation. There are no specific regulatory limits on radioactive particulates concentrations in air against which the measured data can be compared.

Several provincial background monitoring locations provide data for comparison to measurements taken in the LSA and SSA. The HC Radiological Monitoring Network monitors gross beta concentrations in air in Toronto (approximately 45 km west of the DN site, which is outside the RSA). Gross beta activity[3] concentrations measured by HC in this location were in the range 0.18 to 0.41 mBq/m^3 in 2007 with a median of 0.3 mBq/m^3. MoL also reports gross beta activity concentrations at their provincial background location in Arthur, Ontario. The MoL 2007 median of gross beta activity concentration was reported as 0.77 mBq/m^3. Based on the range of observed background gross beta activity concentrations, OPG established a monitoring location just outside the Regional Study Area at Scugog Line 14. Measured gross beta concentrations at this location were in the range of 0.51 to 0.81 mBq/m^3 between August 2008 and January 2009, with a median of 0.70 mBq/m^3.

Air samples were taken in the LSA as part of the baseline characterization during the sampling period November 2007 to January 2009. Gross beta activities were detected above the MDL on each sample and activity concentrations were in the range 0.31 to 1.57 mBq/m^3 with a median value of 0.60 mBq/m^3.

MoL has five monitoring locations in the LSA (Oshawa WSP, Harmony Creek WPCP, Nash Road PS, Ken Hooper Firehall and RCMP Bowmanville). The 2007 median measured by the MoL is 0.78 mBq/m^3.

Air samples were taken in the SSA as part of the baseline characterisation during the sampling period November 2007 to January 2009. Gross beta activities were detected above the MDL on each sample and activity concentrations were in the range 0.23 to 1.36 mBq/m^3 with a median of 0.58 mBq/m^3.

[3] The gross beta activity of a sample is the total radioactivity present in the sample due to beta particle emission, regardless of specific radionuclide source.

For the purpose of comparison, the most recent gross beta data available from provincial background locations and the site study areas are provided in Table 4.7-3. The medians of the samples taken for the baseline characterisation and MoL in the LSA and SSA were comparable with the 2007 median of the MoL provincial background location (Arthur) and the baseline provincial background location (Scugog Line 14). However, the gross beta measurements taken by HC are typically lower than those measured by OPG or MoL.

In conclusion, gross beta in air concentrations in the vicinity of the DN site are similar to historical measurements taken by the MoL, but slightly higher than historical measurements taken outside the RSA by HC.

TABLE 4.7-3
Comparison of Gross Beta in Air Activity Concentrations

Location (Program)	Gross Beta Concentration (mBq/m^3) (min. to max.)	Gross Beta Concentration (mBq/m^3) (median)	Date Range
Background (HC)	0.18 to 0.41	0.30	2007
Background (MoL)	NA	0.77	2007
RSA (OPG)	0.51 to 0.81	0.70	Aug 2008 to Jan 2009
LSA (OPG)	0.31 to 1.57	0.60	Nov 2007 to Jan 2009
LSA (MoL)	NA	0.78	2007
SSA (OPG)	0.23 to 1.36	0.58	Nov 2007 to Jan 2009

NA = Not Available

All individual radionuclide particulate concentrations in both the LSA and SSA were less than relevant MDLs, with the exception of Be-7, which is naturally occurring. Be-7 is formed by cosmic ray bombardment of atmospheric nitrogen and oxygen.

4.7.4.4 Tritium in Precipitation

Tritium levels in precipitation are related to the concentration of tritium in the air since raindrops pick up tritium from the air as they fall. Precipitation can be a significant component in the recharge of shallow groundwater aquifers which could be used for drinking water. Accordingly, tritium concentration in precipitation is compared to the Ontario Drinking Water Quality Standard for tritium of 7,000 Bq/L.

The measured annual average tritium concentrations in precipitation in the RSA in 2007 ranged from 11 to 14 Bq/L, which is higher than the annual average tritium concentrations in precipitation measured at the provincial background locations during 2006[4] of <3.7 Bq/L, which well below the Ontario Drinking Water Quality Standard. As with tritium in air, tritium concentrations in precipitation in the provincial background have trended downwards over time and are now below the MDL of 3.7 Bq/L.

The measured annual average tritium concentrations in precipitation at the monitoring locations in the LSA in 2007 ranged from 9 to 42 Bq/L and in the SSA from 27 to 72 Bq/L, which although higher than the 2006 average annual provincial background level, are also well below the Ontario drinking Water Quality Standard. The median MoL value from the one monitoring location in the LSA (RCMP Bowmanville) for 2007 was 24 Bq/L.

4.7.4.5 Radioactive Particulates in Precipitation

Radioactive particulates in precipitation can also represent a potential exposure pathway to humans and non-human biota. There are no specific regulatory limits for the concentration of radionuclides in precipitation so the particulate deposition rates are compared to the expected levels across Canada.

The annual average gross beta deposition rates in 2007 were 25 Bq/m^2 per month at the one location in the RSA; from 15 to 22 Bq/m^2 per month in the LSA; and from 16 to 23 Bq/m^2 per month in the SSA. The average annual gross beta deposition rate in Canada is typically between 5 and 40 Bq/m^2 per month due to radioactive fallout from both atmospheric nuclear testing and natural sources (OPG 2006a). As such, the gross beta deposition rates in the study areas are within the expected range of background gross beta fallout rates measured in Canada.

Relevant gamma-emitting radionuclide deposition rates were measured in the LSA and SSA as part of the baseline characterisation. The results were all less than MDL, with the exception of the naturally occurring Be-7.

4.7.4.6 External Gamma Dose Rate in Air

The external dose rate in air caused by radioactive noble gases, I-131 and skyshine (i.e., gamma radiation from the site that is reflected by atmospheric particles) is measured on a continuous basis by OPG using sodium iodide gamma ray spectrometers at six locations in the LSA and SSA.

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4 Since the measured tritium concentrations in precipitation have trended downward over time and are below MDL, the sampling of precipitation at background locations was removed from REMP at the end of 2006.

The measured annual average doses in air from noble gases, I-131 and skyshine at the two locations in the LSA and at the four locations in the SSA since 2004 have all been less than the MDLs.

In the fall of 1999, an airborne gamma survey was flown over the DN site and surrounding land areas covering most of the RSA, LSA and SSA. The natural radiation levels of the survey area ranged from 20 to 50 nGy/h, comparable to the values reported by the Geological Survey of Canada for Ontario (Grasty 2000). Lower levels were generally related to urban areas, while higher levels were associated with open areas of farm and parkland. The survey indicated that gamma radiation in the surveyed area is due to naturally occurring radionuclides and that airborne radionuclides from the DN site do not have an observable effect on the gamma radiation levels in its vicinity.

4.7.5 Radioactivity in the Terrestrial Environment

The following sections summarise radioactivity in the existing Terrestrial Environment in terms of external gamma radiation, soil, vegetation, animals and animal products.

4.7.5.1 External Gamma Radiation

External gamma radiation dose is measured on a continuous basis using thermoluminescent dosimeters (TLDs) at air sampling stations located in the RSA, LSA and SSA. OPG also maintains TLDs at various provincial locations.

The annual average dose rate in air from external gamma radiation at the one location monitored in the RSA in 2007 was 55.9 nGy/h (corresponding to an annual dose of 490 μGy), which is within the range of the 2007 provincial background annual average range of 45.0 to 66.5 nGy/h (corresponding to an annual dose range of 395 to 583 μGy).

The annual average gamma dose rates at the monitoring locations in the LSA in 2007 ranged from 52.8 to 56.8 nGy/h (corresponding to annual doses of 463 to 498 μGy), also within the 2007 provincial background range.

In the SSA, the annual average gamma dose rates at the monitoring locations in 2007 ranged from 54.0 to 58.1 nGy/h (corresponding to annual doses of 473 to 509 μGy/a), also within the 2007 provincial background range.

The external gamma dose rates throughout all study areas were relatively constant before 2007 and within the range of the corresponding year's provincial background measurements. The measured annual average gamma doses suggest that the air emissions from the DN site are not resulting in higher gamma radiation levels.

4.7.5.2 Radioactivity in Soil

Radioactive material in soil presents a potential exposure pathway to humans and non-human biota through external gamma radiation, ingestion, inhalation and consumption of vegetables grown in the soil. It is also a pathway through animal food products via animal consumption. There are no specific regulatory limits for the concentration of radionuclides in soil.

The dominant radionuclide measured in the soil samples from the RSA was the naturally occurring K-40. The Cs-134 and Co-60 concentrations were below the detection limits at all of the provincial background locations from 2003 to 2007, while Cs-137 was detected in the majority of the soil samples. The Cs-137 concentrations measured at the provincial background location ranged from <0.4 to 7 Bq/kg in 2007.

Naturally occurring K-40 was also the dominant radionuclide measured in the soil samples from the LSA. The Cs-134 and Co-60 concentrations were below the detection limits at all locations, while Cs-137 was detected in all of the soil samples. The Cs-137 concentrations measured in 2007 ranged from 2.6 to 10.8 Bq/kg, which is slightly higher than the 2007 background levels of <0.4 to 7.0 Bq/kg.

Naturally occurring K-40 was found in the samples from the SSA. C-14 was found in most samples, ranging from <MDL to 301 Bq/kg-C, the upper range values of which are slightly higher than background (226 ± 20 Bq/kg-C). Cs-137 was detected in most of the samples, ranging from <MDL to 8.9 Bq/kg. These Cs-137 ranges are slightly higher than the 2007 provincial background annual average range of <0.4 to 7.0 Bq/kg. Concentrations of all other radionuclides analysed were less than the MDL.

Based on the variance in Cs-137 concentrations throughout the study areas, the fact that they are generally similar to background and that the concentrations of the other reactor-produced radionuclides, Cs-134 and Co-60, are not detectable, it is likely that the Cs-137 in the soil is attributable to fallout from atmospheric nuclear testing.

4.7.5.3 Radioactivity in Vegetation

Radioactive material in vegetation presents a potential exposure pathway to humans and non-human biota through ingestion. It is also a pathway through animal food products via animal consumption. Vegetation samples collected by OPG from 2003 to 2007 included fruit, animal feed, leafy vegetables, above ground and root vegetables. All samples are analysed for tissue-free water tritium (TFWT) and C-14. There are no specific regulatory limits for the concentration of radionuclides in vegetation. Note that only produce was sampled (i.e., no wild vegetation), hence no samples were collected from the SSA since produce is not grown on the DN site.

During 2007, the TFWT maximum annual average concentrations in vegetation samples from the RSA ranged from 13 to 20 Bq/L (OPG 2008a). These concentrations are greater than those from the provincial background locations during the same sampling period (<4.5 to 6.0 Bq/L). Since tritium in vegetation is directly related to the concentration of tritium in air and precipitation, the tritium concentrations in vegetation are influenced by the site meteorology (i.e. concentration decreases with distance and changes with direction). The C-14 maximum annual average concentrations in vegetation samples in 2007 from the two locations in the RSA ranged were 247 and 262 Bq/kg-C. These concentrations are not significantly higher than those measured from the provincial background locations during the same sampling period (215 to 239 Bq/kg-C).

The TFWT concentrations in vegetation samples collected in the LSA in 2007 ranged from 14 to 145 Bq/L. These concentrations are also greater than those from the provincial background locations during 2007. As has been noted, the concentrations of tritium in vegetation are directly related to the concentrations of tritium in air and precipitation, therefore, the higher concentrations in vegetation in the LSA compared to those samples collected in the same wind sector in the RSA is expected. The C-14 maximum annual average concentrations in the vegetation samples in the LSA in 2007 ranged from 214 to 296 Bq/kg-C. These are slightly higher than those measured from the provincial background locations during 2007.

<u>Animal Feed</u>

The annual average C-14 concentrations in 2007 in the two locations measured in the RSA were 221 and 228 Bq/kg-C. These are within the range of annual average concentrations measured in vegetation from the provincial background locations during the same sampling period (215 to 239 Bq/kg-C). The annual average tritium concentrations in 2007 in the two locations measured in the RSA were 20 and 25 Bq/L, which are higher than the annual average provincial background measurements of terrestrial vegetation for that period (<4.5 to 6.0 Bq/L).

The annual average C-14 concentrations in 2007 measured in the LSA in various types of animal feed ranged from 235 to 255 Bq/kg-C. These concentrations are slightly higher than those measured in vegetation from the provincial background locations during the same sampling period (215 to 239 Bq/kg-C). Note that this does not take into account the level of uncertainty in analytical methods; the ranges may be congruent if uncertainties are included. The annual average tritium concentrations in the LSA in animal feed in 2007 ranged from 14 to 31 Bq/L, which is higher than the annual average provincial background measurements of terrestrial vegetation for that period (<4.5 to 6.0 Bq/L).

4.7.5.4 Radioactivity in Animal Products

Only animal products for human consumption were sampled, hence there were no samples collected from the SSA as no animal products for human consumption are produced in that area.

Milk

Emissions to air may affect radionuclide concentrations in milk from nearby dairy farms, representing a potential pathway for humans through ingestion. OPG collects weekly milk samples from dairy farms within the RSA and LSA and quarterly milk samples at background locations from more distant farms in London and Belleville. There are no specific regulatory limits for the concentration of radionuclides in milk.

I-131 was not detected in any of the milk samples collected in the RSA or background locations in 2007. The annual average tritium and C-14 concentrations measured in the two locations sampled in 2007 (5.7 and 10.4 Bq/L for tritium and 239 Bq/kg-C in both locations for C-14) are higher than the 2007 background levels (<4.5 Bq/L for tritium and 226 Bq/kg-C for C-14). The median tritium concentration measured by MoL at the nine monitoring locations in the Darlington/Pickering vicinity measured in 2007 was 8.3 Bq/L.

I-131 was not detected in any of the milk samples collected in the LSA. The annual average tritium and C-14 concentrations measured in 2007 ranged from <4.5 to 7.2 Bq/L and 235 to 261 Bq/kg-C, respectively. These concentrations are also slightly higher than the 2007 background levels (<4.5 Bq/L and 226 Bq/kg-C respectively).

Honey

Bees gather nectar from a wide area and as such, honey is a useful indicator of local and regional conditions. OPG collects samples of honey from a number of commercial apiaries located in the LSA. There are no specific regulatory limits for the concentration of radionuclides in honey.

The 2007 annual average C-14 concentrations in honey ranged from 252 to 274 Bq/kg-C. The 2007 annual average tritium concentrations in honey ranged from 18 to 89 Bq/L, with the concentrations varying with respect to distance and direction from the DN site. Co-60, Cs-134 and Cs-137 were also measured. However, all results for these radionuclides were below the detection limit.

Meat

Sampling of meat for tritium (TFWT and OBT) and gamma-emitting radionuclides was conducted in the LSA as part of the baseline characterisation program. Naturally occurring K-40 was found in the samples. Concentrations of all other gamma-emitting radionuclides analysed were less than the MDL. TWFT was detected in approximately half of the samples, with concentrations in the range <MDL to 22 Bq/kg. OBT was detected in all the samples, with concentrations in the range 5 to 17 Bq/kg. C-14 was also detected in all the samples, with concentrations in the range 236 to 303 Bq/kg-C.

Eggs

Sampling of eggs for tritium (TFWT and OBT), C-14 and gamma-emitting radionuclides was conducted in the Local Study Area as part of the baseline characterisation program. Naturally occurring K-40 was found in the samples. Concentrations of all other gamma-emitting radionuclides analysed were less than MDL. TWFT was detected in half of the samples, with concentrations in the range <MDL to 21 Bq/kg. OBT was detected in all the samples, with concentrations in the range 5 to 13 Bq/kg. C-14 was also detected in all the samples, with concentrations in the range 203 to 266 Bq/kg-C.

4.7.6 Radioactivity in the Surface Water and Aquatic Environments

The following sections summarise radioactivity in the Surface Water and Aquatic Environments in terms of surface water, fish, sediment and sand.

4.7.6.1 Radioactivity in Surface Water

Lake Ontario serves as a source of drinking water and recreation for communities in the RSA and LSA. Surface water from Water Supply Plants (WSPs), lakes and streams, and the DNGS discharges (SSA) were analysed for tritium and gross beta. Tritium and gross beta are considered as they represent potential exposure pathways to humans. Tritium and gross beta are emitted from the DN site in liquid effluents and could be ingested by people living in the Local and Regional Study Areas that get their drinking water from Lake Ontario. The tritium and gross beta results are compared with the following:

- Ontario Drinking Water Quality Standard for tritium [7,000 Bq/L] (MOE 2003a);
- OPG's voluntary Commitment Level for Tritium concentrations at nearby WSPs [annual average <100 Bq/L] (OPG 2006c);
- Drinking Water Screening Level for Gross Beta [1 Bq/L] (OPG 2005b); and
- Provincial background levels from the Great Lakes system and inland lakes/rivers (<4.5 Bq/L for tritium and <0.05 to 0.12 Bq/L for gross beta) (OPG 2008b).

OPG collects surface water samples at five water supply plants (WSPs) in the RSA and LSA (Bowmanville, Oshawa, Newcastle, Whitby and Ajax) and at designated lake locations in the LSA. The annual average tritium concentration from the WSPs in 2007 ranged from 5.9 to 6.1 Bq/L while the 2007 annual average tritium concentrations from the lake locations ranged from 6.6 to 29.2 Bq/L. Both the WSP and lake locations indicated concentrations higher than the annual average provincial background levels in the Great Lakes system and inland lakes/rivers (<4.5 Bq/L). However, they were well below OPG's voluntary commitment level (for nearby WSPs) of 100 Bq/L and a small fraction of Ontario's Drinking Water Quality Standard for tritium of 7,000 Bq/L.

The annual average gross beta concentrations at the WSPs in 2007 were all 0.10 Bq/L, which is in the range of the annual average provincial background levels in the Great Lakes system and inland lakes/rivers (<0.05 to 0.12 Bq/L). Additionally, the gross beta concentrations since 1998 have been fairly consistent and well below the drinking water screening level of 1 Bq/L and within the range of expected gross beta concentrations (0.005 to 0.2 Bq/L) (OPG 2006a) that result from the presence of naturally occurring radionuclides together with fallout from atmospheric nuclear weapons testing. The 2007 annual average gross beta concentrations from the lake locations ranged from 0.11 to 0.18 Bq/L, which is higher than the range of the provincial background levels in the Great Lakes system and inland lakes/rivers.

The analysis for gamma radionuclides and radionuclides relevant to reactor types other than CANDU from samples from Lake Ontario in the RSA indicated concentrations that were all below the MDL.

As part of the EA studies, tritium, gross beta and gamma-emitting radionuclide concentrations have been measured in Lake Ontario in the LSA and SSA on a quarterly basis since November 2007. Tritium concentrations ranged from <MDL to 31 Bq/L, well below Ontario's Drinking Water Quality Standard for tritium of 7,000 Bq/L (MOE 2003a). The gross beta concentrations measured in the SSA ranged from <MDL to 0.2 Bq/L, well below the drinking water screening level of 1 Bq/L (OPG 2005b).

The analysis of samples collected in the LSA and SSA for radionuclides relevant to reactor types other than CANDU indicated concentrations that were all below the MDL.

4.7.6.2 Radioactivity in Fish

Samples of fish in the LSA and SSA are collected annually by OPG and analysed for tritium, C-14 and gamma emitting radionuclides. Samples are also taken from the provincial background locations in Lake Huron and Lake Ontario. Supplemental sampling of fish was conducted as part of the EA studies. There are no specific regulatory limits for the concentration of radionuclides in fish.

The measured annual average tritium concentrations in fish from the provincial background locations in 2007 ranged from <4.5 to 7.7 Bq/L. C-14, Cs-137 and the naturally occurring K-40 were found in all of the fish samples taken from the background locations during 2007, with the annual average C-14 concentrations ranging from 217 to 264 Bq/kg-C and the Cs-137 concentrations ranging from 0.2 to 1.4 Bq/kg. Organically bound tritium (OBT) concentrations in samples collected since 2001 vary throughout the years and for different fish composites.

The measured annual average tritium concentrations in fish sampled from McLaughlin Bay in the LSA in 2007 ranged from 31 to 32 Bq/L, which is higher than the provincial background locations measured in 2007 (<4.5 to 7.7 Bq/L). McLaughlin Bay is a mostly landlocked shallow body of water that is affected by air deposition and behaves more like a pond than part of the lake. It does not exhibit the same dilution patterns present in the lake. C-14 concentrations in the samples were similar to those measured at the provincial background locations; and Cs-134, Cs-137 and Co-60 were not detected in any of the samples. The analysis results for radionuclides relevant to reactor types other than CANDU from samples taken in the LSA were all below the MDL.

The annual average tritium concentrations in fish taken from the SSA in 2007 ranged from <4.5 to 6.3 Bq/L, which is within the provincial background range. Concentrations of C-14 and Cs-137 in these samples were similar to or below the provincial background range; and Cs-134 and Co-60 were not detected in any of the fish samples taken from the SSA

4.7.6.3 Radioactivity in Sediment

OPG collects sediment samples annually in the LSA and SSA as well as at provincial background locations. The samples are analysed for Cs-137, Cs-134, Co-60 and K-40 and, since 2002, C-14. Supplementary sediment sampling was conducted during the EA studies. There are no specific regulatory limits for the concentration of radionuclides in sediment.

The major portion of the activity in the sediments is from the naturally occurring radionuclide K-40. The annual average concentrations of Cs-134, Cs-137 and Co-60 were below the corresponding detection limits in all of the 2007 samples collected in the LSA. The annual average C-14 concentrations in the LSA samples in 2007 were similar to or lower than the range of the provincial background samples (174 to 187 Bq/kg-C). The analysis results for gamma-emitting radionuclides relevant to reactor types other than CANDU from samples taken in the LSA were all below the MDL.

In the SSA, the annual average concentrations of Cs-134 and Co-60 in the samples analysed in 2007 were below the corresponding detection limits and Cs-137 annual average concentrations were similar to those measured at the background locations during 2007 (<0.3 to 1.4 Bq/kg).

The annual average C-14 concentration in the composite sample from the SSA in 2007, 103 Bq/kg-C, was below the provincial background locations (174 to 187 Bq/kg-C). The analysis results for gamma-emitting radionuclides relevant to reactor types other than CANDU from samples taken in the SSA in were all below the MDL.

4.7.6.4 Radioactivity in Lake Ontario Beach Sand

Radionuclides in the liquid emissions from DNGS may can be deposited into lake sediments and subsequently washed up onto beaches. Accordingly, OPG has monitored radionuclides in Lake Ontario beach sands in the LSA since 2003. The samples are analysed for Cs-137, Cs-134, Co-60 and K-40. There are no specific regulatory limits for the concentration of radionuclides in sand.

The major portion of the activity in the sand is from the naturally occurring radionuclide K-40. Cs-134, Cs-137 and Co-60 were below the corresponding detection limits in all of the 2007 samples, which is comparable or lower than the range of measurements in the provincial background.

4.7.7 Radioactivity in the Geological and Hydrogeological Environment

The following sections summarise radioactivity in the Geological and Hydrogeological Environment in terms of groundwater. For details on radioactivity in soil, see Section 4.7.5.2.

OPG routinely collects groundwater samples from locations in the RSA, LSA and SSA and at provincial background locations. Monthly well water samples are collected from farms and residents near the DN site. Quarterly "grab" samples are also taken from water wells throughout the province. These samples are analysed for tritium and gross beta. Supplementary sampling of groundwater was conducted in the SSA as part of the EA studies. .

The measured annual average tritium concentrations in groundwater at the two RSA monitoring locations in 2007 were <4.5 and 5.9 Bq/L, the latter of which is greater than the tritium concentration measured at the provincial background locations (<4.5 Bq/L), but well below Ontario's Drinking Water Quality Standard for tritium of 7,000 Bq/L. The measured annual average gross beta concentrations in groundwater at these locations in 2007 were 0.09 and 0.37 Bq/L, the latter of which is higher than the gross beta concentration measured at the provincial background locations (<0.05 to 0.12 Bq/L), but well below the drinking water screening level of 1 Bq/L (OPG 2005b).

In the LSA, the annual average tritium concentrations measured at monitoring locations in 2007 ranged from <4.5 to 23.5 Bq/L. This range exceeds the range of tritium concentrations measured at the provincial background locations (<4.5 Bq/L). However, all measurements were well below the provincial standard for tritium of 7,000 Bq/L. The annual average concentrations of gross beta measured at the monitoring locations in the LSA in 2007 ranged from <0.05 to 1.76 Bq/L, which is higher than the range at the provincial background locations (<0.05 to 0.12 Bq/L). In samples from one residential well, gross beta activity was found higher than OPG's internal screening level for drinking water of 1 Bq/L (OPG 2005b). The annual gross beta activity at this location was reported as 1.76 Bq/L. Historically, the gross beta activity at this location had been high and subsequent follow-up investigation confirmed the cause of the elevated level to be naturally occurring K-40. The highest gross beta concentration other than that location was 0.75 Bq/L.

The annual average tritium concentrations measured by OPG in the SSA in 2007 ranged from <19 to 340 Bq/L, with the exception of two higher concentration samples that were re-sampled. Both of the re-samples measured <MDL. The range of measured concentrations is higher than the provincial background range. All other radionuclides measured by OPG in the SSA in 2006 were below their MDL with the exception of the naturally occurring K-40.

Groundwater samples were obtained for Radiation and Radioactivity assessment purposes from specific monitoring wells installed in the SSA during the EA studies and analysed for gross beta, tritium and gamma emitters. Tritium concentrations in these samples ranged from <MDL to 84 Bq/L. These concentrations are generally higher than the tritium concentrations measured at the provincial background locations (<4.5 Bq/L). The concentrations of gross beta in these samples ranged from <0.1 to 0.5 Bq/L, which is generally higher than the provincial background range of <0.05 to 0.12 Bq/L. All other radionuclides measured were less than their respective MDLs.

Note that groundwater from the SSA is not used for potable purposes. However, for comparative purposes only, all tritium concentrations measured in the SSA were less than the provincial standard for tritium in drinking water of 7,000 Bq/L and all gross beta concentrations measured were well below the drinking water screening level of 1 Bq/L.

4.7.8 Radiation Doses to Humans

Regardless of where people live or work, they are exposed to radiation from both naturally occurring and anthropogenic sources. The sections that follow summarise the existing radiation dose to members of the public and to workers attributable to the DN site (i.e., DNGS).

4.7.8.1 Radiation Dose to Members of the Public

Annual radiation doses to members of the public as a result of the operation of the DN site are calculated by OPG (OPG 2008b). The dose estimates do not include exposures from naturally occurring or anthropogenic sources or radioactivity that is not attributable to the facility. In order to monitor the highest potential doses for comparison with regulatory requirements, doses to members of potential critical groups that reside in the vicinity of the DN site were calculated.

The assessment of doses to critical groups is based to the extent possible on measured concentrations of radionuclides in environmental media. However, if the measured concentrations are not statistically measurable above background then doses are based on measured station emission data and environmental pathway modelling (OPG 2008a). The doses calculated for each potential critical group include all relevant pathways of radionuclide uptake or external exposure. All the DN potential critical groups reside in the LSA.

In 2007, the critical group dose for the DN site was 1.4 µSv for the farm nursing infant. Annual public doses from the DN site have always been significantly lower (<1 %) than the regulatory limit of 1000 µSv (CNSC 2000) and the public dose attributable to the site has generally been trending lower since 1998. The dose to a hypothetical individual living at the site boundary was reported as the site official dose up to 2002. However, since 2003, the official dose has been based on the site critical group. Since 2003, the critical group annual dose has ranged from 0.9 to 1.7 µSv.

4.7.8.2 Radiation Dose to Workers

OPG maintains a comprehensive dosimetry program to assess all occupational doses of ionizing radiation received by Nuclear Energy Workers (NEWs) at the DN site. All workers on-site are classified as a NEW if there is a potential for them to exceed regulatory dose limits for members of the public. OPG is also required to provide information regarding each worker to the National Dose Registry (NDR) maintained by the Radiation Protection Bureau of HC. The following discussion of worker radiation dose is restricted to the SSA since occupational doses from facility operations occur only in this area.

Access to and activities on the DN site are controlled by OPG, and radiation doses to workers on the site from licensed nuclear activities are monitored and controlled by OPG. Radiation doses to NEWs are well below the regulatory limits of 50 mSv per one year dosimetry period and 100 mSv per five year dosimetry period for NEWs and 1 mSv/a for non-NEWs (CNSC 2000). In addition, doses are controlled in accordance with the ALARA principle.

Collective Dose

There are no regulatory or recommended limits relating to collective dose, however collective dose is reported as a measure of ALARA performance. From 1998 to 2007, the annual collective dose for workers on the DN site ranged from 0.69 to 4.07 person-Sieverts (P-Sv). The average annual collective dose over the past 10 years is 2.53 P-Sv.

As of 1999, a large work program was initiated in four areas: steam generator tubes inspection, feeder inspection, clearance measurements and moderator valve replacements. These activities are ongoing and account for most of the step increase in collective dose that occurred in 1999. The collective doses were fairly stable between 1999 and 2006. The collective dose in 2007 was higher than previous years due to planned outage maintenance activities.

Average Individual Doses

The average individual doses from 1998 to 2007 ranged from 0.75 to 2.18 mSv. During the past 10 years, the average annual individual dose was 1.65 mSv.

As with collective dose, individual doses were also influenced by the ongoing work programs and maintenance outage activities noted above.

4.7.9 Valued Ecosystem Components

The Radiation and Radioactivity Environment is comprised of environmental sub-components that represent aspects of the environment that are potentially susceptible to changes as a result of the Project (e.g., radioactivity in the Terrestrial Environment). Any such changes in these sub-components may result in consequential potential effects on the VECs associated with the susceptible aspect (e.g., VECs in the Terrestrial Environment). Accordingly, radiation and radioactivity is considered a pathway to effects in other environmental components and VECs specific for the Radiation and Radioactivity Environment have not been identified.

VECs as pathways from the Radiation and Radioactivity Environment are summarised in Table 4.7-4.

TABLE 4.7-4
VECs (as Pathways) for the Radiation and Radioactivity Environment

Sub-Component	VECs as Pathways	Rationale
• Radioactivity in the Atmospheric Environment • Radioactivity in the Terrestrial Environment • Radioactivity in the Surface Water and Aquatic Environments • Radioactivity in the Geological and Hydrogeological Environments • Radioactivity in Humans	Pathway to human health	The Radiation and Radioactivity Environment is a pathway for potential effects on human health (i.e., of the general public and of workers) Changes in radiation and radioactivity levels in the environment (including dose to humans) are characterised and described within the Radiation and Radioactivity Environment as the basis for considering associated effects on humans. The effects on humans associated with changes in the Radiation and Radioactivity Environment are described in the Human Health component.
	Pathway to non-human biota health	The Radiation and Radioactivity Environment is a pathway for potential effects on non-human biota. Changes in radiation and radioactivity levels in the natural environment are characterised and described within the Radiation and Radioactivity Environment as the basis for considering associated effects on non-human biota. The effects on non-human biota associated with changes in the Radiation and Radioactivity Environment are described in the Non-Human Biota (Ecological Risk Assessment) component.

The process of selecting VECs is described in Section 3.2.4 and as indicated, consideration of input from the public and other stakeholders was an important aspect of finalizing those to be used. The following specific suggestion concerning VECs in the Radiation and Radioactivity Environment was received as a comment made on the draft EIS Guidelines. It was considered as noted in establishing the final VEC list:

- Add Off-site Soils, and Off-site Terrestrial and Aquatic Ecosystems as VECs: Radiation and Radioactivity is a pathway for the transfer of potential effects to receptors in other environmental components. As such, any changes in radiation and radioactivity are evaluated for effects on VECs within those appropriate other components. Specifically relevant among these are the Aquatic, Terrestrial, Human Health and Non-Human Biota Health components and associated VECs. Effects as they might result from radiation and radioactivity are evaluated throughout the applicable study areas which off-site as well as on-site areas.

4.8 Land Use

This Section provides an overview description of the existing Land Use environmental component. The detailed baseline characterization of the Land Use component is contained in the *Land Use – Existing Environmental Conditions Technical Support Document, New Nuclear – Darlington Environmental Assessment.* The description is presented in the context of the following environmental sub-components:

- Land Use: existing uses of land and policies, regulatory controls and patterns associated with those uses; and
- Landscape and Visual Setting: landscapes, viewsheds, views and vistas of relevance to the Project.

4.8.1 Study Areas

The generic study areas described in Section 3.1.3 were considered for specific application for the Land Use component with modifications made as appropriate. The study areas as applied are described below.

Regional Study Area

The RSA for the Land Use component includes all of the Regional Municipality of Durham, the City of Peterborough and the City of Kawartha Lakes. It also includes portions of the City of Toronto, the Regional Municipality of York, Peterborough County, Northumberland County and the associated lower tier municipalities.

Local Study Area

The LSA for the Land Use component includes all areas surrounding the DN site that are within the Primary Zone for emergency response identified by Emergency Management Ontario. The LSA includes all of the major urbanised communities within Clarington (i.e., Courtice, Bowmanville, Wilmot Creek, Newcastle/Bond Head, Orono) and the urbanised area within the City of Oshawa.

Site Study Area

The SSA applied for the Land Use component was adopted generally without change from the generic SSA. As such, it comprises the DN site and water lots associated with it. The SSA is considered private property under the ownership, care and control of OPG, the proponent of the Project, therefore, the EA-related studies, including potential environmental effects in terms of Land Use, focused on the LSA and RSA.

4.8.2 Existing Land Use

The following pages describe existing conditions in terms of land uses in the RSA and LSA in a context of actual and planned land uses and the policies and programs that affect the uses and development activity occurring or planned, with a focus on the LSA.

4.8.2.1 Planning and Policy Context

Federal

Land use planning in Ontario is predominately carried out within a framework established and implemented by the Province of Ontario and the respective upper-tier, single-tier and lower-tier municipalities which have been delegated planning authority over regional and/or local land use planning matters. However, there are a number of land use planning related matters for which the federal government remains involved. Those of particular relevance as they relate the DN site are:

- Under the *NSCA*, the federal government regulates the management, treatment and handling of radioactive materials which must be approved and licensed by the CNSC. This includes nuclear power plants. Regulatory Document RD-346: Site Evaluation for New Nuclear Power Plants CNSC (2008) sets out the federal regulatory requirements with respect to the site evaluation for new nuclear power generation facilities; and

- The *Fisheries Act* is federal legislation dealing with the proper management and control of fisheries, the conservation and protection of fish and the protection of fish habitat and the prevention of pollution. The Act applies to all Canadian fisheries waters. Project activities that may have an impact on fish habitat will be reviewed by DFO to evaluate the impact on fish habitat and the appropriate authorizations must be obtained.

Provincial

The provincial land use policy regime is established through the *Planning Act* and, the *Provincial Policy Statement*, 2005 (Province of Ontario 2005b) and through other provincial policy initiatives which relate to specific geographical areas of the Province.

The *Planning Act* provides the fundamental land use planning framework in Ontario. It identifies those matters of Provincial interest that the council of a municipality, local board, planning board or Ontario Municipal Board must have regard for when carrying out their responsibilities under the Act. The *Planning Act* also requires that planning decisions be consistent with provincial policy statements and provincial plans in effect at the time.

One of the most relevant current provincial plans with respect to land use planning in the Greater Toronto Area is the *Places to Grow: Growth Plan for the Greater Golden Horseshoe* (Places to Grow) (MEI 2006) issued by the Province under the *Places to Grow Act, 2005.* Places to Grow guides infrastructure planning and strategic investment decisions to support and accommodate forecasted population and economic growth. Municipalities within the Places to Grow jurisdiction must conform to the policies outlined in the document. Redevelopment within the existing urban built area is mandated in order to reduce outward urban expansions and better utilise existing infrastructure. Increased intensification of existing built up areas, are envisaged within areas that support additional growth, including: Urban Growth Centres, intensification corridors, major transit stations, brownfield sites and greyfields. Development within these areas should provide a focus for transit and infrastructure investments to support future growth.

Municipal – Regional Study Area

The RSA includes all or portions of the Regional Municipalities of Durham and York (and the urban areas within them), the Counties of Peterborough and Northumberland (and the urban areas within them), and the Cities of Toronto (the portion formerly known as the City of Scarborough), Kawartha Lakes and Peterborough. In general, the southern and southwestern portion of the RSA is comprised of urban settlement areas and associated land uses. These urban areas include: Oshawa, Whitby, Ajax, Pickering, the City of Toronto and Markham. There are smaller urban centres in the east, north and northwestern portions of the RSA. These smaller urban centres include Newcastle, Port Hope, Cobourg, Uxbridge, Port Perry, Peterborough (City) and Lindsay. The remainder of the land is rural comprised of prime agricultural lands, general open space and rural uses, environmental protection areas, small towns, villages and hamlets.

Because of the Project's location, the municipal planning context at the regional level is most relevant within the Region of Durham and accordingly, the discussion that follows is focused on the planning framework within Durham Region.

The Durham Region Official Plan (DROP) which provides the broad land use framework for the Region has recently undergone a review by Regional staff and elected representatives. Through the review process, the Region prepared updated growth forecasts for the period to 2031, based on more recent growth trend analyses. The recommended population growth forecast is 657,000 by 2011, 842,000 by 2021 and 1,050,000 by 2031. However, the population and employment forecasts prepared as part of the review process differ from the forecasts presented in Places to Grow.

As a result of Places to Grow, the Region initiated a study (i.e., Growing Durham Study) in August 2007 to respond to the recent provincial growth management policy directions, particularly related to population and employment forecasts, intensification and greenfield targets and required land needs. The Draft Recommended Growth Scenario and Policy Directions (RMD 2008d) were released in September 2008, which identified a Recommended Growth Scenario for Durham. This Recommended Growth Scenario was endorsed by the Region's Planning Committee in November 2008. It balances growth across the Lake Ontario shoreline municipalities and reinforces the key drivers of growth including Highway 407 extension including employment growth along this corridor in northeast Pickering and the 407/401 link roads further east; Highway 7 and employment growth along this corridor; the proposed Pickering airport; the build out of the Seaton lands; the development of Oshawa's available greenfield lands, University of Ontario Institute of Technology/Durham College campus expansion and business park; and the Clarington Energy Business Park. The urban structure also provides for growth to 2056 and in particular protects long-term strategic employment lands.

The lakeshore area municipalities in the southern portion of the Region of Durham are mainly urban and the northern area is protected by both the Greenbelt Plan (MMAH 2002) and Oak Ridges Moraine Conservation Plan (MMAH 2002, 2006). The northern area is predominately designated as 'Prime Agricultural Area' in the DROP, for which the predominant use of land is for conservation and a full range of agricultural, agricultural related and non-agricultural uses (subject to satisfying certain criteria).

The DN site is identified in the DROP's land use schedule, but there is no land use designation or pertinent site specific policy. The DN site is located outside the Urban Area boundary. The DROP identifies a 'Waterfront Link' along a portion of the western and northern boundaries of the DN site. The waterfronts of Lake Ontario are to generally be developed as publicly accessible spaces. However, where this is not desirable or in the public interest, Waterfront Links provide for a continuous waterfront system through waterfront trails.

Policies outlined in the DROP which are applicable to the DN site, include:

- General Policy 5.2.5 requires that in the consideration of the location, design and construction of utilities, the proponent will ensure that negative impacts and constraints on the natural, built and cultural environments will be minimised;

- General Policy 5.2.6 states the Region's position that new utilities and any expansions to existing utilities should not be exempt from an environmental assessment under the provisions of the provincial *Environmental Assessment Act (EAA)*;
- General Policy 5.2.7 indicates it is the policy of the DROP that electric power facilities are permitted in all land use designations, provided that the planning of all such facilities satisfies the requirements of the *EAA;*
- General Policy 5.2.8 requires that OPG or other electricity providers/suppliers consult with the Region on the location of any *new* electric power facilities and throughout any required environmental assessment processes;
- Policy 5.3.25 states that Regional Council will, in conjunction with OPG or other electricity providers/suppliers and the Councils of the respective area municipalities, investigate district heating opportunities and the location of industrial energy parks related to the Pickering and Darlington nuclear generating stations; and
- Policy 8C.2.8 states that Employment Areas adjacent to facilities including electric power generating stations will generally be reserved for those industries that benefit from locating in close proximity to such facilities.

The areas directly to the west of the DN site and south of the Highway 401 are designated in the DROP as 'Waterfront Area' and 'Employment Areas'. Lands directly to the north of the DN site are designated 'Employment Areas' and 'Major Open Space Areas'. Lands directly northeast of the DN site are designated 'Employment Areas' and lands located further northeast are designated 'Living Area'. Lands directly to the east of the DN site are designated as 'Specific Policy Area B (Clarington)' which relates to St. Marys Cement.

The DROP identifies the general location of lands identified as 'Key Natural Heritage and Hydrologic Features' within the DN site. It is noted that these features are to be given paramount consideration in light of their ecological functions and scientific, educational and health values.

The future growth areas identified in the DROP include lands generally to the north and west of Oshawa, in addition to lands on the east side of Bowmanville, generally located on the south side of Highway 401 and east of Providence Road. Lands to the east of Courtice, on the east side of Courtice Road have not been identified as a future growth area. However, this area has been specifically appealed to the Ontario Municipal Board. It is further recognised that the recommendations of the Growing Durham Study (Durham 2009a) will introduce new growth management policies and a growth scenario to bring the DROP into conformity with Places to Grow (MEI 2006).

Municipal – Local Study Area (Clarington)

The Municipality of Clarington Official Plan (Clarington 2007c) provides a structural framework for future growth and development in the Municipality to 2016. The Municipality initiated a review and update of the Official Plan in April 2008 in light of recent provincial policy changes, among other matters.

The Official Plan directs that future growth will primarily be accommodated within the Municipality's fully serviced urban areas. Bowmanville will continue to grow as the predominant urban centre in Clarington and is the eastern anchor of the Region. The Plan projects an increase in employment participation rates over the planning period but does not provide an employment growth forecast.

The Municipality of Clarington had a 2006 population of 81,400 persons. The Region of Durham's Recommended Growth Scenario projects a population of 140,000 persons by 2031. This represents additional population growth of 58,600 persons. It is anticipated that the Municipality of Clarington Official Plan will be updated to reflect the Region's recommended growth scenario once approved.

The Official Plan designates the majority of the DN site as a 'Utility', with a small portion of the site in the northeast corner designated as 'Environmental Protection Area'. A Community Park is identified in the western portion of the DN site adjacent to the property boundary. The Plan provides the following general land use guidance with respect to lands designated Utility, which includes the DN site, although it does not provide any specific land use guidance for the DN site:

- New utility facilities are generally permitted within any land use designation provided that such facilities do not adversely impact any adjacent use. New electrical generating stations proposed by private corporations are only permitted by amendment to this Plan and subject to all provincial approvals; and
- In the planning of any major new utility or corridor, including expansions, the proponent must satisfy the Municipality with respect to possible impacts as related to environmental, economic, social, transportation and other concerns as determined by the Municipality. The proponent may be required to enter into an agreement with the Municipality which includes, but is not limited, to such matters as compensation and mitigation of adverse effects.

The Community Park designation provides that the predominant use of land shall be for active and passive recreational and conservation uses. Community Parks are intended to serve the recreational needs of a series of neighbourhoods, providing outdoor and indoor recreational facilities. Community Parks are anticipated to serve a population of 15,000 to 25,000 persons and are roughly 4 to 12 ha in size.

The Environmental Protection Area designation recognises the most significant components of the Municipality's natural environment. The associated policies require that these areas and their ecological functions be preserved and protected.

The Official Plan identifies a Waste Disposal Assessment Area (i.e., the Northwest Landfill Area) on the DN site. The corresponding policies generally restrict development within and adjacent to the Waste Disposal Assessment Area to protect public health and safety and ensure land use compatibility.

The Official Plan also identifies a small portion of lands as Hazard Land within the northeast corner of the DN site, in addition to the Regulatory Shoreline Area along Lake Ontario. The corresponding policy framework generally restricts new development in hazard lands and regulatory shoreline areas, which are to be defined by the Central Lake Ontario Conservation Authority (CLOCA).

The land use designations for the abutting lands include:

- The area directly to the west of the DN site is designated 'Waterfront Gateway' and 'Business Park';
- The land directly to the north of the DN site is designated 'Light Industrial' and 'Green Space' with associated areas of 'Environmental Protection'; and
- The land directly to the east of the DN site is designated 'Waterfront' and 'General Industrial'. The St. Marys Cement site to the east is designated Aggregate Extraction Area and identified as 'Special Policy Area C' which provides specific provisions that recognise the existing licensed extraction area and cement manufacturing facility and the Westside Marsh.

The Official Plan identifies a portion of the lands within the Natural Heritage System, including 'Significant Valley Lands' associated with the Environmental Protection Area designation in the northeast corner of the site; and two areas of 'Significant Woodlands' located generally within the northeast portion of the site. The Natural Heritage System represents important natural heritage features and ecological functions which should be preserved and protected. An Environmental Impact Study is required for development on lands located within or adjacent to these natural heritage features.

The majority of the DN site is zoned as "Agricultural", which permits single detached residential units and various non-residential uses and establishes yard and storage requirements. Utilities or generating facilities are not included in the list of permitted non-residential uses. However, the Zoning By-law does not prohibit the use of any lot or the erection or use of any building or structure for the purposes of public services provided by a Public Authority, which possesses all the necessary powers, rights, licences and franchises. A Public Authority is defined as a Federal, Provincial, Regional or Town agency and includes any commission, board, corporation, authority or department established by such agency. Therefore, generating facilities on the DN site are considered to be a permitted use, notwithstanding the provisions of the Agricultural Zone.

The Clarington Energy Business Park is located immediately west of the DN site, bounded by the rail corridor (south), South Service Road (north), Solina Road (east), and Courtice Road (west). The Secondary Plan consists of 129 hectares and accommodates prestige employment uses within a business park setting. The site has attributes to become a focal point for new development within the Durham Energy Cluster and the Plan encourages future development that promotes energy efficiency, natural heritage and energy conservation and innovation in the fields of energy. Although the DN site is not located within the Clarington Energy Business Park Secondary Plan, one of the goals of the Secondary Plan is to "support the operation, maintenance and enhancement of the Darlington Nuclear Power Plant."

Municipal – Local Study Area (Oshawa)

In 2006 the City of Oshawa had a population of 148,000 persons. The Growing Durham Study (Durham 2008d) projects that the City will have a population of approximately 175,000 by the year 2021 and 197,000 persons by 2031. This represents additional population growth of approximately 49,000 persons from 2006 to 2031. It is anticipated that the City of Oshawa Official Plan (2007) will be updated to reflect the Region's recommended growth scenario once approved. It is also expected that the City will work with the Region to determine additional opportunities for growth within the urban area and the need to designate additional urban lands north of the existing Major Urban Area boundary to meet the population and employment targets for the City.

The northern part of the City of Oshawa (generally north of Winchester Road) is primarily designated Open Space and Agricultural, with the exception of the Hamlet designation at the intersection of Columbus Road and Simcoe Street. The southern part of the City is designated a range of urban land uses, which consist predominately of residential and industrial uses and areas of open space, recreation and existing and planned commercial areas.

4.8.2.2 Development Activity in the Local Study Area

Municipality of Clarington

The Municipality of Clarington is experiencing high levels of development activity. The development is occurring within the urban areas of Bowmanville, Newcastle, Orono and Courtice. For the most part, new greenfield community development is within the designated urban areas, but outside of the downtown urban area. Bowmanville is the dominant urban area in the Municipality for residential growth.

Infill development, redevelopment and intensification within the Municipality are less common than suburban development. Given the relative size of the urban areas in Clarington, infill within the Municipality of Clarington is rare. However, Bowmanville, Newcastle and Orono are undertaking or have recently undertaken a Community Improvement Planning process to recommend ways to revitalise the communities both financially and physically. This Community Improvement Planning process could lead to future infill and intensification development in these communities. It is anticipated that intensification through infill development and redevelopment will be likely within the larger urban areas of Bowmanville and Courtice.

City of Oshawa

In 2007, the City issued a total of 1,368 building permits comprised of 41% residential, 31% industrial/commercial and 28% institutional/government.

Similar to the Municipality of Clarington, the City of Oshawa is bordered in the north by the Oak Ridges Moraine and the Greenbelt Plan area which limits the developable areas. Accordingly, most of the future development area in Oshawa is located north and east of the existing urban area (south of Conlin Road East).

The City of Oshawa's downtown urban area provides greater opportunities for intensification and infill development. In 2005, the City of Oshawa completed a Downtown Oshawa Action Plan which identified actions to improve the development opportunities in the downtown area, and to encourage private sector investment for both residential and commercial development and connect various initiatives that were occurring in the downtown area. This Action Plan led to the initiation of a Downtown Master Plan including urban design guidelines, Downtown Business Plan, a Downtown Parking Strategy and a Market Analysis Study. All of these municipal initiatives are intended to revitalise the downtown core of the City and promote intensification, infill and redevelopment.

4.8.2.3 Existing Land Uses and Areas of Land Use Change

A survey based on aerial photography, satellite views and visual reconnaissance was conducted throughout the LSA to consider the actual (versus planned or designated) uses of lands as a basis for considering how these uses may be affected by the Project. The actual uses of lands are summarised below.

The DN site is surrounded by rural and industrial land uses. Highway 401 runs east to west directly north of the DN site, beyond which are rural residential and agricultural uses. To the east is the St. Marys Cement plant beyond which is a residential neighbourhood. Agricultural uses, automotive uses and the Courtice water pollution control plant are located immediately west of the DN site and Darlington Provincial Park is located further to west on the Lake Ontario shoreline. The urban areas within the LSA include residential, commercial and employment areas which are generally located in the Municipality of Clarington south of the 3rd Concession and in the City of Oshawa south of Conlin Road. The rural areas of the LSA include agricultural areas, rural hamlets and conservation uses which are generally located to the north of these roads.

The Municipality of Clarington includes four settlement areas within the LSA: Courtice, Bowmanville, Newcastle and Orono.

Courtice

Within the settlement area of Courtice, development is largely concentrated in proximity to the Oshawa border, centred on King Street (Regional Highway 2). Low density residential uses are distributed throughout the settlement area with much of it being south of King Street. There are instances of higher-density residential development; however, the majority of it is also situated south of King Street.

Institutional land uses are located immediately north of King Street and between the King Street and Bloor Street corridors.

Commercial development is generally located either abutting or in proximity to the major travelled roads (i.e., Highway 401 and King Street).

Employment uses are generally located immediately north of King Street abutting Townline Road North and in proximity to Highway 401 at the western municipal boundary abutting the City of Oshawa.

Bowmanville

Within the settlement area of Bowmanville, development is largely concentrated between the north/south road of Mearns Avenue at the east and Scugog Street at the west. Development is generally concentrated in an area that is bounded at the north by Concession 3 and at the south by Baseline Road West. Residential development consists primarily of low to medium density uses which are generally equally distributed through the settlement area with some occurrence of higher density development as well.

Institutional uses are generally located throughout the settlement area. One use is located south of Baseline Road East, immediately west of Liberty Street South.

Commercial development is concentrated in areas abutting, or in proximity to, the major travelled roads (i.e., Highway 401 and King Street).

Employment uses are concentrated at the intersection of Haines Street and Baseline Road East and between Baseline Road East and Highway 401.

Newcastle

Within the settlement area of Newcastle, development is largely concentrated between the eastern boundary of the LSA and Rudell Road and between King Avenue to the north and Lake Ontario to the south. Low density residential uses are distributed throughout the settlement area.

Institutional uses are generally located at the intersection of Given Road and King Avenue at the north end and on Rudell Road near Highway 401 at the south end.

Commercial development is largely concentrated in an area abutting, or in proximity to, the intersection of Mill Street and King Avenue.

Employment uses are concentrated in an area located between Highway 401 and the CN railway line.

Orono

Within the settlement area of Orono, development is largely concentrated between the western boundary of the LSA and Main Street and exists between Taunton Road to the north and Summerville Drive to the south. Low density residential uses are distributed throughout the settlement area.

Institutional uses exist in two areas that abut the Highway 35/115 corridor.

Commercial uses are located abutting Main Street, between Mill Street and Park Street.

Employment uses are located abutting the Highway 35/115 corridor at the extreme south and north of the settlement area.

City of Oshawa

Within the LSA boundaries of the City of Oshawa, low, medium, and high density residential uses were observed. There is a higher concentration of low and medium density residential uses.

Commercial uses within the City are located along most of the major thoroughfares. The majority of single-tier commercial clusters are located on Taunton Road at the north, Simcoe Street (North and South), King Street (East and West), Bloor Street (East and West) and the intersection of King Street West and Stevenson Road South (Oshawa Centre).

Major employment uses are located south of Highway 401 and west of Park Road South (General Motors). Smaller employment uses are located in the area of east of Simcoe Street East and south of Highway 401.

4.8.3 Landscape and Visual Setting

A change in the visual character of a community relates directly to potential socio-economic effects. Visual dominance of features considered unusual or unnatural in the setting may contribute to reduced property values and changes in people's sense of satisfaction with community. Significant changes deemed "unpleasant" in the visual character of a community can also be a source of stigma because of the negative images associated with that community. Because the Project will involve visually-prominent features (e.g., soil disposal piles and berms; large buildings and structures), the existing visual setting is established in order to consider how it might change as a result of the Project.

4.8.3.1 Existing Visual Character

The existing visual character of the site of the Project (DN site) is described in terms of views from both within the LSA and throughout the RSA to ensure an appropriate framework for considering changes and effects associated with its implementation.

The existing visual character of the developed portion of the DN site is generally typical of the industrial characteristics of much of the Lake Ontario shoreline in the general vicinity, which includes the existing St. Marys Cement plant and the Courtice water pollution control plant. The DN site is located south of Highway 401 with the existing operating portion of the property positioned behind the Northwest Landfill Area and generally well-developed vegetation on the northern property limit. These areas provide effective screening and limit direct views of the existing DNGS buildings. Nonetheless, there are vantage points within the LSA and RSA from which portions of the DNGS buildings are visible.

The St. Marys Cement plant is located immediately east of the DN site. It is characterised by several large, tall concrete silos and conveyor systems that are clearly visible from a considerable distance. As such, the St. Marys Cement plant is visually prominent within the immediate vicinity of the DN site. Similarly prominent features associated with the existing DN site are the electrical tower lines that exit the property to the north and across Highway 401 and to the east, parallel to and south of Highway 401.

Highway 401 and Highway 35/115 are prominent features of the physical landscape in the vicinity of the DN site. Both are multi-lane expressways with rights-of-way more than 100 m wide. Highway 401 parallels the DN site throughout its entire width. It accommodates a large volume of east and west-bound traffic traveling past the DN site. Highway 35/115 is several kilometres to the west and provides a link from Highway 401 north to Peterborough.

Both the existing DNGS and the St. Marys Cement plant are dominant in views from Lake Ontario. In these views, the Project site generally appears as an undeveloped area of shoreline dominated by the bluffs which remain in place between DNGS and St. Marys.

Photographs illustrating views from highway 401 are provided as Figure 4.8-1.

Figure 4.8-1

Visual Assessment View

Highway 401 traveling Westbound, north of the DN Site
Facing South-West (No-Foliage)

Highway 401 traveling Eastbound, west of the DN Site
Facing South-East (No-Foliage)

Date: September 2009

Project: 34500

SOURCE:
ADAPTED FROM MMM GROUP, LAND USE, ENVIRONMENTAL EFFECTS T.S.D., FIGURES 4.3-12 AND 4.3-14, 2009

ONTARIO POWER GENERATION

4.8.4 Valued Ecosystem Components

VECs were selected for each of the sub-components of the Land Use environmental component to represent features or aspects of this component that could be affected by the Project. Each VEC was deemed to be an element of importance within the geographic extent of Project works and susceptible to change and effect as a result of Project-related activities. The VECs and their rationale for selection are described in Table 4.8-1.

TABLE 4.8-1
VECs for Land Use

Sub-Component	VEC	Rationale
Land Use	Land use planning regime in Local Study Area	Changes in land use policy in the future, including restrictions on development. Property use, and development potential and opportunities are important factors in land valuation. Ability to continue existing services and ongoing and future business opportunities.
Landscape and Visual Setting	Visual aesthetics	The quality of views and vistas could have an effect on property values and the use and enjoyment of lands. Quality of views and vistas from Lake Ontario and its waterfront could have an effect on recreational opportunities and use and enjoyment of the Lake.

4.9 Traffic and Transportation

This Section provides an overview description of existing conditions in the Traffic and Transportation environmental component. The detailed baseline characterization of the Traffic and Transportation component is contained in the *Traffic and Transportation – Existing Environmental Conditions Technical Support Document, New Nuclear - Darlington Environmental Assessment*. The description is presented in the context of the following environmental sub-components:

- Transportation System Operations: operational efficiency and adequacy of all modes of transportation (i.e., road, rail, marine) relative to demand; and

- Transportation System Safety: safety-related conditions associated with all modes of transportation (road, rail and marine).

4.9.1 Study Areas

The generic study areas described in Section 3.1.3 were considered for specific application for the Traffic and Transportation component with modifications made as appropriate. The study areas as applied are described below.

Regional Study Area

The RSA applied for the Traffic and Transportation component is consistent with the generic RSA. The RSA is primarily relevant for consideration of cumulative effects since traffic and transportation issues directly associated with the Project will be focused in the LSA (see below).

Local Study Area

The LSA applied for the Traffic and Transportation component is generally consistent with the generic LSA. It considers the key intersections and road links that experience current DNGS-related traffic within a 10-km radius from the DN site. This area includes the southeast portion of the City of Oshawa and part of the Municipality of Clarington south of Taunton Road, including the communities of Courtice and most of Bowmanville.

Site Study Area

The SSA applied for the Traffic and Transportation component consists of the road, rail and marine access points into the DN site, as well as Transportation related elements internal to the site (i.e., queuing).

4.9.2 Transportation System Operation – Roads

4.9.2.1 Roads System

The discussion of existing conditions in terms of Traffic and Transportation is primarily focused within the LSA since it is within this zone that potential consequences of the NND Project will be experienced. Traffic associated with the Project beyond the LSA will have been absorbed within the system infrastructure such that it will not be discernable outside of background traffic conditions. The key roadways and intersections selected as further focus in the LSA represent the key routes that converge upon or diverge from, the DN site and, therefore, change and effect associated with the Project can be readily measured at these locations.

The key roadways included in the detailed assessment are described as follows:

Holt Road is a two-lane north-south arterial road under the jurisdiction of the Municipality of Clarington, with a posted speed limit of 60 km/hr. The southern segment of Holt Road is the primary access for the DN site.

Park Road is a two-lane north-south minor road under the jurisdiction of the Municipality of Clarington, with a posted speed limit of 60 km/hr. The southern segment of Park Road provides an alternative access for the DN site from the west side. This road is also the main access point to the Visitors Information Centre via 2nd Line West.

South Service Road is a two-lane east-west collector road under the jurisdiction of the Municipality of Clarington. This roadway runs along the south side of Highway 401 from Courtice Road in Courtice to Waverly Road in Bowmanville. The posted speed limit is 60 km/hr. It provides the primary connection from the DN site access at Holt Road to major north/south routes and interchanges along Highway 401.

Waverly Road/Durham Regional Road 57 is a two-lane north-south arterial road under the jurisdiction of the Region of Durham with a posted speed limit of 60 km/hr. It has full interchange access to Highway 401 and intersects with South Service Road at the south end. It provides the primary connection point for DN site access from the east (via South Service Road and Holt Road).

Courtice Road/Durham Regional Road 34 is a two-lane north-south arterial road under the jurisdiction of the Region of Durham with a posted speed limit of 60 km/hr. It has full interchange access to Highway 401 and intersects with South Service Road at the south end. It provides an alternative connection point for DN site access from the west and north-west (via South Service Road and Holt Road).

Baseline Road is a two-lane east-west arterial road under the jurisdiction of the Municipality of Clarington between Prestonvale Road in Courtice and Lambs Road (Bowmanville). The posted speed limit through this section is 60 km/hr. Baseline Road is located just north of Highway 401 and provides connection to Waverly Road, Holt Road and Courtice Road.

No bus-based transit services operate in the vicinity of the DN site. The closest transit service is Durham Regional Transit (Route 501) approximately 4 km to the east, near Baseline Road and Waverly Road. To the west, the nearest transit service route is in Oshawa, at a distance of about 7 km.

Two private service providers are responsible for all school bus operations in the LSA. In general, school bus traffic in the LSA is relatively light. Bus routes are subject to changes based on student volumes and demands. However, an ongoing requirement for student bussing can be anticipated throughout the LSA.

There is little or no pedestrian foot traffic or bicycle traffic in the near vicinity of the DN site (e.g., immediately adjacent to the SSA) and there are no provisions for such traffic (i.e., pedestrian sidewalks or cycling paths along either Holt Road or South Service Road near the DN site access or leading into the site). The Waterfront Trail passes through the DN site south of South Service Road. East of the site, the Trail returns to the shoulder of South Service Road and continues as such to Waverly Road. West of the DN site, the Trail parallels Osborne Road eventually intersecting with South Service Road. The majority of Waterfront Trail (and other DN site amenity) users travel to the site by motor vehicle.

4.9.2.2 Employee Travel Patterns

The results of an employee survey indicate that the automobile is the dominant mode of transportation for DN site employees. Over 90% of employees who responded to the survey drive to work, while another 8% of respondents carpool to work. Based on the survey results, it was extrapolated that the majority of the employees travel to work via three main gateway routes: Highway 401/Holt Road exit (36%), Highway 401/Waverly Road exit (31%) and southbound on Holt Road (21%). These routes to the DN site are the most direct and also reflect the relative location of the employees' residences from the DN site.

The main access into the DN site is via Holt Road. Turning movement counts confirmed that many employees commute from the north via Holt Road, while another sizeable group travels from the east via Highway 401, exiting at the Waverly Road interchange and taking South Service Road to Holt Road. A third group travels from the west via Highway 401 arriving at the DN site using the Holt Road exit from Highway 401. A small number of employees arrive via the South Service Road westbound. These arrivals all converge at the Holt Road guardhouse, routinely causing queues and delays during shift changes. A second site access at Park Road off South Service Road is mainly used by the public to access the Waterfront Trail and the DNGS Visitors Information Centre. Its use by OPG staff is limited to outage periods and morning and afternoon peak traffic periods. As such, it receives only a small amount of daily traffic.

Trip generation information for the DN site at the Holt Road entrance was collected during a queuing survey for both non-outage and outage conditions. Peak hour entering and exiting traffic is summarised in Table 4.9-1.

TABLE 4.9-1
Peak Hour Entering and Exiting Traffic

	A.M. Peak Hour (Vehicle trips and % of total)			**P.M. Peak Hour (Vehicle trips and % of total)**		
Non-Outage Period	Inbound	Outbound	Total	Inbound	Outbound	Total
	941 (97%)	29 (3%)	970	44 (4%)	1008 (96%)	1052
	Peak Hour: 0630-0730			Peak Hour: 1450-1550		
Outage Period	Inbound	Outbound	Total	Inbound	Outbound	Total
	1111 (92%)	101 (8%)	1212	47 (6%)	767 (94%)	814
	Peak Hour: 0630-0730			Peak Hour: 1500-1600		

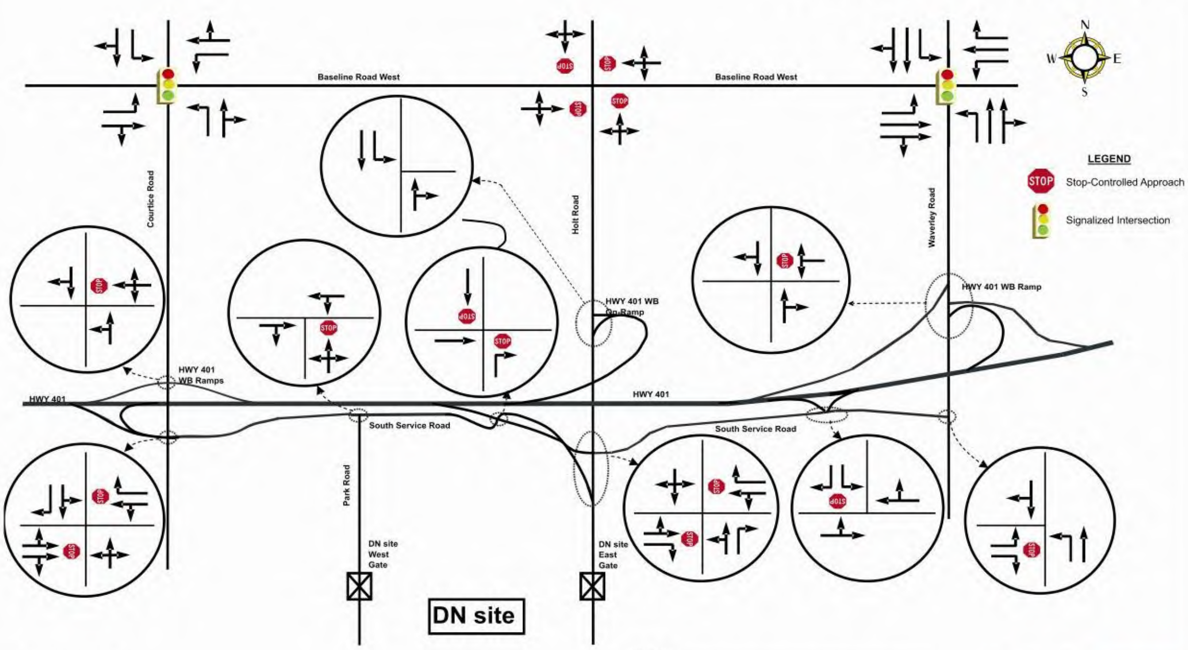
Based on the results of queuing surveys, traffic entering the DN site does not routinely result in excessive queuing problems. The queue to enter the DN site mostly remained on Holt Road, south of South Service Road. On occasion and for short periods of time, the queue extended back to the South Service Road/Holt Road intersection with traffic blockage and short queues formed beyond the intersection as vehicles bound for the DN site waited to proceed. However, the queue dissipated on average within approximately 10 minutes.

4.9.2.3 Intersection Capacity

Traffic operations at key intersections in the LSA were analysed to determine the existing Level of Service (LOS) during weekday a.m. and p.m. peak hours for both non-outage and outage conditions. The intersections analysed and their lane configurations are illustrated on Figure 4.9-1. The intersection capacity analyses are summarised in Table 4.9-2 (Non-Outage Period) and Table 4.9-3 (Outage Period).

Figure 4.9-1

Existing Lane Configurations



Date: September 2009
Project: 34500

SOURCE:
ADAPTED FROM MMM GROUP, TRAFFIC AND TRANSPORTATION EXISTING ENVIRONMENTAL CONDITIONS T.S.D., FIGURE 3.1-5 2009

TABLE 4.9-2
Intersection Capacity Analysis Non-Outage Period

Intersection	Control Type	Weekday A.M. Peak Hour		Weekday P.M. Peak Hour	
		LOS[1] (Delay in seconds)	Critical Movement(s)[2] (v/c)	LOS (Delay in seconds)	Critical Movement(s) (v/c)
Courtice Road at Baseline Road	Signalised	B (10)	--	B (17)	--
Hwy 401 WB On/Off Ramps at Courtice Road	Unsignalised	B (10)	--	B (13)	--
Courtice Road at South Service Road	Unsignalised	B (12)	--	B (14)	--
South Service Road at Park Road	Unsignalised	A (9)	--	A (9)	--
Hwy 401 EB Off-Ramp at South Service Road (West of Holt Road)	Unsignalised	B (12)	--	B (12)	--
Holt Road at Baseline Road	Unsignalised	C (23)	--	C (16)	--
Hwy 401 WB On-Ramp at Holt Road	Unsignalised	A (8)	--	A (9)	--
Holt Road at South Service Road	Unsignalised	F (172)	WB-LTR (1.01)	E (48)	--
Hwy 401 EB On/Off Ramps at the Waverly Road Interchange (on South Service Road)	Unsignalised	C (15)	--	F (1082)	SB-L (1.57)
Waverly Road at Baseline Road	Signalised	C (25)	WB-L (0.86)	C (24)	--
Hwy 401 WB On/Off Ramps at Waverly Road	Unsignalised	B (14)	--	C (16)	--
Waverly Road at South Service Road	Unsignalised	B (13)	--	D (31)	--

Notes:
LOS: Level of Service
v/c: volume to capacity ratio
1 The LOS at an unsignalised intersection is defined by the movement with the highest delay.
2 Critical movements are those with a v/c exceeding 0.85 for a signalised intersection or with a LOS of 'E' or 'F' for an unsignalised intersection

The LOS is a qualitative measure of traffic flow at intersections based on vehicle delay and queue length at the approaches. The LOS is calculated in terms of the ratio of traffic volumes and approach capacity (v/c ratio). The ratio is classified within a range of A to F with a LOS of E or F indicating unacceptable traffic conditions.

During non-outage periods, the analysed intersections currently (see Figure 4.9-1) operate at an acceptable overall LOS with the exception of the Highway 401 Eastbound On/Off Ramps at the Waverly Road Interchange (on South Service Road); and Holt Road at South Service Road, where individual movements currently operate at capacity resulting in delays during either the a.m. or p.m. peak hour. Results indicate that the southbound left-turn movement exceeds capacity. However, based on the queuing observations for the non-outage period, queuing was not a significant issue at these locations.

TABLE 4.9-3
Intersection Capacity Analysis - Outage Period

Intersections	Control Type	Weekday A.M. Peak Hour		Weekday P.M. Peak Hour	
		LOS[1] (Delay In Seconds)	Critical Movement(S)[2] (V/C)	LOS (Delay In Seconds)	Critical Movement(S) (V/C)
Courtice Road at Baseline Road	Signalised	A (8)	--	B (14)	--
Hwy 401 WB On/Off Ramps at Courtice Road	Unsignalised	B (11)	--	B (13)	--
Courtice Road at South Service Road	Unsignalised	B (12)	--	B (14)	--
South Service Road at Park Road	Unsignalised	A (9)	--	A (9)	--
Hwy 401 EB Off-Ramp at South Service Road (West of Holt Road)	Unsignalised	B (12)	--	A (10)	--
Holt Road at Baseline Road	Unsignalised	D (26)	--	B (14)	--
Hwy 401 WB On-Ramp at Holt Road	Unsignalised	A (7)	--	A (9)	--
Holt Road at South Service Road	Unsignalised	F (474)	WB-LTR (1.21)	B (10)	--
Hwy 401 EB On/Off Ramps at the Waverly Road Interchange (on South Service Road)	Unsignalised	C (15)	--	F (432)	SB-L (1.20)
Waverly Road at Baseline Road	Signalised	C (26)	WB-L (0.90)	C (29)	NB-LTR (0.87)
Hwy 401 WB On/Off Ramps at Waverly Road	Unsignalised	B (14)	--	C (16)	--
Waverly Road at South Service Road	Unsignalised	B (12)	--	C (19)	--

Notes:
LOS: Level of Service
v/c: volume to capacity ratio
1 The LOS at an unsignalised intersection is defined by the movement with the highest delay.
2 Critical movements are those with a v/c exceeding 0.85 for a signalised intersection or with a LOS of ‘E’ or ‘F’ for an Unsignalised intersection

During the outage period, traffic operations and LOS at the analysed intersections were generally similar to those during the non-outage period. The intersection of Holt Road at South Service Road is currently operating at LOS F during the weekday a.m. peak hour. The westbound approach operates at capacity with an average delay of almost eight minutes during outage periods. Similar to the non-outage period, this approach is operating at poor LOS. The queue observations at this approach also indicated a maximum queue length of 12 vehicles, which lasted for about six minutes. Therefore, queuing and traffic operations at this approach are currently not a significant problem. The conditions are generally similar in the weekday p.m. peak hour for the Highway 401 Eastbound on/off ramps at the Waverly Road Interchange.

The queuing conditions observed on site at the Highway 401 eastbound off ramp at South Service Road/Waverly Road intersection during the weekday p.m. peak hour were not of concern. Queuing was observed for the southbound left-turn movement and consisted of a maximum of 16 vehicles in the queue, primarily due to the heavy east-west traffic. However, the queue dissipated after a few minutes and no spillback onto Highway 401 had occurred. Therefore, those vehicles making the southbound left turn are able to find gaps in the east-west traffic to complete the manoeuvre.

4.9.2.4 Road Link Capacity

The overall operations of the boundary road network are satisfactory and the volumes on most of the road segments are considerably below their total capacities. One assessed location, however, Westbound Baseline Road west of Courtice Road during the a.m. peak period, experienced a volume-to-capacity (v/c) ratio above the critical 85 percent threshold (v/c > 0.85).

4.9.2.5 Planned Roadway Improvements

A number of improvements to the provincial and municipal roadway infrastructure are to be expected in the future. Those improvements that are well enough advanced in their planning stages to identify as reasonably likely in the near and intermediate term include the following.

Highway 401 and Holt Road Interchange

Currently, the Holt Road interchange on Highway 401 only provides access for motorists travelling to and from the west. A more complete interchange at Holt Road will provide enhanced accessibility for motorists travelling to and from the east and west. This interchange improvement is expected to be completed by 2012. Additional Highway 401 improvements may also be required as part of the Highway 407 extension. Details with respect to these improvements are still to be determined.

Highway 407 and Durham Links

The current eastern section of Highway 407 terminates at Brock Road in Pickering. Proposed expansion plans would extend the corridor eastward to connect with Highways 35/115 in the northeast quadrant of the Municipality of Clarington. Two new north-south connector routes in Durham Region (Durham Links) will also be constructed to provide a connection between Highway 401 and Highway 407, one of which, the East Durham Link, will be just west of the DN site. Its construction is likely to also include re-alignment of South Service Road in the vicinity of the DN site. A detailed schedule for completion of the Highway 407 extension project has not yet been determined, however, as indicated in Section 8.2.3, its phased construction is anticipated during the period 2013-2016. The East Durham Link is expected to be constructed during the late stages of the overall Highway 407 project.

Regional and Local Roads

Municipal road improvements within the LSA that have been identified include at the intersections of Taunton and Courtice Roads; Taunton Road and Regional Road 57; Taunton Road and Main Street; and Rossland Road and Waverly Road. These improvements are all anticipated to be carried out during the time frame of 2013-2021. None of these intersections is included in those analysed (see Figure 4.9-1).

Planned and Proposed Developments

The industrial area located west of the DN site has been proposed as the location for the future Clarington Energy Business Park. Among others uses, the Energy Park and areas adjacent to it are expected to accommodate a Water Pollution Control Facility (now in place), a Regional (Durham and York Regions) Energy from Waste (EFW) Facility and an OPG office complex, both proposed. According to the Clarington Energy Business Park Secondary Plan (Clarington 2007a) a new road (Energy Drive) is proposed within the southern part of the Energy Park which will connect with Courtice Road to the west and South Service Road to the east. Two north-south streets are also proposed, between Osborne Road and east limit of the property. The timing of these developments has not been determined.

4.9.3 Transportation System Operation - Rail

Two major railway lines exist within the LSA; the Canadian Pacific (CP) line (Belleville Subdivision) north of Highway 401; and the Canadian National (CN) line (Kingston Subdivision) south of Highway 401. The CN railway line bisects the SSA in an east-west direction. A number of freight trains operated by both CP and CN, as well as passenger trains operated by VIA Rail, use these railway lines on a daily basis. Railroad traffic in the LSA is summarised in Table 4.9-4.

TABLE 4.9-4
Railroad Traffic in LSA

Railway Company	Subdivision Used	Number of Trains (Daily Average)
Canadian Pacific Railway (CPR)	CP Belleville	Eastbound – 11 freight trains (incl. 8 intermodal trains) Westbound- 9 freight trains (incl. 7 intermodal trains)
Canadian National Railway (CNR)	CNR Kingston	Eastbound – 10 freight trains (incl. 4 intermodal trains) Westbound – 10 freight trains (incl. 3 intermodal trains)
VIA Rail	CNR Kingston	Eastbound – 9 to 10 trains Westbound – 9 to 10 trains

Note:
Intermodal freight transport is defined as the use of two or more modes to move a shipment from origin to destination. For example, using ships and trains, or trucks, ships and trains. Intermodal goods are shipped in large sealed containers that are not opened until they reach their destination.

Passenger and freight train traffic is expected to increase in the future due to factors such as trends in the industry and concerns with rising fuel costs. In addition, the proposed high-speed passenger rail service that is being considered between Quebec City and Windsor is likely to further increase the activity levels along one of the rail corridors through the LSA and potentially, the SSA. Although no other significant changes are expected to occur on the corridors, the projected growth in rail traffic may trigger the need to improve safety-related control measures such as gates, signage, signals and grade separations.

4.9.4 Transportation Systems Operation – Marine

The Port of Oshawa, located approximately 6 km west of the DN site, is the only major commercial port within the LSA. It is capable of handling all types and sizes of vessels entering the Great Lakes St. Lawrence Seaway System (i.e., maximum 225.5 m in length, 23.7 m beam, 8.1 m draft and 35.5 m height above water). Should the NND Project involve marine transport of large or oversized components, it can be reasonably assumed that the Port of Oshawa would be the most likely commercial port destination for the marine shipments, and from which local transfer would be by barge to the DN site. An alternative marine destination may be the existing privately-owned and operated wharf facility at St. Marys Cement, located immediately east of the DN site. This wharf is currently used primarily by St. Marys to support their cement manufacturing operations, however, it is considered physically capable of accommodating commercial marine traffic (e.g., shipments of road salt for the Region of Durham are received).

The current navigation routes for commercial shipping in Lake Ontario are located considerably offshore, generally near the middle of the lake. Assuming that most commercial ships are expected to be sailing to or from Toronto, Hamilton or the Welland Canal along the traditional shipping routes, the potential shipping and delivery activities that may occur around the DN site during construction are not expected to interfere with the normal navigational operations.

The area immediately offshore of the DNGS where its cooling water intake and diffuser are located has been marked as a prohibited zone on the navigation charts. This zone is approximately 1,400 m wide (measured alongshore) and extends approximately 2,000 m into the lake. The navigation chart also indicates private markers above the diffuser and intake.

Marine transportation activities are primarily conducted by private sector business interests and the level of activity is directly related to the economic climate and competitive interests. For these reasons, little information is available from marine transportation operators with respect to future marine traffic activities and volumes. However, based on observed conditions, it is reasonable to conclude that there is sufficient capacity in open water and along-shore shipping routes to accommodate current marine traffic as well as reasonably-expected future increases in demand without posing any additional safety risks. The key constraints will be at the ports, marinas or wharfs. Based on the information provided by the Port of Oshawa, this facility is currently under utilised from a commercial perspective with no indication that this demand is expected to change in the near future.

4.9.5 Transportation System Safety – Road

4.9.5.1 Collision Analysis

Historical collision data from 2002 to 2006 at key locations along the Highway 401 mainline and ramps, intersections and mid-block locations within the LSA were compiled and collision rate calculated. The analysis focused on Highway 401, Baseline Road, South Service Road, Courtice Road, Solina Road, Park Road, Holt Road and Regional Road 57/Waverley Road. The total number of collisions between 2002 and 2006 was 819. Of these, 630 were highway mainline/ramp collisions, 93 were intersection collisions and 96 were mid-block collisions.

During the period 2002 to 2006, the intersection of Baseline Road and Regional Road 57/Waverly Road experienced the highest number of collisions (33 collisions); the intersection of Baseline Road and Holt Road experienced 14 collisions; and the third most frequent collision location was Baseline Road and Courtice Road intersection, with 13 collisions.

Collision rate at intersections of 1.5 collisions per mev (million entering vehicles) or on road links of 1.5 collisions per vehicle-kilometre travelled, are widely recognised to be thresholds that indicate a potential safety problem. The collision frequency rate in the investigated intersections and links in the LSA are illustrated on Figure 4.9-2. As shown, several intersections and links exceed this threshold.

4.9.5.2 Road Safety Audit

A road safety audit was conducted along major roadways within the LSA to identify possible deficiencies in physical conditions or elements of the roadway relevant to road safety, such as signage, markings, roadway geometry, pavement conditions, etc. The audit was particularly focused on intersections and sections of roads adjacent to land uses that were identified as sensitive with respect to youth and elderly pedestrian traffic (e.g., hospitals, schools, churches, community centres and retirement homes).

A number of potential safety-related conditions were identified and will be considered in the assessment of potential effects. In general, the concerns are not major and are not unlike those that can routinely be found in similar study areas. The most common concerns include pavement conditions, approach configurations, sightline issues and inadequate pedestrian facilities.

The road safety audit was supplemented with a review of road conditions in the LSA considering the Pavement Conditions Index (PCI) as prepared by the Region of Durham. The PCI is a numerical index that indicates the condition of the roadway in a range from 0 to 100, with 100 being the highest quality. The condition of the roads in the LSA is highly variable. Many of the newer roads rate 100 on the PCI, while many others rate below 20. There are also large variations within each road. Overall, most of the roadways within the LSA are within the PCI Rating range of 26 and 60, which is considered an average rating where some upgrades are required.

4.9.6 Transportation System Safety – Rail

The Transportation Safety Board of Canada provided national rail safety statistics for years 2007 and 2008. This information provides an understanding of the number and frequency of incidents and distinguishes between types of accidents (i.e., collisions, derailments, trespassers,

Figure 4.9-2

2005 Traffic Collision Rates

Date: September 2009

Project: 34500

SOURCE:

ADAPTED FROM MMM GROUP, TRAFFIC AND TRANSPORTATION EXISTING ENVIRONMENTAL CONDITIONS T.S.D., FIGURE 3.1-10 2009

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fires/explosions, accidents involving passengers, dangerous goods, etc.) and the provinces in which they occur. The statistics indicate that among all provinces, Ontario had the highest number of accidents, fatalities and serious injuries during 2007 and 2008.

Rail incident data during the period 1985 to 2008 for the 10-km section of tracks from Newcastle to just east of Oshawa (including that section of CN tracks which passes through the DN site) are summarised on Table 4.9-5.

TABLE 4.9-5
Rail Occurrence Summary for the LSA

Subdivision	Derailment Incidents	Incidents at Crossings	Dangerous Goods – Trains (Rail Cars)	Dangerous Goods – Release	Fatalities	Injuries
CP Belleville Subdivision [1] (Mile 161 - 171)	0	4	0 (0)	0	6	1
CN Kingston Subdivision [2] (Mile 287 - 297)	6	3	3 (10)	0	4	0
Total	**6**	**7**	**3 (10)**	**0**	**10**	**1**

Note:
[1] Reporting period - December 1988 to June 2004
[2] Reporting period – August 1985 to October 2007

The data indicate that there were more incidents on the CN Rail tracks, including derailments and fatalities, during its 21-year reporting period than on the CP Rail tracks during its 16-year reporting period. However, although there were fewer overall incidents on the CP tracks, there was a higher number of fatalities and injuries. No dangerous goods were spilled or released in any of the incidents by either railway company. Many of the incidents were due to intentional damages by vandals and the majority of the reported injuries and fatalities were due to trespassers gaining access to the train tracks, unrelated to operational issues.

4.9.7 Transportation System Safety - Marine

No serious marine-related safety incidents occurred in the area near the DN site between 2002 and 2007. Most reported events were isolated, minor accidents with natural components (i.e. running aground or collisions with rocks) and/or weather-related. These incidents generally resulted in minor to moderate damages of the vessels. Others minor events were also identified relating to on-board incidents resulting in crew injuries. Overall, marine navigation activities around the Darlington/Oshawa area or the DN site are not considered to be at high risk for collisions or incidents and the Transportation Safety Board of Canada has not identified any specific issues or concerns with respect to safety in this area.

4.9.8 Valued Ecosystem Components

VECs were selected for both sub-components of the Traffic and Transportation component to represent the broader range of receptors that could be affected by the Project. Each VEC was deemed to be an element of importance within the geographic extent of Project works and susceptible to change and effect as a result of Project-related activities. The VECs and their rationale for selection are described in Table 4.9-6.

TABLE 4.9-6
VECs for Traffic and Transportation

Sub-Component	VECs (or Pathways)	Rationale
Transportation System Operations (Road, Rail, Marine)	Transportation System efficiency and adequacy relative to demand	Ongoing efficient operation of the transportation system supports business, residents, tourism, agriculture, property values, and overall general economic health and sustainability. Added traffic or changing traffic patterns may also affect VECs in the biophysical and socio-economic environments (e.g., dust and airborne contaminants; economic development; human health).
Transportation System Safety (Road, Rail, Marine)	Transportation System Safety	Transportation-related accidents represent a risk to human health and safety, as well as a risk to the natural environment.

4.10 Physical and Cultural Heritage Resources

This Section provides an overview description of the existing Physical and Cultural Heritage Resources component of the environment. The detailed baseline characterization of Physical and Cultural Heritage Resources is contained in the *Physical and Cultural Heritage Resources – Existing Environmental Conditions Technical Support Document, New Nuclear - Darlington*. The description is presented in the context of the following environmental sub-components:

- Archaeology: Aboriginal and Euro-Canadian resources comprising both sub-surface features and artifacts that pertain to archaeological sites (including marine archaeological sites) and areas of archaeological potential; and

- Built Heritage and Cultural Landscape: Euro-Canadian resources pertaining to built heritage features such as architecture or above-ground structural remains and artifacts, or cultural landscape units such as farm complexes, roadscapes, waterscapes, railscapes, historical settlements, cemeteries or commemorative sites/plaques.

A third possible sub-component, Palaeontology, is not relevant for these EA studies due to the absence of identified physical heritage resources, such as palaeontological sites, within the DN site.

4.10.1 Study Areas

The generic study areas as described in Section 3.1.3 were considered for specific application for the Physical and Cultural Heritage Resources component of the environment with modifications made as appropriate. The study areas as applied are described below.

<u>Regional Study Area</u>

The RSA is not relevant to this environmental component because it is deemed unlikely that there will be any interactions between the Project and Physical and Cultural Heritage Resources beyond the LSA.

<u>Local Study Area</u>

The LSA has been adopted without change from the generic LSA.

Site Study Area

The SSA has been slightly modified from the generic SSA: it is land-based only and does not extend into Lake Ontario.

The primary focus of this environmental component was the SSA since physical disturbance associated with the Project will be limited to this area. Background research was conducted for the LSA to provide overall context for conditions within the SSA, however, archaeological field investigations were only conducted within the SSA. To enhance identification and analysis of built heritage resources and cultural heritage landscapes located in the SSA, a surrounding buffer zone extending up to 1.2 km north and 250 m east and west of the SSA, identified here as the "SSA buffer zone", was also subject to a field review. This field review was conducted to confirm the presence of cultural heritage resources outside of the SSA and to collect comparative data to assist when evaluating the cultural heritage significance of resources located within the SSA.

4.10.2 Archaeology

Existing conditions in terms of archaeological resources are described below in the context of the LSA and SSA. Background research was only performed for the LSA, whereas both background research and field studies were conducted in the SSA.

Local Study Area

According to the Ontario Archaeological Sites Database (OASD) maintained by the Ontario Ministry of Culture (MCL) and other sources, 69 sites have been registered within the LSA. Among these, 59 sites have Aboriginal components and 13 have Euro-Canadian components. The temporal span of Aboriginal sites stretches from the late Paleo-Indian period between approximately 12,500 and 11,000 years Before Present (BP) through to the late nineteenth century.

Settlement in this area of Upper Canada began near the lakeshore with the first settlers choosing lands near the mouths of major creeks. In the west part of the LSA, an abandoned French trade cabin east of Oshawa Harbour was occupied in 1778 by a Mr. Wilson. Clarke Township was surveyed by 1797 and surveys of the neighbouring townships were probably similar in time. Responding to the emerging market, several mills were built on Bowmanville Creek in 1805 and 1806 and these formed the nucleus of what would later become Bowmanville. By the 1850s, the townships were well settled with schools, churches and a municipal government.

Lake transportation had always been vital for moving people and goods. In 1856, the Grand Trunk Railway was completed, providing land connections to Toronto to the west and Port Hope and Kingston to the east. The historic atlas maps from the second half of the nineteenth century, illustrate well established settlement within the LSA and vicinity, including East Whitby Township, Darlington Township and Clarke Township. Transportation networks of roads and rail lines were in place and the towns of Oshawa and Bowmanville were thriving, as were the numerous small villages and hamlets in the surrounding countryside.

In addition to the expanding settlement on land, Ontario's waterways were also a hub of activity. Aboriginal Peoples travelled the Great Lakes for trade and settlement. During the seventeenth century, the fur traders travelled the same routes in search of furs to send to Europe. As settlement and trade with Europe increased, so did the number of ships. By 1893, there were 3,018 registered Canadian and American ships travelling the Great Lakes. It is estimated that the number of shipwrecks on the Great Lakes lake bottoms today could exceed well over 4,000. It is possible that some may exist within or in close proximity to the LSA.

Site Study Area

The SSA consists of the southern two-thirds of Lots 18 to 24, Broken Front Concession, Geographic Township of Darlington, Regional Municipality of Durham and encompasses an area of approximately 485 hectares. It is defined on the north by the South Service Road, on the west by Solina Road, on the south by the Lake Ontario shoreline and on the east by the east-west mid-lot in Lot 18. Field investigations were limited to the land-based portion of the SSA.

On the east side of Solina Road on Lot 24, a monument exists which consolidates the headstones from the Burk family cemetery. Based on information currently available (air photos, survey plans and pre-1980s inspection reports), the cemetery is still located in the immediate vicinity of the monument, and there is no evidence to suggest that any of the burials have been re-located to another off-site cemetery. It is possible, however, that the monument may also include headstones from other small cemeteries in the area.

It is noted that the MCL's registry of marine sites was also contacted in order to confirm the presence or absence of underwater archaeological sites in the off-shore vicinity of the SSA. According to the MCL, there are no known marine archaeological sites in the lake waters near the SSA (personal communication, Erika Laanela, MCL, August 3, 2007).

A Stage 1 archaeological assessment includes an inspection visit to the property to gain first hand knowledge of the area's geography, topography, and current conditions and to determine the potential for archaeological resources. Based on Stage 1 archaeological assessment results for the SSA, a number of areas were determined to have archaeological site potential.

Prior to any land disturbing activities, a Stage 2 archaeological assessment is conducted for any previously undisturbed lands determined to have archaeological potential in order to identify any archaeological remains that may be present. Stage 2 archaeological field investigations conducted in 26 Test Areas identified within the SSA yielded a total of 12 pre-contact Aboriginal sites. All of the pre-contact Aboriginal sites consisted only of one or two isolated finds, despite intensive re-survey at all locations. Diagnostic artifacts consisting of projectile points were recovered on two of the sites (P1 and P6); a biface, identified as a knife, was one of two artifacts identified on another site (P2); and the other pre-contact Aboriginal sites contained only non-diagnostic flaking debris. Sites P1 and P6 date to the Middle Archaic (ca. 6,000-4,500 BP) and Late Archaic (ca. 3,300 BP) periods, respectively.

The Stage 2 investigations also identified 12 archaeological sites of Euro-Canadian origin. Major sites are represented by Sites H1 (Brady, AlGq-83), H5 (Metcalf, AlGq-85) and H7 (Crumb, AlGq-86) which exhibited archaeological deposits and locations that link them to the nineteenth century occupation of this portion of Darlington Township. All three have potential archaeological significance or interest.

A series of other Euro-Canadian sites was also recorded. Site H2 (Poley Farm), while associated with a 19th century homestead, does not retain any archaeological significance or interest. Site H3 is also associated with a nineteenth century homestead dating to the early 20th century, but it does not retain any archaeological significance or interest. Site H4 consists of a small, diffuse scatter of historical material which does not relate to any known historically mapped homestead and does not retain any archaeological significance or interest. While Site H6 is situated in the vicinity of a mapped mid-nineteenth century homestead, the field investigation did not confirm an actual association. Similarly, although Sites H8 and H9 are situated within remnant homestead landscapes, the sites do not have archaeological significance. Finally, although Sites H10 and H11 are associated with remnant landscape features, including a stone fence and spruce-lined clearing, systematic test pit survey in the area failed to identify or recover any archaeological evidence of any earlier occupation, despite archival mapping showing settlement in the area. These sites therefore do not retain any archaeological significance or interest. Site H12 consists of an isolated Euro-Canadian findspot which is not considered to be a significant archaeological resource.

Based on the Stage 2 archaeological assessment results, five pre-contact Aboriginal sites and three Euro-Canadian sites retain sufficient heritage significance and value to warrant further archaeological consideration. These sites either contain diagnostic artifacts that provide pre-contact Aboriginal cultural affiliation, or archaeological deposits and locations that link them to the 19th century occupation of this portion of Darlington Township. The Stage 3 archaeological assessment consisted of more detailed surface survey and/or test excavation at each site to determine site limits and the nature of their deposits, and to consider possible mitigation requirements: The Stage 3 assessment results are summarized as follows:

- Pre-contact Aboriginal Sites P1-P4 and P6: despite several visits to each site, no additional archaeological material was found any of the sites. No further archaeological work was recommended at any of the sites;

- Site H1 (the Brady site): within 23 excavated one-metre square test units, the number of artifacts per unit ranged from 6 to 159 and included a range of highly fragmented ceramics, glass, metal, bone and brick. Seven possible features were noted. The artifact assemblage is indicative of a homelot, dating from approximately 1800 to 1845, and it is recommended that the site be subjected to a Stage 4 archaeological mitigation, if it can not be protected from disturbance;

- Site H5 (the Metcalf site): within 68 excavated one-metre square test units, the number of artifacts per unit ranged from 2 to 497 and included a range of domestic artifacts including ceramics, glass, metal, bone and brick, as well as tools. Eight possible features were noted: one of the test units was actually located within a deep feature, likely a root cellar or perhaps a privy; but it was not excavated to subsoil in order to protect its context for future investigation. Testing also revealed that a sizable portion of the site had been previously disturbed. In general, the artifact assemblage is indicative of a post-1870s farmstead, and due to its late date and generally disturbed context, no further work at the site is recommended; and

- Site H7 (the Crumb site): within 16 excavated one-metre square test units, the number of artifacts per unit ranged from 3 to 129 and included a range of ceramics, glass, metal, bone and brick. The artifact assemblage is indicative of a homelot, likely that of A. Crumb. Two possible features were noted, one dark stain and one possible post-mould. Therefore, the site can be tightly-dated and represents a significant resource connected to the economic growth of Darlington Township in the mid-19th century. As such, it is recommended that the site be subjected to a Stage 4 archaeological mitigation, if it can not be protected from disturbance.

The locations of the Stage 3 archaeological assessment sites are shown on Figure 4.10-1.

A Stage 2 underwater archaeological assessment of the inland shore of the SSA was not included in the baseline characterisation program. However, a series of underwater videos made at 27 locations in the vicinity of the NND Project proposed lake infill area during the Aquatic Environment baseline characterisation program in November 2008 (see Section 4.4.2.6) was reviewed for the presence of any cultural remains that could suggest marine archaeological sites. No cultural remains or marine archaeological sites were observed.

Figure 4.10-1

Locations of Stage 3 Archaeological Assessment in the Study Area

LEGEND

Site Study Area

Aboriginal site (e.g. Site P1)

Euro-Canadian site (e.g. Site H1)

Test Area (e.g TA21) containing sites requiring Stage 3 investigations

0 100 200 400 600
Metres

Date: September 2009

Project: 34500

SOURCE:
ADAPTED FROM ARCHAEOLOGICAL SERVICES INC., PHYSICAL AND CULTURAL HERITAGE RESOURCES EXISTING ENVIRONMENTAL CONDITIONS T.S.D., FIGURE 3.1-19, 2009

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4.10.3 Built Heritage and Cultural Landscapes

Existing conditions in terms of built heritage and cultural landscapes are described below in the context of the SSA.

The SSA has origins in 18th century survey and settlement of Darlington Township. However, most of it has been extensively altered from its original Southern Ontario agricultural landscape. North-south township roads which intersect or border the SSA have been subjected to varying degrees of modifications in order to accommodate increasing vehicular demands over the past century. While Maple Grove Road has been little altered and consists of a one-lane gravel tree-lined road, current Park Road and Holt Road have both been re-aligned, widened and paved. Most of the landscape alteration was conducted in the past 30 to 40 years in order to accommodate the construction and operation of the DNGS facility.

To confirm the extent of landscape alteration within the SSA, field survey data was collected from the SSA buffer zone for comparative purposes. A field survey of the SSA buffer zone confirmed that this area consists of a mid to late-nineteenth century cultural heritage landscape, which retains a high degree of heritage integrity. Lands surrounding the SSA contain a number of intact, active, nineteenth century agricultural landscapes. The northerly extensions of roadways that bisect the SSA feature two-lane rights-of-way, undulating terrains, vegetative screens, and narrow shoulders. Along Baseline Road, a series of nineteenth century farmhouses and agricultural complexes are extant and in some cases, actively farmed. Extant residences in this area reflect a varied range of architectural styles, building materials, and construction periods.

Based on a cursory review of extant resources in conjunction with historic mapping, identified cultural heritage resources in this area date to as early as the 1860s and are historically associated with early settlement patterns and economic development activities linked with agricultural production. With the exception of the area under subdivision development east of Green Road, the SSA buffer zone successfully illustrates nineteenth century built forms and landscape features that were previously extant and intact prior to construction of the DN site to the south.

Based on a review of aerial photographs and a series of field assessments in April, May and June of 2007, and comparative data collected from the SSA buffer zone, six distinct cultural landscape units (CLU) with clear boundaries and varying levels of landscape alteration were identified within the SSA. Each unit was assigned a level of integrity characterizing the degree to which the landscape had been altered from its initial 19th century agricultural landscape. Understanding a resource's degree of integrity enables consideration of its potential cultural heritage value. While other factors and attributes can contribute to its value, (e.g., contextual, historical, and architectural attributes) consideration of "integrity" establishes those resources that may represent significance. Integrity levels can range from 1 (little to no alterations) to 5 (complete alteration of the landscape). Level 1 cultural landscapes are considered to retain heritage significance (and a combined presence of built features would indicate that the cultural heritage significance continues to be fully expressed). In contrast, Level 2, 3, 4, and 5 cultural landscapes are considered to lack cultural heritage significance; and an absence of tangible built features and landscape elements in combination with wide-ranging site interventions post 1970, substantially limit the extent to which such resources may be considered significant. While Level 2, 3, 4, and 5 cultural heritage landscapes can retain features such as building foundations, fence lines, and vestiges of former farm fields, these features alone do not necessarily indicate that a specific cultural landscape is significant[5].

Therefore, considering the above, while six cultural heritage landscapes were identified, none were found to be significant (i.e., Level 1). Table 4.10-1 presents a summary of the cultural landscape units identified within the SSA. The locations of the units are shown on Figure 4.10-2.

TABLE 4.10-1
Summary of Cultural Landscape Units (CLU) in Site Study Area

CLU #	Location within DN Site	Level	Agricultural Landscape Components and/or Remnants
CLU 1	Northeast corner	2	Roadscapes/trailscapes; fieldscapes; tree lines/fence lines; waterscapes; farmstead foundations; water trough; stone lined well; woodlot
CLU 2	Southeast corner	3	Roadscapes; fieldscapes; tree lines/fence lines; waterscapes; woodlots
CLU 3	North-central portion	4	Roadscapes/trailscapes; fieldscapes; tree lines/fence lines; former farmsteads; woodlots
CLU 4	Northwest corner	5	Roadscapes; tree lines/fence lines; cemetery
CLU 5	Southwest portion	5	None
CLU 6	CNR line	5	Railscape; roadcuts and crossings

Two individual built heritage features (BHF) were identified within the SSA during the field assessment: the Burk Cemetery, and Burk Pioneer Cemetery Monument and Plaque (BHF 1) which commemorates the location of the Burk Cemetery; and the historic cairn (BHF 2) which commemorates the opening of the DNGS in 1989. Both were determined to have potential heritage value or interest. There were no heritage properties within the SSA that are designated under Part IV of the *Ontario Heritage Act*.

[5] This definition as it applies to cultural heritage resources is not to be confused with the term "significant" that may be used elsewhere throughout this EIS and associated documents to describe residual adverse environmental effects identified as a result of the EA.

Figure 4.10-2

Locations of Cultural Landscape Units

Compared to the LSA (and the RSA) and the SSA buffer zone, the SSA is of relatively low heritage interest in terms of the overall integrity of its built heritage features and cultural landscapes. The area north of Highway 401 serves as a more robust and intact cultural heritage landscape that retains a much higher degree of heritage integrity than those altered cultural heritage landscapes located within the SSA.

4.10.4 Valued Ecosystem Components

VECs were selected for each of the subcomponents of the Physical and Cultural Heritage Resources component of the environment to represent the broader range of receptors that could be affected by the Project. Each VEC was deemed to be potentially present within the geographic extent of Project works and susceptible to physical disturbance from Project-related activities. The VECs and their rationale for selection are described in Table 4.10-2.

TABLE 4.10-2
VECs for Physical and Cultural Heritage Resources

Environmental Sub-component	VEC	VEC Indicator and Rationale
Archaeology	Aboriginal Archaeological Resources	Archaeological sites containing Aboriginal sub-surface features and artifacts. Relevant for our understanding of Aboriginal history from circa 11,000 BP to the 1750s, for research or public education purposes, or to have spiritual or cultural meaning to Canadians, particularly to First Nations.
	Euro-Canadian Archaeological Resources	Archaeological sites containing Euro-Canadian sub-surface features and artifacts. Relevant for understanding of Euro-Canadian history from the 1680s to the early 20th century, for research or public education purposes, or to have spiritual or cultural meaning to Canadians.
Built Heritage and Cultural Landscapes	Euro-Canadian Built Heritage Resources	Built heritage features (BHF) containing architecture or above-ground structural remains and artifacts. Relevant for understanding of Euro-Canadian history from the 1790s to the early 20th century, for research or public education purposes, or to have spiritual or cultural meaning to Canadians.
	Euro-Canadian Cultural Landscape Resources	Cultural landscape units (CLU) defined by farm complexes, roadscapes, waterscapes, railscapes, historic settlements, cemeteries, and historic/ commemorative sites. Relevant for understanding of Euro-Canadian history from the 1790s to the early 20th century, for research or public education purposes, or to have spiritual or cultural meaning to Canadians.

4.11 Socio-Economic Conditions

This Section provides an overview description of the existing Socio-economic Environment. The detailed baseline characterisation of the Socio-economic Environment is contained in the *Socio-economic Environment – Existing Environmental Conditions Technical Support Document, New Nuclear – Darlington Environmental Assessment*. The description is presented in the context of the following environmental sub-components (collectively considered as community assets) and the attributes of each that are considered appropriate for this EA:

- Human Assets: as represented by the population and demographics, skills and labour supply, educational; health and safety, social services, and economic development services;

- Financial Assets: as represented by employment, business activity, tourism, income, residential property values and municipal finance and administration;

- Physical Assets: as represented by housing, municipal infrastructure and services; and community character (the related physical assets of land use, and traffic and transportation are addressed as separate environmental components);

- Social Assets: as represented by community and recreational facilities and programs, use and enjoyment of property and community cohesion (a related social asset, physical and cultural heritage, is addressed as a separate environmental component); and

- Natural Assets: as represented by Atmospheric Environment, Surface Water Environment, Aquatic Environment, and Terrestrial Environment. For the purposes of this Socio-economic Assessment, the natural assets sub-component is detailed in separate TSDs.

The description of the Socio-economic Environment applies the concept of "community well-being" as its overall analytical framework. This concept has been used as the basis for sociological, economic and sustainable development planning studies in Canada and internationally.

The use of the concept of community well-being focuses the assessment on understanding the interactions of the Project with those aspects of a community that help maintain it and fulfill the needs of its residents. To understand the interactions of the Project with community well-being, it is necessary to consider a wide range of community components that determine its strengths and weaknesses, and vulnerability to the effects of the Project. These components can be considered as "community assets" that must be created, maintained or enhanced in order to achieve community well-being. Collectively, the above-noted environmental sub-components are referred to as community assets.

4.11.1 Study Areas

The generic study areas described in Section 3.1.3 were considered for specific application for the Socio-economic Environment with modifications made as appropriate. The study areas as applied are described below.

Regional Study Area

The generic RSA was expanded for the Socio-economic Environment to include selected single, upper and lower tier municipalities within the City of Toronto, Regional Municipality of York, Regional Municipality of Durham, the City of Peterborough, Peterborough County, Northumberland County and the City of Kawartha Lakes. The RSA includes all areas surrounding the DN site that are within the 50-km secondary zone for emergency responses defined by Emergency Management Ontario.

Local Study Area

The generic LSA was modified for the Socio-economic Environment to include all areas surrounding the DN site that are within the 10-km primary zone for emergency responses defined by Emergency Management Ontario. The LSA consists of all of the major urbanized communities within Clarington (i.e., Courtice, Bowmanville, Wilmot Creek, Newcastle and Orono) and the majority of the urbanized area within the City of Oshawa.

Site Study Area

The SSA for the Socio-economic Environment includes the property under the control of OPG, on which the proposed new nuclear station and ancillary facilities will be located. This includes the community and recreational features on the DN site such as the upper and lower soccer fields, the Waterfront Trail, the DN baseball field and the Information Centre. The SSA is relevant to the Socio-economic Environment in the context of public access and availability of the DN site and how it is used by people.

4.11.2 Human Assets

The Human Assets sub-component considers the skills and knowledge available in the community and the ability of community organisations and institutions to provide opportunities for growth and learning and for skills and knowledge development. In addition, access to essential services that are fundamental in maintaining people's feelings of personal health, sense of personal safety and their overall satisfaction with community are considered.

4.11.2.1 Population and Demographics

The demographic composition of a community is an important influence on well-being and other key measures of the social fabric and structure within which we live. The demographic characteristics of the population are also an indicator of vulnerable groups (e.g., seniors, ethnic groups), influence its cohesiveness and is a determinant in the physical and social assets necessary to support a community.

The following population and demographic summary was derived primarily from the most recent (2006) census data (Statistics Canada 2006). These data are reasonably expected to also represent the current conditions.

Regional Study Area

The RSA is home to approximately 1.7 million people, or 14% of the province's total population. Of this, about 86% reside in Durham and York Regions and the portion of the City of Toronto included in the RSA (i.e., the former Borough of Scarborough). The remaining 14% are residents of the Cities of Kawartha Lakes and Peterborough and Peterborough and Northumberland Counties. The City of Toronto, including East Toronto portion of the RSA is the most densely populated (approximately 3,900 persons/km^2), followed by York Region (507 persons/km^2) and Durham Region (222 persons/km^2). The least densely populated areas in the RSA are the County of Northumberland (43 persons/km^2), City of Peterborough/ Peterborough County (35 persons/km^2) and the City of Kawartha Lakes (24 persons/km^2).

Growth in the RSA population has outpaced that of Ontario and the City of Toronto. Since 1996, the RSA population has grown by about 19% compared to 13% for Ontario and only 5% for the City of Toronto. More women than men reside in the RSA as is also the case for both the province as a whole and the City of Toronto. However, the gender mix does vary substantially between the municipalities.

In 2006, approximately 32% of the RSA population was under 25 years of age which is generally consistent with the corresponding Ontario-wide cohort. Similarly, about 13% of both the RSA and Ontario populations was 65 years of age and over. Of the upper-tier municipalities in the RSA, the age distribution in Durham Region, York Region and Toronto (both partial) were generally similar to that of Ontario. On the other hand, the Cities of Kawartha Lakes and Peterborough and Peterborough County (partial) have a generally older population with less than 16% under 14 years of age (versus more than 18% Ontario-wide); and approximately 19% at 65 years of age and over (versus about 14% Ontario-wide).

The two main ethnic groups residing in the RSA are persons of British and Asian origins although the ethnic distribution has changed substantially over the past decade, with the proportion of persons of British descent decreasing and of Asian origin increasing. This is also the trend in the general population of Toronto and Ontario. Persons in the RSA who reported Aboriginal identity increased from 0.5% to 0.8% of the population between 1996 and 2006, with almost half of the total residing in Durham Region.

The average number of persons per household ranges from 2.3 in the City of Peterborough to 3.1 in the Town of Ajax. Since 1996, there has been a decreasing trend in household size among RSA municipalities. This is largely attributed to increased incomes and changing lifestyles that result in either smaller families or younger members leaving their households.

Overall, rates of mobility across the RSA are similar to those in the City of Toronto and Ontario as a whole. In the RSA, there is a slight decrease in percentage of non-movers from 1996 to 2006 in York Region, while the remaining municipalities either have minor variations or slight increases in the number of non-movers.

Local Study Area

The population in the LSA is approximately 190,600 persons, or 11% of the RSA population. In 2006, the City of Oshawa had a population density of approximately 328 persons/km^2 while the Municipality of Clarington had a density of 127 persons/km^2. The LSA population grew by approximately 6.8% between 1996 and 2006 with most of the growth occurring in the urban areas of the Municipality of Clarington.

Roughly equal proportions of the LSA population are men and women and between 1996 and 2006, the LSA population aging trends were similar to those in the RSA and Ontario. The proportion of children and younger adults in the total population decreased, while the share of adults aged 45 and over significantly increased. In 2006, approximately 33% of the LSA population was under 25 years of age and about 13% was 65 years of age and over. This distribution is generally similar to the RSA and the province in general. At 36.9 years, the median age in the Municipality of Clarington is below that of Oshawa (39.4 years) and the overall LSA (38.1 years).

The ethnicity of the LSA population is largely British, other North American and European. The LSA has a much lower population of persons of Asian descent and a higher population of persons of British, French and European origins than does the RSA. The LSA includes an Aboriginal identity population of 3,220 persons. This number has almost doubled since 1996.

There are 2.6 persons per household in the LSA. This number has decreased since 1996 in a pattern comparable to the general trend across the RSA and Ontario as a whole.

The percentage of non-movers is higher in the LSA than in the RSA and having increased since 1996, this indicates a more stable population.

4.11.2.2 Skills and Labour Supply

The skills and labour supply available in a community are important features of robustness within that community. They directly influence the proportion of a community's labour needs that can be met locally and hence the potential for individuals and households to realise employment benefits. Skills and labour supply can also indirectly influence the quality of other human assets in that a deficiency of necessary skills available locally may contribute to a diminished sense of community well-being.

In 2001, the wholesale and retail industry and manufacturing sector made up over 30% of the labour force in the RSA. However, since 2001 the RSA has experienced a decline in the labour force employed in the manufacturing sector. During this same period, the construction industry experienced an increase in its labour force size which largely reflects the broad trend of increased activity in residential housing construction during this period. However, the momentum appears to be slowly diminishing and labour markets are entering a stable period of mild adjustments.

Trade specific data were collected and stakeholder interviews undertaken with construction trades councils/training boards, individual trade unions, several major RSA construction companies involved in heavy industrial construction or general contracting and Ontario-wide training institutions. All of the relevant stakeholders interviewed and all available data indicate that over the 2001-2007 period there was, and continues to be, a shortage of skilled labour in the industrial / engineering trades and other skilled trades involved in major construction projects across Ontario.

Given the current demand pressures on the skilled trades associated with the construction labour force, attracting new entrants, in competition with other industries and occupations, is a priority in the construction industry. Many industry programs have been initiated during the past several years. RSA stakeholder interviews also indicate that the construction industry, as a whole, has successfully gained the attention of government, educators and target groups alike on the importance of this issue. In Ontario, apprenticeships provide the traditional and most important source of skilled labour. The RSA stakeholder interviews and the labour market conditions noted above indicate the growing need for apprenticeship positions, training facilities, programs and instructors.

The distribution of the labour force by industry in the LSA is generally similar to that of the RSA with the exception that manufacturing makes up a larger proportion of the labour force by industry in the LSA. This is attributable to the presence of the automotive manufacturing sector in the City of Oshawa. As in the RSA, the size of the labour force in manufacturing decreased between 2001 and 2006, while the labour force in the construction industry increased.

The labour force in occupations unique to processing, manufacturing and utilities declined in the LSA municipalities between 2001 and 2006. Trades, transport and equipment operators and related occupations remained relatively constant in the LSA as in the RSA. In 2006, 18% of the LSA labour force was employed in this category, compared to 13% in the RSA.

4.11.2.3 Education

Education and opportunities for it directly affect a community's well-being by determining the skills and knowledge inherent in the community. To an individual, family or household, education provides the academic or vocational requirements for self-development and potential employment.

There are 10 school boards servicing the municipalities within the RSA, including five Public Boards, four Catholic Boards and one French Board. There is a general trend of declining enrolment across most of these School Boards.

Seven major post secondary institutions are represented within the RSA; some with multiple campuses and others being campuses of facilities with base operations outside the RSA. Of these, Durham College and the University of Ontario Institute of Technology (UOIT), both based in Oshawa, provide the full range of skills development for the energy sector. UOIT offers programs in nuclear engineering, as well as the only electrical systems engineering degree in the world and Durham College offers a range of apprenticeship programs and training for skilled trades.

Five different school boards operate within the LSA municipalities. Durham District School Board, Durham Catholic District School Board and Conseil Scolaire de District du Centre-Sud-Ouest operate schools in the City of Oshawa. Kawartha Pine Ridge District School Board, Peterborough, Victoria, Northumberland and Clarington Catholic District School Board operate schools in the Municipality of Clarington.

The projected enrolment numbers indicate a decline in the number of students for the 2008/2009 academic year. Despite the recent declines in enrolment, some school boards have plans for new schools, some of which are currently under construction. For example, the Conseil scolaire de district du Centre-Sud-Ouest has plans for 10 new schools over the next five years. In the case of the Peterborough Victoria Northumberland and Clarington School Board, increasing enrolment is largely driven by population growth in the Municipality of Clarington. The Education Development Charges being levied by LSA school boards suggest that there are increasing pupil accommodation needs in the Municipality of Clarington.

Some of these local schools have established formal and informal links with OPG and the DN site. Although there are no formal specific educational facilities on the DN site, OPG operates a Public Information Centre that is used by schools for educational purposes. School children also undertake field trips along the Waterfront Trail on the site and participate in various environmental programs offered by OPG (e.g., Earth Angels tree planting program). The DN site is a Corporate Lands for Learning site that is used for educational purposes by various schools and park programs.

4.11.2.4 Health and Safety Facilities and Services

The key health and safety assets of a community are its fire services, policing and emergency preparedness and health care services. The availability of, and access to, such services is an important measure of people's feelings of health and a sense of safety and accordingly, their degree of satisfaction with the community in which they reside.

Fire Protection

Fire services are mandated by the provincial government to offer a specific level of service to the communities in which they serve. In the larger urban centres, fire departments are staffed by full- and part-time fire fighters. However in smaller communities, the crew of a fire department is typically comprised of a mix of full-time and volunteer fire fighters. This is the case in the Municipality of Clarington. The larger fire services also provide specialised hazardous materials-related (HAZMAT) response. This is particularly true of the City of Toronto Fire Services which operates a Chemical, Biological, Radiological and Nuclear (CBRN) Team in conjunction with the Toronto Police Service, which is made up of officers with specialised training to deal with unique situations including nuclear related emergencies.

The Municipality of Clarington's Emergency and Fire Services is moving towards meeting the 10 in 10 rule for level of service, a guideline of the Ontario Fire Marshall's Office, which calls for 10 firefighters to be on-scene at an incident within 10 minutes.

The DN site operates a fully staffed, trained and equipped Emergency Response Team (ERT) whose objective in terms of a fire or related incidence, is to respond to the event within 10 minutes. The Municipality of Clarington's Emergency and Fire Services can be called upon in the event of a medical emergency at the DNGS and would respond to incidents involving DN site-related vehicles off the DN site. A Memorandum of Understanding exists between the Municipality of Clarington and OPG that provides a defense-in-depth approach to fire protection and provides a framework for effective response to fires by both organizations.

Police Services

The Durham Region Police Service (DRPS) provides law enforcement throughout the largest portion of the RSA. The major urban centres (i.e., Clarington, Ajax / Pickering, Whitby) are served by a community policing office staffed by the DRPS.

Through an agreement with OPG, the DRPS provides a dedicated Nuclear Site Response Team at each of the Darlington and Pickering nuclear generating stations. However, OPG is currently transitioning to its own Nuclear Response Force (NRF) at the DN site comprised of professionally-trained officers.

The City of Toronto, York Region, City of Kawartha Lakes, and the City of Peterborough / Peterborough County all also have their own police services. Law enforcement is provided to the smaller communities in Northumberland and Peterborough Counties by the Ontario Provincial Police.

Emergency Preparedness

Emergency preparedness in Ontario is governed by the *Emergency Management and Civil Protection Act* which requires all upper and lower tier municipalities in the Province to have approved plans in place to deal with large-scale emergencies. All single, upper and lower tier municipalities in the RSA meet this requirement. Some municipalities are also required to formulate Nuclear Emergency Response Plans. These include the City of Toronto due to its proximity to the Pickering Nuclear site, and Durham Region due to the presence of both the Pickering and Darlington nuclear sites within its jurisdiction. The Municipality of Clarington, the City of Oshawa and the Town of Ajax also have their own nuclear emergency plans.

Nuclear emergency preparedness is a responsibility of all levels of government and the nuclear facility operators; however, in a nuclear emergency the Province takes the lead and issues directions through Durham Region to its area municipalities. Durham Region has established the Durham Emergency Management Office (DEMO) to work with Emergency Management Ontario (EMO) and OPG to ensure nuclear emergency preparedness is in place

OPG supports the ongoing development and maintenance of the emergency preparedness programs of various organizations and agreements have been established between OPG and EMO, DEMO, the City of Pickering, Municipality of Clarington and the City of Peterborough for this purpose. OPG's emergency preparedness staff participate in regular meetings with the Province and local municipalities to review the status of off-site preparedness and ongoing improvements.

Health Care

Local Health Integration Networks (LHIN) were created by the Province to provide efficient and effective health care services to Ontarians on a regional basis. There are 14 LHINs across Ontario; two, Central East LHIN and Central LHIN, serve the residents of the RSA. Overall, hundreds of health care facilities including addiction centres, community care access centres, community health centres, community support services, hospitals, long term care facilities and mental health facilities are available to the population in the RSA.

Lakeridge Health operates hospitals in the RSA including in Bowmanville, Port Perry, Oshawa and Whitby. Other hospital corporations also operate facilities in the RSA including in Ajax and eastern Toronto, in Uxbridge and Markham/Stouffville and in Peterborough and Cobourg. Memorial Hospital in Bowmanville maintains a close relationship with the DN site. This facility is equipped with radiation decontamination equipment, regularly re-stocked by OPG which also provides radiation protection support when required.

Durham Region also convenes the Durham Nuclear Health Committee that serves as a forum for the discussion of health issues relating to the Darlington and Pickering Nuclear sites. The Province, the Region, local area municipalities, OPG and citizens are represented on this committee. In addition, the Regional Health Department answers questions from the general public on health and safety matters and operates a health information hotline.

4.11.2.5 Social Services

Social services directly affect community well-being through their availability to assist residents to achieve a better quality of life through the alleviation of needs and problems. Formal social services are largely provided by Regional governments although an informal social services network is typically provided by community-based organisations.

Comprehensive social services programs are delivered within the LSA and much of the RSA by single and upper tier municipal governments, including Durham Region. These programs are focused on children's services, family services, housing services, income support, long-term care, services for seniors and the Ontario Child Benefit.

4.11.2.6 Economic Development Services

Economic development refers to the services provided by municipalities and affiliated organisations to its residents and businesses, aimed at generating wealth through increased employment and business activity, and attracting investment and tourists. These are important assets for a community because they support residents and business operators in the pursuit of their financial objectives.

Municipal economic development organisations are well integrated into the economic and social fabric of the communities in the RSA and LSA. Most of the economic development departments have been in existence for at least 10 years and some have been operating for 25 years or more (e.g., Durham Region, City of Oshawa).

Economic development officials focus on consultation and partnership building to achieve their objectives. They are members of numerous local business organisations such as chambers of commerce, tourism boards, service clubs and regional and province-wide organisations.

Most relevant to the NND Project are the economic development objectives of the Region of Durham, the Municipality of Clarington and the City of Oshawa.

Durham Region has four key focal points for business growth as the core of their economic development activities, specifically, agri-business, energy, technology based manufacturing and tourism. The closure of the General Motors truck plant in May of 2009 marked a further and dramatic downsizing of the automotive industry in Durham Region and the City of Oshawa in particular. GM employment in the Region now stands around 9,000; which is down from approximately 20,000 in the late 1980s. Despite these circumstances, the Region continues to display evidence of prosperity with general population growth and employment growth, particularly in the service and energy related sectors.

With respect to energy, Durham Region intends to continue to leverage the Durham Energy Industry Cluster (consisting of the Pickering and Darlington nuclear generating sites and the research, development and energy-related manufacturing and nuclear service industry associated with them) as an economic engine for growth in the Region, and credit Durham College and UOIT for their role in contributing to Durham's knowledge based industries. Building permits serve as one barometer of economic development. Permits issued in the Region in 2008 amounted to $1.3 billion, down 9.3% from 2007, however, still the fourth highest level in the Region's history and 1.6 times the 30-year historical average. Non-residential building permits accounted for approximately 43% of this sum.

The Municipality of Clarington intends to design and develop the Clarington Energy Business Park on 129 ha located immediately west of the DN site. The park is an ambitious undertaking and a cornerstone of Clarington's and Durham Region's economic development strategy. The Municipality is also pursuing the establishment of a Science and Technology Business Park in Bowmanville as an opportunity to attract jobs and secure a strong tax base.

The City of Oshawa's economic development initiatives are closely linked with those of Durham Region and other "lakeshore communities". The focal points for business growth are also energy, technology based manufacturing and tourism. The City is also proactive in matters of business retention and recruitment. New construction and revitalisation of Oshawa's downtown and expansion at the UOIT continue to provide business opportunities.

4.11.3 Financial Assets

The Financial Assets sub-component considers the opportunities available to people for employment and participation in the economic life of the community, including the monetary or financial resources that people and municipalities use to achieve their economic objectives. Financial assets are key determinants of a community's overall economic vitality.

4.11.3.1 Employment

Employment is an important financial asset of any community as it determines the participation of residents in its economic life. As such, employment is a major determinant of overall community well-being.

Data from the past two censuses indicate that employment rates in the more urbanised municipalities of Durham and York Regions have traditionally been higher than those observed in the City of Toronto and Ontario, while the remaining RSA municipalities have tended to have lower employment rates. The automotive and power generation sector companies have traditionally been the major employers in Durham Region. This is due to the presence of General Motors (GM) in Oshawa as well as OPG's presence in Pickering and Clarington. The major public sector employers are hospitals and municipal governments.

However, during the recent past and most notably beginning in mid-2008, there has been major change in the global economy with one of the most-affected sectors being the North American automotive industry. Forecasters have predicted that as many as 25,000 jobs could be eliminated from Ontario's auto assembly and parts industries in 2008 and 2009 combined. This auto industry downturn goes much deeper than past cyclical dips and to survive, the industry must, and is taking steps to significantly downsize and restructure. These actions are already taking place in Durham Region and are expected to continue until industry-wide stability is re-established. The effect on local and regional employment and economic conditions are expected to be profound given that GM has long been a dominant employer in the Region.

Currently, the DN site currently employs approximately 2,800 persons. The majority of these employees reside within Durham Region, with lesser numbers in Northumberland County.

Approximately 84% of DN site employees reside within the RSA. In recent years OPG has been one of the single largest employers in the Durham Region. An examination of place of work data from the 2006 census indicates that 31% of the constituent labour force in Durham Region worked within their municipality of residence (i.e., lived and worked in their own community), 24% worked elsewhere within the Region and 35% worked outside Durham Region. For the City of Oshawa, statistics showed that 43% of its labour force work in the municipality, 26% work within Durham Region and 19% work outside the Region. Municipality of Clarington statistics show that 28% of its labour force work in the Municipality, 45% work within Durham Region and 17% work outside the Region.

The employment rate in the LSA has risen from 60.3% in 1996 to 62.4% in 2006. This trend is observed throughout both LSA municipalities. This pattern is opposite to that experienced across the RSA, where employment rates decreased between 1996 and 2006.

4.11.3.2 Business Activity

Business activity generates the employment opportunities and income that people use to achieve their personal financial objectives which define their style and quality of life. To the municipality, community or region, the level of business activity also influences human, physical assets and social assets.

Between 2002 and 2006, the non-residential taxable assessment (i.e., commercial and industrial assessment) across all RSA municipalities increased substantially. As an overall measure of business activity, this represents a substantial increase. During the same period, the non-residential taxable assessment across both LSA municipalities increased as well; almost 18% in the Municipality of Clarington and over 23% in the City of Oshawa. While maintaining the growth trend, the increase in the LSA is substantially lower than the average increases across the RSA.

The DN site contributes to business activity in the RSA through its salaries to workers which are then spent on goods and services. In 2007, the DN site's total payroll costs were approximately $438 million. The vast majority of this money, approximately $276 million per year, is injected into the economy of Durham Region. Within Durham Region, businesses in the City of Oshawa and the Towns of Whitby and Ajax likely capture most of this spending.

The DN site also contributes directly to business activity in the RSA through its purchases of goods and services. Over the past three years (2005-2007), the DN site spent an average of \$19.5 M on goods and services from companies in the RSA. Over this period of time, the DN site's direct spending in the RSA has increased by almost 160%. The largest portion of this spending was captured by the City of Pickering at approximately \$10.5 M average per year. In the LSA, the DN site spent an average of \$871,952 on goods and services, with the largest amount captured by the City of Oshawa at approximately \$562,000 average per year.

The RSA businesses supplying goods and services to the DN site are small to medium sized enterprises. Most employ 100 workers or less, with an average of just under 70 employees and over half have fewer than 20 employees in the RSA. These suppliers are largely manufacturing, construction or wholesale trade companies, whose client base was largely in the utility, construction and manufacturing sectors. Despite OPG's increase in spending within the RSA over the past three years, a nearly equal number of companies experienced a decrease in the business activity derived from the DN site as those that experienced an increase in their business activity. Nevertheless, many business suppliers have major plans for expansion. Most of these companies are not dependent on the existing DN site for their business.

The nuclear service industry within the RSA, and particularly in the City of Toronto, is well established and economically strong. In a survey of the nuclear service industry in 2008, most respondents reported an increase in business activity over the past five years and although they also typically operated in others lines of business, the most common response offered for the growth in their business was the increased demand for nuclear products and services.

Within the LSA, the area nearest the DN site contains many business operations where the majority of these are light industrial enterprises involved in the transport, automobile and manufacturing sectors, or small scale commercial businesses. Immediately east of the DN site is St. Marys Cement plant, which operates one of the largest quarrying and cement manufacturing operations in Ontario.

Agriculture is also an important component of the economic base within the RSA and the LSA, particularly in the northern-most designated Greenbelt area. The largest number of farm operators and farms are in Durham Region followed by the City of Kawartha Lakes. Farms sizes are somewhat larger in the City of Kawartha Lakes than in the Durham Region. Approximately 46.3 ha of Class 1 agricultural land is farmed under a lease agreement on the eastern portion of the DN site. This land is leased to one full-time farm operator and resident of the LSA. It is currently used for cash crops (e.g., corn, white beans).

Lake Ontario supports a commercial fish industry with the harvest coming primarily from the Canadian waters east of Brighton (including the Bay of Quinte) and the St. Lawrence River. In 2008, the lake-wide total commercial harvest (all species) was approximately 170,000 kg, down approximately 16% from 2007. Over the preceding 10-year period the harvest has decreased substantially, with 438,000 kg taken in 1999. The 2008 harvest was the lowest during this period. The total value of the fish harvested in 2008 was approximately $294,000. The most represented were Yellow Perch, Lake Whitefish, Sunfish, and Brown Bullhead which collectively were 67% of the total.

The DN site is located within Lake Ontario's quota zone 1-8 which extends from Niagara Region in the west to approximately Cobourg in the east. Although a commercial fishery exists in this zone, the OMNR Lake Ontario Management Unit confirmed that actual fishing is exclusively in the western part of the zone in the waters off Niagara Region. There is no commercial fishing activity in the vicinity of the DN site or in Durham Region.

4.11.3.3 Income

Income derived from employment, business activity or from tourism is considered a financial asset and a major determinant of overall community well-being. Income provides a sense of personal security and contributes to a person's own self image and status within a community. Income provides the financial means for residents to undertake a variety of educational, social and community activities that strengthen a community's human and social assets.

In 2006, the average household income in the RSA was approximately $78,200, similar to the Ontario average yet lower than in the City of Toronto. In 2006, York and Durham Regions had the highest average household income among RSA municipalities. These higher incomes can be largely attributed to the presence of large high paying corporate employers in these regions.

Over the past 10 years, average household incomes have increased across each RSA municipality, the City of Toronto and Ontario as a whole. Across the RSA, this increase approached 39% (approximately 4% per annum), but did not keep pace with increases across Ontario, which approached 48% over 10 years.

In 2006, the average household income in the LSA was approximately $74,000, slightly lower than the RSA and Ontario averages. The average household income in the LSA increased by 24.2% between 1996 and 2001, which is comparable to the trend observed in the RSA. Between 2001 and 2006, average household income increased by 12.4%, which is higher than the average increase in the RSA and much higher than the average increase in Toronto at 5.9%.

4.11.3.4 Tourism

Tourism plays a major role in the well-being of the communities and their residents in the RSA and LSA by providing a source of permanent and seasonal employment, and contributing to local and regional business activity and the tax base.

The proximity of the City of Toronto to most of the RSA municipalities, their landscapes and physical settings; the history and heritage of the RSA communities, the abundance of beaches, parks, recreational areas, arts and entertainment establishments make tourism an important business sector of the economy in the RSA. Overall, in 2007 the RSA municipalities attracted over 28 million visitors (27% of total Ontario visitors), generating close to $5 billion in spending. The City of Toronto was the hub of the tourist industry, attracting over 15 million visitors, with Durham Region being the next most visited municipality in the RSA with over 3.8 million visitors. An important component of the overall tourist market to Durham Region is same day visitors, sometimes referred to as "day-trippers". In 2007, same-day person trips accounted for approximately 75% of the total visits to Durham Region and about 48% of the total visitor spending in the Region.

The two LSA municipalities offer many attractions, historic sites, nature trails and conservation areas, sport venues, wineries, zoos and, in the case of Clarington, a picturesque countryside and a historic downtown. Some of the largest and most visited natural and conservation areas within the LSA are Enniskillen Conservation Area, Harmony Valley Conservation Area, McLaughlin Bay Wildlife Reserve, Oshawa Second Marsh and Darlington Provincial Park. The LSA also contains several tourist accommodations including hotels, motels, B&Bs and a major campground. The operators interviewed all noted the importance of a positive community image and environmental quality to the success of their operation, and credit increased local and regional population levels and regional tourism for their success.

BOWMANVILLE ZOO
- circa 1919 -

While most of the tourism attraction operators do not have any formal business links with the DN site, several credited the presence of the station's work force and OPG's sponsorship of events to the stability of their business activity over the past several years. Most tourist attraction operators interviewed during the EA did not feel that their customers link their operation with the presence of the DN site. Notable in this respect, however, were interview comments offered by the operator of the Darlington Provincial Park expressing a concern for potential stigma associated with the DN site, and a related effect on park visits since both the park and the station share the 'Darlington' name and because the station is visible from the park along the shoreline.

Darlington Provincial Park is one of the most popular tourist features in the LSA. It is located approximately 2.5 km west of the DN site along the shoreline of Lake Ontario south of Highway 401. Annual visitation to the park varies year to year. Since 1996 the park has experienced an increase of over 18,000 annual visitors resulting in an overall growth of approximately 18% or just over 1% per year. Visits peaked in 2004 at 133,600, however, levels have declined over the past several years and in 2008, the park registered 113,284 visitors. The average length of stay and average party size remained relatively constant until 2002 when both suddenly rose by 20-25%. When specifically asked about the influence of the DN site on their visiting habits, none of the interviewed park visitors indicated that the presence of the DN site had an effect on their use or enjoyment of the park.

4.11.3.5 Residential Property Values

The value of residential property determines the ability of a resident to purchase a home. Property values also determine in part, municipal tax revenues and therefore, a municipality's financial health. The focus on property values reflects the potential for those values to be affected by the project as a result of issues of health and safety, nuisance effects (e.g., noise, dust, odours, traffic), visual intrusion and as a result of changes in community character that would make it less attractive to prospective buyers.

Over the past decade, the GTA has experienced a substantial increase in residential property values with the average housing price increasing from approximately $211,000 in 1997 to $376,000 in 2007. Compared to the rest of the GTA, average residential property values within the RSA are lower. The only exception is in York Region, where average property values have surpassed $400,000. Despite being lower than the rest of the GTA, property values throughout the RSA have increased over the past five years.

Average residential property values in the LSA in 2007 ranged between $216,000 in Oshawa to $247,000 in Clarington. Although property values have increased dramatically over the past decade, the relative increase in values has been lower than increases in the other areas of the GTA.

Property values in City of Oshawa and Municipality of Clarington have consistently increased during the past 5 years, although they have levelled off slightly since 2005. Through the use of Municipal Property Assessment Corporation's (MPAC's) property value data and based on a representative sample set of over 560 properties, it is concluded that property values vary by community and dwelling type in relation to proximity to the DN site. The data demonstrate that property values do not substantially decline as a result of proximity to the DN site. Values increase only marginally with increasing distance from the DN site for single-detached dwelling units only. Other built features in close proximity to the DN site such as Highway 401, St. Marys Cement operations, waste management facilities and the sewage treatment plant contribute to the observed trends in property values. The absence of municipal water and waste water services and land use zoning in the rural areas surrounding the DN site are also seen as contributors to the observed trends in residential property values nearest the DN site. For all other unit types sampled, including semi-detached dwellings, townhouses/rowhouses and duplexes, property values decrease with increasing distance from the DN site.

4.11.3.6 Municipal Finance and Administration

To residents, the manner in which municipalities manage their affairs can directly affect their tax burden and consequently their spending power. For municipalities, the ability to gain funding and manage their financial and administrative affairs directly affects the availability and quality of services they can provide.

Regional Municipality of Durham

Durham Region provides the services relating to policing, transit, land use planning, roadways, public health and social services, water and wastewater, solid waste disposal and recycling, solid waste collection, (except in Whitby and Oshawa), as well as services to support economic development and tourism. In 2007 the Region had revenue fund receipts of approximately $860 million. Social and family services accounted for 26% of Durham's expenditures followed by environmental services at 23% (principally water, waste water and solid waste) and protection services (principally police) at 17%. The overall debt burden of the municipality at the end of 2007 stood at $200 million. Durham Region's 2007 annual debt-to-revenue ratio was 4.1%, well below the Ontario Ministry of Municipal Affairs and Housing cap of 25%, based on a 2007 debt payment of $25.4 million relative to own-source revenues of about $617 million.

Municipality of Clarington

The Municipality of Clarington administers services that pertain to local planning, streets and sidewalks, fire protection, parks and recreation, tax collection, building inspections and permits and public libraries.

In 2007, the Municipality of Clarington's revenue fund receipts amounted to approximately $53 million with the principal sources being property taxes (66%), user fees and charges (10%), licenses and permits (8%) and transfer from own funds (6%). The current value municipal assessment base is roughly $7.0 billion. Residential and farm properties account for 91% of this total and the remaining 9% is accounted for by commercial, industrial and pipeline properties. The distribution of expenditures in 2007 was such that recreation and cultural services was a dominant expenditure category at 30%, followed by transportation services at 27% and protection services (principally fire) at 20%.

The overall debt burden of the municipality at the end of 2007 stood at approximately $35.2 million and the annual debt-to-revenue ratio was approximately 5.7%. This is well below the Ontario Ministry of Municipal Affairs and Housing cap of 25%, based on a 2007 debt payment of about $3.0 million relative to own-source revenues of about $45.3 million. Using these financial indicators, it can be concluded that the Municipality of Clarington is fiscally sound.

OPG pays taxes to the Municipality of Clarington for the buildings, structures and lands located on the DN site as valued by the MPAC and in accordance with a formula set by the Province under the *Assessment Act.* OPG pays on average approximately $4 million per year in taxes to the Municipality; these taxes represented approximately 11% of the Municipality's total tax receipts in 2007.

As with many other municipalities, the Municipality of Clarington does have some fiscal challenges. At present, it is faced with pressure from some land developers to increase the rate of development beyond that which was anticipated under provisions of the current Development Charges By-law. A review of the situation commissioned by the Municipality concluded that the proposed developments, given the Municipality's current policies and practices, "will have a negative fiscal impact". The review indicated, that should these developments proceed, the fiscal pressure on the Municipality would increase as significant capital investments by it would be required over and above existing commitments; and further, that these circumstances could also jeopardize plans to advance non-residential development.

City of Oshawa

The City of Oshawa administers services that pertain to local planning, streets and sidewalks, fire protection, parks and recreation, waste collection, tax collection, building inspections and permits and public libraries. Total revenue fund receipts amounted to approximately $117 million in 2007. Taxes account for 79% of total revenues followed by user fees and charges and licenses and permits both at 6%. The current value municipal assessment base is roughly $11.4 billion. The distribution of expenditures in 2007 was such that recreation and cultural services was a dominant expenditure category at 38%, followed by protection services (principally fire) at 27%, and transportation services at 19%.

The overall debt burden of the city at the end of 2007 stood at approximately $101 million and the annual principal and interest payments on this amount total approximately $8.4 million. Building permit values issued in 2007 amounted $324,000 overall with $178,000 accounted for by residential properties and $146,000 accounted for by all other property classes.

4.11.4 Physical Assets

The Physical Assets subcomponent considers the basic infrastructure that allows a community to function effectively. The availability and quality of such physical assets serve to attract and retain people and investment in the community; and they influence personal health and satisfaction with community.

4.11.4.1 Housing

Housing considered in its broadest form encompasses individual dwellings or residences and their broader neighbourhoods and communities. A dwelling or place of residence provides the basic shelter and sanitary facilities necessary for physical health. Adequate housing provides privacy and security, each having a symbolic value which contributes to psychological health and a sense of personal safety and is often the most important determinant of an individual's use and enjoyment of property and their satisfaction with community. For the municipality, the quality of housing is a factor in establishing community character and cohesion, and in the financial health of the municipality.

Of the more than 600,000 private dwellings in the RSA, almost 70% of them are located in Durham Region and the City of Toronto. In 1996, the majority of occupied private dwellings in the RSA were single detached houses (61%), which was almost twice as many as the City of Toronto (31.7%). In general, there has also been an increasing trend to own dwellings rather than rent property across the RSA, Toronto and Ontario

There has been a 4.2% increase in total private dwellings from 2001 and 2006 in the LSA compared to the 11.7% increase across the RSA. The change in total private dwellings in Clarington was much higher than in Oshawa (17.5% versus 7.8%) indicating that the Municipality of Clarington has experienced more residential growth over the past five years than most municipalities across the RSA. Virtually, all of this growth in housing has been directed to the urban areas within Clarington.

Downtown Oshawa has been designated as an urban growth centre by the Province of Ontario. As such, housing growth in Oshawa has largely occurred within the downtown area and the existing urban boundaries, with greater levels of intensification in Oshawa south of Taunton Road.

There is substantially less diversity in the housing stock of Clarington with very small rental market (11%) in comparison to the City of Oshawa, other RSA municipalities, the City of Toronto and Ontario as a whole (e.g., in Ontario, the rental market represents about 30% of total occupied dwellings).

4.11.4.2 Municipal Infrastructure and Services

Municipal infrastructure and services are the basic physical assets or support structure of any municipality, community or region. To a resident they define the style of quality of life, people's use and enjoyment of property and satisfaction with community. For the municipality, such infrastructure represents major expenditures, thus affecting its financial base. The availability and quality of municipal infrastructure serve to attract new residents and businesses thereby influencing its future economic development and community character.

Electricity Supply

Many residents within the RSA live in small and rural areas where electricity is delivered by Hydro One Networks Inc. (Hydro One). A number of local electricity distribution companies operate in the more urban areas of the RSA serving over 460,000 residential, commercial and industrial customers. These include in Clarington by Veridian Connections and Hydro One; and in Oshawa by Oshawa PUC Networks.

Water Supply

Across the RSA, the responsibility for water supply to major urban centres, including collection, treatment and distribution, lies with the upper tier municipalities, including the City of Toronto, the Regions of

York and Durham, the City of Peterborough, the County of Peterborough and the County of Northumberland.

Within the LSA, water supply and treatment are the responsibility of the Region of Durham. In the Municipality of Clarington, water treatment and supply facilities are located in Bowmanville, Newcastle and Orono. Each of these facilities currently has and is projected to have excess capacity. Current operations at the DN site consume approximately 182,000 imperial gallons per day, which is a very a small fraction the total consumption in the Municipality. The Region of Durham is currently completing its water and wastewater master plan and has identified opportunities for, and constraints to, extending additional water services in the Region to meet projected demand. It is notable that within the Municipality of Clarington, some key constraints to servicing will need to be addressed by the Region and the Municipality to facilitate planned growth. For example, the area of the Municipality earmarked for potential growth is estimated at 3,650 ha; and the growth areas located outside of the currently-serviced areas will generate significant water demand.

Sanitary Sewage Collection and Treatment

Responsibility for the management of sanitary sewage, including collection, treatment and disposal lies with the upper tier municipalities, that is the City of Toronto, the Regions of York and Durham, the City of Peterborough, and the Counties of Peterborough and Northumberland.

In the LSA, sewage treatment facilities are provided in Bowmanville, Newcastle and Oshawa and there is a significant excess treatment capacity in all three municipalities. Currently, there is about 700,000 imperial gallons/day of excess capacity in the Municipality of Clarington and this is expected to more than double by 2020. Despite this capacity, within the Municipality of Clarington, there are some important constraints to servicing that will need to be addressed by the Region and the Municipality to facilitate planned growth. For example, current Greenbelt policies prohibit wastewater system inter-connections to Orono.

Sanitary sewage generated within the DN site is currently treated at an on-site facility.

Municipal Solid Waste Management

Overall management and disposal of municipal solid waste in Ontario is the responsibility of the upper tier municipalities. Waste collection services are typically carried out by each lower tier municipality.

Waste (i.e., non-radioactive) generation at the DN is managed through industrial/commercial contracts. All such waste materials are tested for radioactivity prior to release for recycling or disposal. The conventional wastes generated typically include such materials as soil, concrete, asphalt, bricks, electronics, glass, wood, metals and paper, fish and algae from the screenhouse and other organic wastes. OPG's aggressive recycling efforts have resulted in almost a 70% diversion rate.

Communications Infrastructure

Communications infrastructure refers to telephone, internet and TV. Most households and businesses within the RSA have access to all these forms of communication. Where cable TV is not available, satellite connectivity is available from a variety of commercial sources. Also some remote internet users have access to high-speed broadband connectivity through a variety of retailers.

4.11.4.3 Community Character

Community character is considered a physical asset of a community because it is largely determined by land uses. However, a community's character is also influenced by its other assets (e.g., population, employment, business activity) and its physical features (i.e., geographic/ environmental features). Community character influences the human, physical and social assets that contribute to community well-being. In addition, the character of a community is also a measure of its attractiveness as a place to live, visit or conduct business. The focus in terms of community character is in the LSA and the Municipality of Clarington in particular as the host community for the DN site.

The community of Bowmanville is the most populated of Clarington's urban areas and tends to attract most of the new residents and home builders. Bowmanville has been described as a community that epitomises small town life, having a wealth of family amenities, large rural areas and farms, although the rural area is diminishing with increasing urbanization. The community houses Clarington's municipal government buildings and its museums, marina and zoo are the major tourist attractions. A dedicated Business Improvement Area has maintained the heritage appeal of Bowmanville's main street, providing shopping in the many retail outlets along the main street.

The community of Courtice is the most recently developed urban centre in Clarington, which contains several unique heritage buildings. For the most part, Courtice is a mix of farmland, business and shopping districts, and residential neighbourhoods. Clarington Council wants a unique downtown and main street for Courtice.

The community of Newcastle is the third largest of Clarington's urban centres. The community encompasses the original harbour community known as Bond Head and has retained its heritage flavour and waterfront atmosphere which draw many visitors during the summer months. Residents of Newcastle tend to rely on the larger urban centre of Bowmanville to the west for services and shopping.

The community of Orono can best be characterised as small town with a rural, country way of life. Farming is the dominant activity and host community for the Durham Central Fairgrounds. Orono is also surrounded by several hamlets such as Hampton, Tyrone and Enniskillen.

The City of Oshawa is the most urbanised area within the LSA and one of the largest urban centres along the north shore of Lake Ontario. The City is known for its well developed manufacturing base and the presence of GM Canada's head office and several automotive assembly plants. The City is serviced by the main lines of the Canadian Pacific and Canadian National Railways, harbour facilities and the Oshawa Municipal Airport. Despite its reputation as a manufacturing town, Oshawa is realising the rebirth of its downtown core and has developed into a modern city with a balance of residential, commercial, industrial, social and recreational facilities. Northern portions of the City have extensive residential and commercial developments, farmlands and open space.

The shoreline of Lake Ontario is a defining feature of the communities in the LSA. There are a number of well-known natural areas, including Darlington Provincial Park, McLaughlin Bay Wildlife Reserve, Oshawa Second Marsh Area, and Port Darlington / Bowmanville Harbour Conservation Areas, along the shoreline of Oshawa and Clarington. Many of these natural areas provide passive recreational opportunities, such as hiking, swimming, canoeing / boating, fishing, and wildlife viewing.

Aside from the marshes and wildlife reserves in the LSA, the area within Oshawa closest to the shoreline is a combination of industrial and residential uses. In Clarington, DN site and the St. Marys Cement plant are dominant industrial features along the shoreline. The DN site also provides a considerable contribution to the passive recreational features through the provision of 7.5 km of the Waterfront Trail, along with active recreational facilities including soccer fields and baseball diamonds. Other built features along the shoreline, such as the Port Darlington Marina and the Port of Newcastle, contribute to the LSA's physical character and provide recreational opportunities for residents and visitors.

Based on the results of public attitude research, residents within the LSA reported the most positive influence on the image of their community relates to social and community issues (41%). Specifically, the friendliness of neighbours was identified as a positive influence in the LSA (15%), indicating the predominance of tight-knit communities across the entire study area. Community service issues were cited as the next most frequent positive influence on community image (17%). Overall, the DN site is not seen by many LSA respondents as an influence on community character or image. Approximately 2% identified the site as having a negative influence, and 1% identified it as having a positive influence on community character or image.

4.11.4.4 Other Physical Assets

Land uses and the transportation infrastructure are also considered to be Physical Assets. The directly relevant aspects of land use are the existing and evolving land use planning context, particularly the policies and plans applicable to the RSA and LSA; and the visual character of the LSA. Both of these elements are addressed in Section 4.8 of this EIS.

Similarly, the relevant aspects of traffic and transportation include the availability and service levels of transportation infrastructure in the LSA, and its relative operational safety. Both of these elements are addressed in Section 4.9.

4.11.5 Social Assets

Social assets considers the social and community activities in which people participate and the facilities or amenities that they draw upon in pursuit of their personal and community well-being objectives. These facilities, amenities and activities serve to create networks within the community and among communities, increase connectivity and cohesion and generate relationships and community pride.

4.11.5.1 Community and Recreational Facilities and Programs

Community and recreational activities encompass social, cultural or leisure activities including those that may be organised or unorganised, facility-based or resource use-based. They can include indoor or outdoor sports facilities, parks or open space; a variety of community meeting places such as community centres, club facilities and places of worship. As such, these facilities and programs are important assets and major determinants of overall community well-being.

Several hundred community and recreational facilities are available to the residents of the RSA, although the numbers and types vary considerably by municipality. Major recreational features in the RSA include five Provincial parks, numerous conservation areas, major urban parks and forests (e.g., Rouge Park, the Altona Forest, Ganaraska Forest) and recreational trails (e.g., Waterfront Trail, Oak Ridges Moraine Trail, TransCanada Trail), and tourist attractions including zoos, museums, galleries and casinos.

In the LSA, residents of the Municipality of Clarington and the City of Oshawa have access to a wide variety of public and privately operated community and recreational facilities and amenities that include a number of indoor and outdoor recreational facilities the most popular of which are the arenas, pools, soccer and baseball facilities, community centres, libraries, museums and conservation areas. These are concentrated in the communities of Courtice, Bowmanville and Newcastle. In general, the more urbanised areas (e.g., Oshawa and Bowmanville) have the largest concentrations of such features in the LSA.

The SSA also offers recreational opportunities. The Waterfront Trail traverses through the DN site for approximately 7.5 km providing a focus for human enjoyment of the immediate area both within and surrounding the DN site. OPG has developed a fitness loop consisting of four exercise stations with educational signage, along with several picnic areas, benches and a lookout over Lake Ontario from a covered gazebo. The Waterfront Trail and Fitness Loop run adjacent to Coots Pond which is a focal point for nature viewing on the DN site.

The DN site also offers several sports fields for use by local residents. The Lower Soccer Fields, located along the western fenceline of the site off Solina Road, contain five soccer fields, two of which have night lighting, picnic areas, a playground and two large parking lots. The Upper Soccer Fields are located within the fenced area of the DN site on top of the former soils disposal area (i.e., Northwest Landfill Area). These sports fields are maintained by the Municipality of Clarington through agreement with OPG. A baseball diamond, with night lighting is also located along the Lake Ontario shoreline near the DN Information Centre and is used primarily by OPG employees.

The spring season is the most popular for recreational use of the DN site, with this attributable to the emergence of birds, wildflowers and other wildlife. Nevertheless, during the summer when soccer season begins, there tends to be many more people on-site on week nights and weekends when sports team practices or games are scheduled. A survey of recreational users of the DN site estimated approximately 80 persons on the site during these times, the majority of these being children. During tournament weekends, the number of persons on the site can approach several hundred. Similarly, OPG organises several events at the DN site for community members. For example, during the late spring and summer seasons, OPG organises “Tuesdays on the Trail”. During this and other events the number of people using the site is estimated to be at least 50 persons. During periods outside of team sports events, the users survey indicated that less than 10 people are likely to be using the site during any given daylight hour.

OPG also operates the DN Information Centre which, since being renovated in 2007, has increasingly been used as a place for students, researchers and other visitors to gather information relating to electricity production and nuclear power from OPG staff, with a variety of presentations and educational exhibits.

4.11.5.2 Residents’ Use and Enjoyment of Private Property

The ability to use and enjoy one’s own property is a major determinant of personal satisfaction with community. The use and enjoyment of property provides opportunities for interaction among neighbours which helps to create networks within the community and increase connectivity and cohesion, and generate relationships and community pride.

Based on the results of public attitude research, 18% of LSA respondents identified social and community issues (e.g., crime, friendliness of neighbours) as having the greatest influence on their use and enjoyment of property. A generally similar percentage mentions community infrastructure and development issues with no particular issue being dominant. Other issues that influence their use and enjoyment of property were high taxes (5%) and the availability of nearby recreation features/activities (4%). The DN site does not appear to be a factor in the use and enjoyment of property within the LSA.

A DN site neighbour survey and roundtable meetings with DN site neighbours were also undertaken to gain insight into people’s use and enjoyment of property in the immediate site vicinity. Respondents indicated general satisfaction with living in the neighbourhood and as a rule, did not “often think about” living near the DN site. Popular uses of their outdoor property include gardening, relaxing outside, family gatherings and general outdoor recreational activities; and expressed dislike of traffic volumes and speeding on local roads, lack of municipal services (e.g., water, sewers, sidewalks), general growth and development in their neighbourhood.

4.11.5.3 Community Cohesion

A cohesive community maintains and generates relationships and community pride, and helps in defining a common vision among its residents which in turn serves to maintain and enhance other community assets and overall community well-being. Public attitude research conducted during the EA studies indicated that a sense of community, the friendliness of neighbours, a sense of caring in the community for others, along with cultural diversity and acceptance were attributes that supported community well-being.

The results of the public attitude research show that there is a strong sense of belonging and most people feel that there is a common vision among residents in the LSA. Roughly one-third of the respondents indicated that their community is “very cohesive”. Assessments of community cohesion are similar regardless of the perceived distance from the DN site, employment by OPG, and most demographic characteristics. There are, however, some noticeable differences between municipalities. For example, within the LSA, Clarington respondents indicated a higher rating of their community’s cohesiveness (38% “very”) than Oshawa respondents (26%).

Through its Corporate Citizenship Program, OPG provides financial support and hands-on involvement to registered charities and not-for-profit community, educational and environmental organisations. These involvements include a wide range of activities from rain barrel programs to community festivals to tree plantings. OPG is particularly proud of its contribution to the Waterfront Trail, its partnership with Durham College and UOIT, many partnerships with local schools and environmental groups, and support for children’s sports teams and recreational organisations. In addition to this corporate program, OPG employees contribute individually through volunteering, coaching of amateur sports, participating in local service groups and fundraising for local charities.

4.11.5.4 Other Social Assets

Physical and cultural heritage resources are also considered to be Social Assets. The directly-relevant aspects of heritage resources are addressed in Section 4.10 of this EIS. Three Euro-Canadian sites were identified in the SSA and are considered to have potential heritage value and interest such as to warrant mitigation. A monument, the Burk Pioneer Cemetery Monument and Plaque, is located on the east side of Solina Road in the vicinity of the soccer fields, and consolidates the headstones from the Burk family cemetery. Based on information currently available (air photos, survey plans and pre-1980s inspection reports), the cemetery is still located in the immediate vicinity of the monument, and there is no evidence to suggest that any of the burials have been re-located to another off-site cemetery.

There are no heritage properties within the SSA designated under Part IV of the *Ontario Heritage Act*. With respect to the cultural landscape, baseline studies confirmed that compared to the LSA and RSA, the SSA is of relatively low heritage interest in terms of the overall integrity of its built heritage features and cultural landscapes.

4.11.6 Natural Assets

The Natural Assets subcomponent considers the biophysical environment upon which community well-being depends. Effectively, the biophysical conditions within which people exist are a significant determinant in how they respond within their surroundings, particularly concerning both their physical well-being and their sense of well-being. The natural assets relevant for the socio-economic assessment are listed below. Each has been treated as a separate environmental component in this EA and as such, has been the subject of detailed studies for the purpose of establishing existing conditions relevant to each. As it was applicable for purposes of the socio-economic assessment, data regarding each biophysical subcomponent was derived from the detailed studies performed and described elsewhere in this EIS. The references to the other relevant sections of the EIS are noted.

- Atmospheric Environment (EIS Section 4.2);
- Surface Water Environment (EIS Section 4.3);
- Aquatic Environment (EIS Section 4.4);
- Terrestrial Environment (EIS Section 4.5);
- Geological and Hydrogeological Environment (EIS Section 4.6); and
- Radiation and Radioactivity (EIS Section 4.7).

Potential environmental effects in terms of Natural Assets are considered within the appropriate bio-physical environmental components noted above. Consequential effects that may occur in the socio-economic environment as a result of change and effect in the bio-physical components are represented within the other sub-components of the Socio-economic Environment.

4.11.7 Public Attitudes Towards Individual and Community Well-Being

The preceding sections have described the existing Socio-economic Environment within a framework of "community assets" that determine or influence any person's or community's well-being. Public attitude research was conducted to gauge the overall sense of well-being and satisfaction with community among residents of the RSA and LSA. The following three broad indicators were used, based on the reasonable postulation that greater community well-being is achieved when more people feel healthy living in their community:

- People's feelings of personal health;
- People's sense of personal safety; and
- People's overall satisfaction with community.

The research results indicate that most people across the RSA and LSA rated their feelings of personal health and sense of personal safety as either "excellent" or "good". One-quarter of the respondents rate their personal health as "excellent' while very few rate it as "poor". Similarly, 78% of LSA respondents describe their sense of personal safety as "excellent" or "good" and very few respondents state "poor". Less than 1% of the 1200 persons interviewed in the RSA and LSA mentioned the issue of nuclear power generation as an issue that negatively influenced their sense of personal security. Public attitude research results indicate that people's sense of community and the quality of policing are the dominant influences on people's sense of personal safety. Finally, the vast majority of people across the RSA and LSA are also either "somewhat" or "very satisfied" with living in their community.

Public attitude research results from the LSA indicate that a strong majority of respondents are either "very" or "somewhat" confident in the safety of the existing DN site and its ongoing operations and that its ongoing operations do not affect their day-to-day living. These findings are likely related to the fact that very few respondents think about the station "very often".

Respondents from within the LSA, identified a variety of features as being important to the maintenance and enhancement of their community well-being. They placed the highest importance on the availability of community and recreational facilities and programs (14%), followed by community safety and policing (13%), green space, parks and trails (7%), the quality of downtown (5%), transportation infrastructure and transit (5%), schools and school funding (3%) as most important attributes of community well-being. The majority of respondents across the LSA consider the negative consequences related to increasing urbanisation as the greatest threat to community well-being over the next decade. Concerns that dominate people's responses include economic (tax increases), social (increased crime), infrastructure (more traffic on already congested roads), and the community (from health care demands to loss of the small town atmosphere).

Overall, the RSA and LSA municipalities can be characterised as having a reasonably healthy balance of community assets that contribute to their well-being.

4.11.8 Valued Ecosystem Components

VECs were selected for each of the subcomponents of the Socio-economic Environment to represent the broader range of receptors that could be affected by the Project. Each VEC was deemed to be an element of importance within the geographic extent of Project works and susceptible to change and effect as a result of Project-related activities. The VECs and their rationale for selection are described in Table 4.11-1.

TABLE 4.11-1
VECs for the Socio-Economic Environment

Environmental Sub-component	VEC	Rationale
Human Assets	Local and regional population	Population levels, density and the demographic make-up of communities influence the need for, availability and quality of municipal infrastructure, community services and affect a municipality's financial status. They also influence a community's character, cohesion and the ability of people to use and enjoy their property, ultimately affecting a community's well-being.
	Education	The educational facilities and programs available to community residents provide the academic or vocational requirements for self-development and potential employment. They serve to attract new residents and business opportunities. Education enhances the skills and knowledge in a community that contributes to its economic development. Educational facilities often act as a focus of local community life.
	Health and safety services	The availability of fire services, policing and emergency preparedness and health care services plays a crucial role in maintaining people's feelings of health and their sense of safety on a daily basis and during crisis situations.
Financial Assets	Local and regional economic development	Communities require growing employment opportunities, business activity and household incomes along with a stable and skilled labour force to maintain and/or grow their economies and attain their economic development goals.
	Tourism	Tourism is an important component of the local and regional economy. Tourist features often act as a focus of local community life, are a source of community pride and can contribute to the character of a community
	Agriculture	Agriculture (i.e., farming and agri-businesses) is an important component of the local and regional economy. Agriculture also influences a community's character and cohesion, ultimately affecting a community's well-being.
	Residential property values	The value of residential property determines the ability of people purchase a home. A home is often an individual's largest single personal investment and is therefore key determinants of one's financial status. Property values determine in part municipal tax revenues and therefore, a municipality's financial health.
	Municipal revenues and financial status	The ability of a municipality to generate revenue and its overall financial status has a direct bearing on the level and quality of facilities and services available to its residents and businesses.
Physical Assets	Housing	Housing is a fundamental component of any community. It provides basic shelter, privacy, security which contributes to individual and community well-being.
	Community character and image	The distinctive and unique qualities of a community define its character. A community's character shapes its image among its own residents and to people outside the community.
	Municipal infrastructure and services	Municipal infrastructure is the basic physical asset or support structure of any community. It includes the electricity supply, water supply, sewage and solid waste systems. Its availability and quality affects community well-being.

TABLE 4.11-1 (Cont'd)
VECs for the Socio-Economic Environment

Environmental Sub-component	VEC	Rationale
Social Assets	Community and recreational facilities and services	The community and recreational facilities and services available to community residents provide a means for individuals to participate and contribute to community life. They influence people's feelings of personal health and satisfaction with community. They may serve to attract residents and tourists. The establishment, operation and maintenance of these features often constitute major municipal expenditures thereby influencing a community's financial health.
	Ability to use and enjoy property	People's ability to use and enjoy property is a fundamental determinant of their satisfaction with community.
	Community cohesion	The level and quality of social interaction, the extent of a common vision or unity among residents, commitment to and identification with community is a reflection of its vitality and stability.
Natural Assets	No VECs Selected	Potential environmental effects in terms of Natural Assets are considered within the appropriate bio-physical environmental components (see Section 4.11.5.5). Consequential effects that may occur in the socio-economic environment as a result of change and effect in the bio-physical components are represented within the sub-components and VECs indicated above.

The process of selecting VECs is described in Section 3.2.4 and as indicated, consideration of input from the public and other stakeholders was an important aspect of finalizing those to be used. The following specific suggestions concerning VECs in the Socio-Economic Environment were received as comments made on the draft EIS Guidelines. They were considered as noted in establishing the final VEC list:

- Add Light Levels as a VEC: Lighting is considered a feature of the Project and Good Industry Management Practice relating to lighting design is included as an in-design mitigation measure to address potential effects (see Section 2.6.9). Lighting is not included as a VEC, however, is evaluated for its potential to affect other VECs (e.g., terrestrial biota and visual aesthetics);

- Add Demand for Skilled Labour as a VEC: A shortage of skilled labour can quickly become a surplus as a result of economic slowdown, as recently demonstrated by the downturn that began in late 2008 and has continued into 2009. For this reason, aspects of skilled labour based on relative availability rather than simply shortages, are considered within the Human Assets environmental sub-component (see Section 4.11.2);

- Add Demand for Aggregate as VEC: Demand for building materials, including aggregate, may be considered as either or both a beneficial consequence of development (i.e., business opportunity) and a negative consequence (resource depletion). For this reason, resource use, including aggregate, is evaluated in the broader context of Sustainability (see Section 6.2);

- Add Potential for Stigma as VEC: Stigma has a negative connotation so it does not fall within the common understanding of a VEC, which is traditionally defined as a feature of ecological, social, cultural or economic value. For this reason, stigma is not addressed as a VEC, but more appropriately as a potential effect of the Project with the associated VEC being Community Character (see Section 4.11.4.3);

- Add Public Access To and Use Of the Waterfront and Users of Future Waterfront Parks as VECs: Potential effects on recreational facilities are considered within the Social Assets environmental sub-component with Community and Recreational Facilities and Services as the VEC (see Section 4.11.5.1). The Project is proposed to be developed completely within the DN site on lands that are under the care and control of OPG. Access to waterfront areas beyond the DN site will not be affected by the project since project works will not extend into these areas (waterfront areas within the DN site will necessarily be restricted to the public for security reasons); and

- Add Nuclear Emergency Infrastructure, Equipment, Plans and Procedures as a VEC: Emergency preparedness is included as a specific element of the Human Assets environmental component with Health and Safety Services being the VEC (see Section 4.11.2.4).

4.12 Aboriginal Interests

This Section provides an overview description of existing conditions in terms of Aboriginal Interests. The detailed baseline characterisation with respect to Aboriginal Interests is contained in the *Aboriginal Interests – Technical Support Document, New Nuclear - Darlington Environmental Assessment*. Additional elements of Aboriginal Interests specifically as they relate to archaeological resources (i.e., subsurface features and artefacts) are discussed in Section 4.10 of this EIS, which addresses physical and cultural heritage resources of both Aboriginal and Euro-Canadian origin. Aboriginal Interests are considered in the context of the following environmental sub-components:

- Aboriginal Communities - as represented by Aboriginal communities, councils and organisations that may have an interest in the Project;
- Traditional Land and Resource Use – the historical presence and use of lands by Aboriginal Peoples; and
- Ceremonial Sites and Significant Features – the continued presence of sites or features of ceremonial significance to Aboriginal Peoples.

The Aboriginal Interests baseline characterization program was conducted within the context of a larger Aboriginal Engagement Program. That overarching program is described in Section 10.6 of this EIS.

4.12.1 Study Areas

The generic study areas described in Section 3.1.3 were considered for specific application for Aboriginal Interests with modifications made as appropriate. The study areas as applied are described below.

<u>Regional Study Area</u>

The RSA considered for Aboriginal Interests is an on-land area extending approximately 50 km from the DN site. Aboriginal groups beyond the RSA were included in OPG's Aboriginal Engagement Program. It was recognized that there may be communities, councils and organizations beyond the 50-km distance that may have an interest in this Project (e.g. the possibility of a historical treaty, traditional land use and/or current connection to the lands and resources).

Local Study Area

The LSA was adopted without change from the generic LSA. It includes the DN site and immediate vicinity, generally corresponding to the 10-km emergency planning zone centred on the DN site as identified by Emergency Management Ontario.

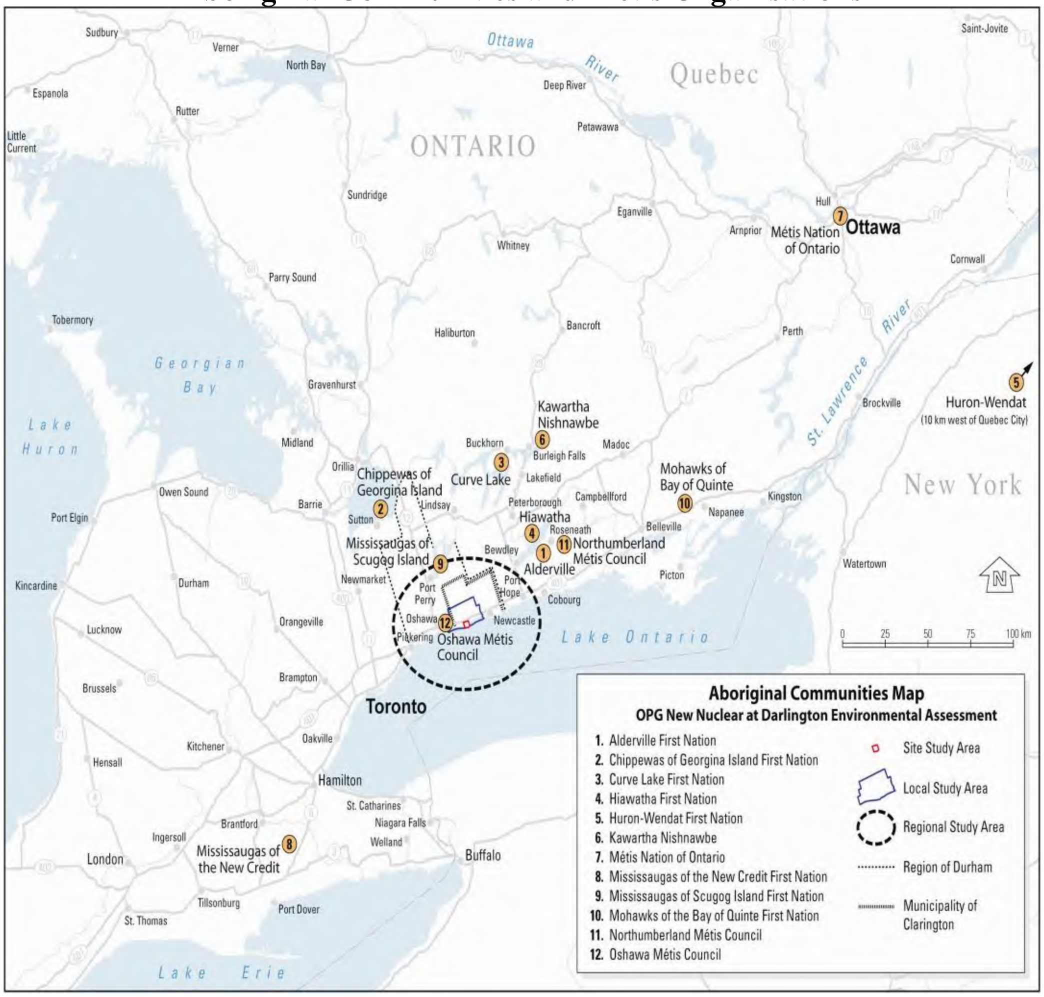
Site Study Area

The SSA was adopted without change from the generic SSA. It covers the entire DN site, including all facilities, buildings and infrastructure of DNGS and lands and portions of Lake Ontario under the care and control of OPG.

4.12.2 Aboriginal Communities, Councils and Organizations

Thirteen Aboriginal communities, councils and organizations were identified as having a potential interest in the Project due to their historical land use and treaty relationship with the lands in, and surrounding, the RSA. These groups are located at distances of approximately 50 to 732 km from the DN site, none of which are in the LSA (Figure 4.12-1).

FIGURE 4.12-1
Aboriginal Communities and Métis Organisations



Research conducted and discussions held to date have not identified any Métis communities in the RSA, or Métis Persons who are currently harvesting within this area. OPG staff is currently engaging with the Métis Nation of Ontario (MNO) and the Northumberland and Oshawa Métis Councils to discuss this and ensure that the current understanding is correct. Métis organisations and community councils were included in the EA engagement program on the basis of their potential interest in traditional Métis harvesting territories and to ensure that a Métis perspective was included in this assessment.

The Aboriginal communities, councils and organizations included in OPG's Aboriginal Engagement Program are profiled in the following pages.

4.12.2.1 Aboriginal Communities

In the late 1800s, several First Nations located in central Ontario and along the north shore of Lake Ontario claimed fishing, hunting and trapping rights over certain lands where title had not been extinguished by surrender or otherwise. A Federal Commission was chaired which led to the acquisition of three separate parcels of land in central and southern Ontario in 1923. The purchases were known collectively as the "Williams Treaties" under which First Nation signatories surrendered their right, title and interest in those lands. Several First Nations were included in OPG's Aboriginal Engagement Program because of their actual or possible future interest in the NND Project as signatories of the 1923 Williams Treaties. They, as well as other Aboriginal communities included in the engagement program are described below.

<u>Alderville First Nation</u>

Alderville First Nation is based out of the south side of Rice Lake near Roseneath, Ontario. The First Nation has a registered population of 1,008 (as of June 2008) and an elected Council comprised of a Chief and four Councillors. Band elections are held every two years. The Alderville First Nation is a member of the Ogemawahj Tribal Council, and is associated with the Union of Ontario Indians – Southeast Region and the United Anishinabek Council.

<u>Chippewas of Georgina Island First Nation</u>

The Chippewas of Georgina Island First Nation is a signatory of the 1923 Williams Treaties. Chippewas of Georgina Island First Nation is based out of three islands in the south eastern portion of Lake Simcoe within the Regional Municipality of York. The First Nation has a registered population of 695 (as of June 2008) and an elected Council comprised of a Chief and four Councillors. The Chippewas of Georgina Island First Nation is a member of the Ogemawahj Tribal Council and the Union of Ontario Indians – Southeast Region.

Curve Lake First Nation

Curve Lake First Nation is a signatory to the 1923 Williams Treaties. Curve Lake First Nation is based out of two islands and a peninsula in Buckhorn Lake, approximately 15 km north of Peterborough, Ontario. The First Nation has a registered population of 1,794 (as of June 2008) and an elected Council comprised of a Chief and eight Councillors. Curve Lake First Nation is not affiliated with any tribal council but is associated with the Union of Ontario Indians – Southeast Region.

Hiawatha First Nation

The Hiawatha First Nation is based out of the north side of Rice Lake in Peterborough County, Ontario. The First Nation has a registered population of 439 (as of June 2008) and an elected Council comprised of a Chief and four Councillors. The Hiawatha First Nation is not affiliated with any tribal council but is a member of the Association of Iroquois and Allied Indians.

Huron-Wendat First Nation

The Huron-Wendat First Nation (alternatively referred to as the "Nationne Huronne-Wendat") is based out of Wendake, Quebec on the eastern bank of the St. Charles River. The First Nation has a registered population of 3,012 (as of June 2008) and an elected Council comprised of a Chief and 19 Councillors.

Kawartha Nishnawbe

The Kawartha Nishnawbe is a self-identifying Anishnaabe community in the Kawartha area. The Kawartha Nishnawbe community has a historic interest in the lands covered by the 1923 Williams Treaty. This community is historically associated with the Mississauga Nation which was an ancestor of the Kawartha Nishnawbe and involved in the signing of the Williams Treaties in 1923. The Kawartha Nishnawbe community currently occupies land in Burleigh Falls, Ontario.

Mississaugas of New Credit First Nation

The Mississaugas of New Credit First Nation is a descendent of the Mississauga Nation and a signatory to the 1923 Williams Treaties. The Mississaugas of New Credit First Nation is based out of Tuscarora Township, south of Brantford, Ontario. The First Nation has a registered population of 1,795 (as of June 2008) and an elected Council comprised of a Chief and seven

Councillors. The Mississaugas of New Credit First Nation is a member of the Association of Iroquois and Allied Indians.

Mississaugas of Scugog Island First Nation

The Mississaugas of Scugog Island First Nation is a descendent of the Mississauga Nation and is a signatory of the 1923 Williams Treaties. The community is situated on Reserve Numbers 060196 and 060197 with an approximate land base of 321 ha and 140 ha, respectively. The total registered population as of June 2008 was 193. The First Nation has an elected council comprised of a Chief and two councillors. The Mississaugas of Scugog Island First Nation is a member of the Ogemawahj Tribal Council and the United Anishinabek Council and is associated with the Union of Ontario Indians – Southeast Region.

Mohawks of the Bay of Quinte First Nation

The Mohawks of the Bay of Quinte First Nation is based out of Deseronto of Tyendinaga Mohawk Territory, east of Belleville, Ontario and is historically associated with lands surrendered to the Crown by the Mississauga Nation. The First Nation has a registered population of 7,760 (as of June 2008) and an elected Council comprised of a Chief and four Councillors. The Mohawks of the Bay of Quinte First Nation is a member of the Association of Iroquois and Allied Indians.

Please see *Aboriginal Interests – Technical Support Document, New Nuclear - Darlington Environmental Assessment* for a description of Aboriginal communities OPG contacted as recommended by CNSC staff following a February 2009 meeting.

4.12.2.2 Métis Organisations and Councils

The following section provides a summary of the Métis organizations and councils included in OPG's Aboriginal Engagement Program. There are Métis persons who reside in the EA Study Areas however, research conducted and discussions shared to date have not identified Métis communities in the RSA, or Métis persons who are currently harvesting within this area. OPG staff is currently engaging with the MNO and regional councils to ensure that this understanding is correct.

Métis Nation of Ontario

The MNO was formed in 1994 and is a representative body at the provincial and national level. The MNO seeks to "bring positive change to the socio-economic circumstances of communities and in creating self-sustainability for its people". At present, the MNO registry includes 380 Métis communities.

In July 2004, the Ontario Ministry of Natural Resources and the MNO entered into an interim harvesting agreement permitting Métis persons to harvest food within their traditional territories conditional upon on the basis of having a harvesting card. Over the past several years, the MNO has developed its environment portfolio which focuses on environmental issues of interest to the Métis Nation. It has also worked with its citizens in developing policy positions, programs and procedures in efforts to preserve and protect the environment for subsequent generations.

Ontario Métis Aboriginal Association

The Ontario Métis Aboriginal Association (OMAA) was originally formed under the Ontario Métis Non-Status Indian Association and managed political, social and economic service initiatives for Aboriginal Peoples in Ontario. The OMAA was based in Sault Ste. Marie and formally ended its operations in January 2007.

Northumberland Métis Council

The Northumberland Métis Council is one of several Métis regional councils of which the MNO membership is comprised. The Council is based in Roseneath, Ontario and represents MNO members living in Northumberland County.

Oshawa Métis Council

The Oshawa Métis Council is one of several Métis regional councils of which MNO membership is comprised. The Council represents MNO members living within the RSA.

4.12.3 Traditional Land and Resource Use

Neither the research conducted for the EA studies nor engagement with Aboriginal communities, councils and organizations suggested any current use of lands, water or resources in the LSA or SSA by Aboriginal Peoples including with respect to commercial fishing and traditional activities (e.g. relating to food, camping, travel, social or cultural purposes).

To date, research and engagement has not suggested that the Project would affect Aboriginal rights, Aboriginal title or treaty rights within the RSA. In addition, research and engagement has not identified any potential impacts to traditional land use activities or physical and cultural heritage resources. It is understood that signatories to the 1923 Williams Treaties surrendered claims to Aboriginal and treaty rights in the RSA.

4.12.4 Ceremonial Sites and Significant Features

Following an assessment of Physical and Cultural Heritage Resources throughout the SSA and based on input received in response to OPG's Aboriginal Engagement Program, ceremonial sites or features of cultural or spiritual importance were not identified. Some archaeological artefacts pertaining to Aboriginal Peoples and heritage were identified as isolated find spots in the SSA (see Section 4.10). These findings confirmed that hunting and gathering activities occurred in this area however, they were not of the nature to suggest historical Aboriginal settlement or representing archaeological findings of significance or concern.

4.12.5 Valued Ecosystem Components

VECs were selected to represent each of the sub-components of Aboriginal Interests. Each VEC was deemed to be an element of importance within the geographic extent of the Project works and susceptible to change and effect as a result of Project-related activities. The VECs and their rationale for selection are described in Table 4.12-1.

TABLE 4.12-1
VECs for Aboriginal Interests

Sub-component	VEC	Rationale for Selection
Aboriginal Communities	Community Characteristics	Large projects can result in adverse direct and indirect effects on Aboriginal communities and residents.
Traditional Land and Resource Use	Hunting and Fishing for Subsistence.	Hunting, fishing and trapping are traditional land uses which may be a source of food, medicines and economic benefit.
	Fishing, Trapping and Traditional Harvesting and Collecting for Sustenance, Recreational and Economic Purposes.	
Ceremonial Sites and Significant Features	Locations and features of cultural or spiritual importance.	Sites or features considered to be culturally and/or spiritually significant are valued by Aboriginal Peoples and could have historic or religious importance.

Efforts to solicit feedback on VECs did not result in feedback by Aboriginal communities, councils or organizations identified for this assessment.

4.13 Health - Human

This Section provides an overview description of existing conditions in terms of how they may be factors in effects on Human Health.

The existing factors that may affect Human Health are presented in the *Human Health – Technical Support Document, New Nuclear – Darlington Environmental Assessment*. The Human Health TSD differs from the TSDs relating to other environmental components in that it presents a compilation of the various elements within the other environmental components that are factors in affecting Human Health. This section describes the existing conditions relative to those elements. The potential consequences of changes in those elements as a result of the NND Project and associated effects on Human Health are addressed in Section 5.13.

The consideration of Human Health is framed in a context of the following environmental sub-components:

- Health and Well-being of the General Public: the general public may be exposed to health risk as a result of the Project. Exposures and risk may be in the form of either or both radiological and non-radiological parameters; and

- Health and Safety of Workers: workers may be exposed to health risk as a result of performing duties related to the Project. Exposures and/or risk may be in the form of either or both radiological and non-radiological parameters.

The Valued Ecosystem Components (VECs) considered relevant to Human Health are:

i) Members of the Public; and
ii) Workers on the DN site.

The study areas described in Section 3.1.3 were considered for specific application in the consideration of Human Health issues with modifications made as appropriate. The study areas as applied include the full extent of the study areas defined for the other environmental components, since considerations in terms of Human Health must bound the effects in those other sub-components that may be factors in Human Health. The study areas are described below.

Regional Study Area

The RSA applied for Human Health includes selected upper and lower tier municipalities within the City of Toronto, Regional Municipality of York, Regional Municipality of Durham, the City of Peterborough, Peterborough County, Northumberland County and the City of Kawartha Lakes.

Local Study Area

The LSA applied for Human Health includes all of the DN site's immediate neighbours and the major urbanized communities within Clarington (i.e., Courtice, Bowmanville, Newcastle and Orono) and much of the urbanized area within the City of Oshawa.

Site Study Area

The SSA for Human Health includes the property under the control of OPG on which the proposed new nuclear station and ancillary facilities will be located.

4.13.1 Context for Human Health Considerations

The World Health Organization (WHO) defines health as "*a state of complete **physical, mental** and **social** well-being and not merely the absence of disease or infirmity*" (WHO 1946). Human Health is mentioned numerous times throughout the EIS Guidelines and in different contexts, such as community health, public health, worker health, and Aboriginal health, all of which require the application of the WHO definition of health. This definition is defined in the EIS Guidelines as "*physical health and well-being and associated emotional, social, cultural and economic aspects*" (Section 10.2.6).

OPG assessed potential Human Health effects within the broad context of the WHO's definition of Human Health. In keeping with the requirements of the EIS Guidelines as well as precedence in several Canadian jurisdictions, community health profiles of the LSA communities are presented in the context of the health framework utilized for this study. Accordingly, these health profiles represent the current (or baseline) conditions affecting the physical, mental and social well-being of the general public within the LSA and of workers on the DN site. The framework and influencing factors are shown graphically on Figure 4.13-1. The figure illustrates the relationships between several of the environmental components discussed in the EIS and the three aspects of human health: physical well-being, social well-being, and mental well-being.

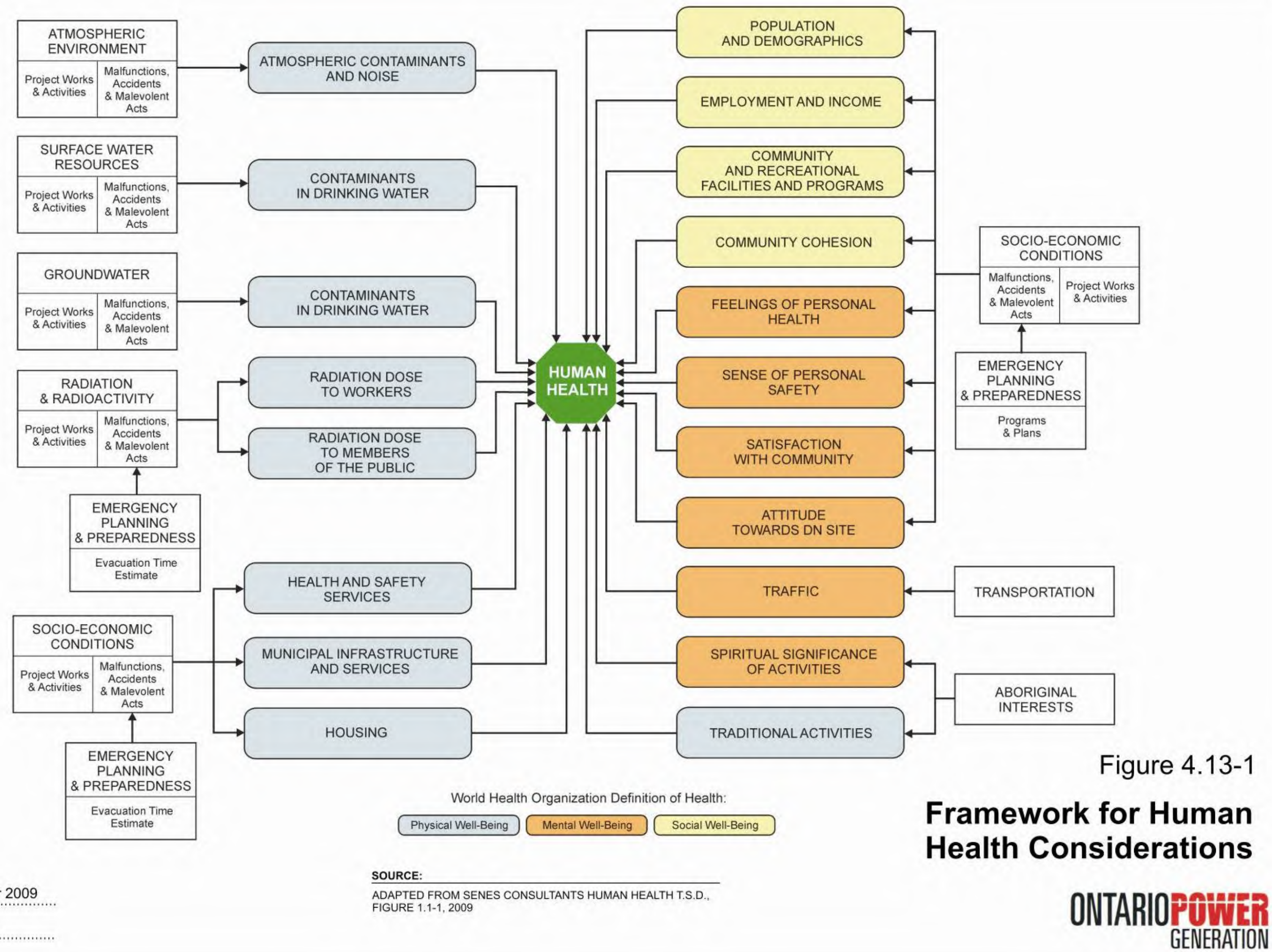


Figure 4.13-1

Framework for Human Health Considerations

ONTARIO POWER GENERATION

As previously mentioned, the VECs selected to represent the Human Health environmental sub-components are members of the public and workers on the DN site. The environmental components that were deemed to have a potential effect on the VECs for human health are provided in the unshaded boxes on the figure. Effects from the environment on human health are the result of changes to certain aspects of an environmental component. The shaded boxes provide the identified aspects of each environmental component where a change has the potential to result in an effect on human health. These aspects are shaded to identify whether the resultant effect would be related to physical well-being, mental well-being or social well-being.

The nearest Aboriginal community is at least 50 km from the proposed site. Furthermore, engagement with Aboriginal communities, councils and organizations established that there is no use of lands, water or resources in the LSA and SSA for traditional purposes, nor were any ceremonial sites or features of cultural or spiritual significance identified in the SSA. (see Section 4.12). For these reasons, although Aboriginal interests are typically a unique consideration in the framework for human health consideration (Figure 4.13-1), the potential influence of the NND on the health of Aboriginal Peoples is considered in the same context as for other members (i.e., non-Aboriginal) of the public for this assessment.

4.13.2 Community Health Profiles

In describing the community health profiles, relevant information concerning the influencing factors has been derived from the descriptions of existing conditions for the applicable environmental components presented elsewhere in this chapter of the EIS and their respective TSDs, as they apply to the LSA communities. The indicators chosen from those environmental components to characterize current conditions with respect to physical, social and mental well-being reflect the likely interactions between the NND Project and the health of the general public and workers at the DN site. Human Health considerations related to malfunctions, accidents and malevolent acts are addressed in Chapter 7.

The characterization of the factors influencing **physical well-being** is focused on the physical aspects of the applicable environmental components such as air quality, noise, surface water and groundwater quality, and background radioactivity and radiation doses. Socio-economic conditions related to physical well-being, such as health and safety services, municipal infrastructure and services, and housing are also considered. Characterization of the factors influencing **mental and social well-being** is focused primarily on the data developed for establishing existing conditions in the Socio-economic Environment (Section 4.11). Indicators for social well-being include population and demographics, employment and income, community and recreational facilities and programs, and community cohesion. Indicators for mental well-being of the public include feelings of personal health and safety, satisfaction with community, attitude towards the DN site, and traffic.

4.13.3 Physical Well-Being

Physical well-being refers to the state of a person functioning without disease, illness or injury. It is influenced by biophysical environmental factors such as the presence of chemical or radiological contaminants in air or water, noise, dust, safety concerns, injuries, or accidents.

4.13.3.1 Radiation and Radioactivity

Dose to Workers at the DN Site

Radiation doses to NEWs, non-NEWs on the DN site and visitors to the DN site are measured or calculated by OPG. During the Operation and Maintenance, and the Decommissioning phases, the access and movement of non-NEWs on the NND site will be controlled by OPG. Radiation doses to these workers (non-NEWs) as a result of licensed activities on site will be controlled by OPG, thus ensuring that they do not exceed 1 mSv/y, the regulatory limit for individuals who are not NEWs.

Through careful monitoring (and as noted in Section 4.7.8) radiation doses to NEWs at the existing DN site are known to be well below the regulatory limits of 50 mSv per one-year dosimetry period, and 100 mSv per five year dosimetry period (i.e. an annual average of 20 mSv/y) (Canada Gazette 2000). In addition, OPG implements comprehensive ALARA programs, including detailed radiation work planning and monitoring.

Radiation Doses to Members of the Public

Radiation doses to the general public are also calculated by OPG. The total dose to the most exposed critical group in 2007 as a result of operation of DNGS was 1.4 µSv (Section 4.7). This dose is well below the regulatory limit for members of the public of 1000 µSv/y (1 mSv/y).

Regardless of where people live or work, they are exposed to baseline sources of radiation from naturally occurring radiation and radioactivity, and anthropogenic sources. As discussed in the *Human Health TSD* (Section 4.4), the magnitudes of background sources vary greatly both in time and space and are mainly attributable to ionizing radiation from cosmic rays (e.g., people at high latitudes and high altitudes receive higher doses than people at low latitudes and altitudes); naturally occurring radionuclides in air, water, and food; and gamma radiation from radioactive material in the soil, rocks and building materials used in homes. Doses from natural background radiation are variable, with the dose from natural background sources in Canada at about 1,840 μSv/y. In addition, people are exposed to anthropogenic sources of background radiation from medical and dental procedures, and from commercial/industrial processes. The theoretical incremental dose of 1.4 μSv from the operation of DNGS is a small fraction of the annual dose from natural background radiation in Canada (1,840 μSv/y) and, as such, would not likely affect the physical well-being of members of the public. Since this dose is primarily due to air emissions and as the result of increased atmospheric dispersion with increasing distance, the resultant air concentrations of radioactive emissions from the DN site will also decrease with increasing distances. Therefore, the doses and risks to people who live further away from the site will also decrease with increasing distance.

4.13.3.2 Atmospheric Environment

Air Quality

Air quality in the vicinity of the DN site does not differ substantially from the general air quality in southern Ontario within the Quebec-Windsor corridor and the Greater Toronto Area (GTA). The substances that combine to produce smog or acid rain (CO, NO_x, VOCs, SO_2 and SPM) dominate air quality effects. Concentrations of these conventional parameters in air in the LSA are largely attributable to traffic from Highway 401 and local roads, with activities at the DN site and on-site traffic contributing only a small fraction to background air concentrations. Under existing conditions, air concentrations are well below applicable ambient air quality criteria (AAQC) which are set to be protective of Human Health.

DNGS emits various contaminants from on-going maintenance and operational activities (laboratories, etc.). These have been assessed as part of the recent application for a Certificate of Approval (Air) submitted for the DN site (OPG 2008a). This document indicates that the current site activities comply with all applicable criteria. With the exception of combustion sources (testing of back-up power supply) and chemicals associated with steam generator water treatment, the emissions of most of the chemicals at the DN site are considered negligible (as defined by the MOE).

Noise

The noise environment in the vicinity of the DN site is typical of an urban setting, as defined for noise assessment, dominated by traffic on Highway 401 and Baseline Road, as well as noise from the nearby St. Marys Cement plant and DNGS. Based on sound level measurements conducted in 2008, the noise environment at the nearest residential areas to the DN site would be classified as a Class 1 Area which is defined as: "*…an area with an acoustical environment typical of a major population centre, where the background sound level is dominated by the urban hum*".

Human Health Risk Assessment

To enhance the discussion of physical well-being with respect to conventional (i.e., non-radiological) factors, a human health risk assessment of several airborne emissions was undertaken. The risk assessment methodology was used, in part, to characterize the human health risks associated with the existing environment in order to provide a point of comparison for the determination of the potential incremental health effects from the NND Project. Details of the risk assessment are in the *Human Health TSD*.

The risk assessment followed procedures outlined by regulatory agencies such as Health Canada, the Ontario Ministry of the Environment and the United States Environmental Protection Agency. Constituents of Potential Concern (COPC) were selected based on the air quality evaluation. The risk assessment determined that current conditions (i.e., NND Baseline) do not, in and of themselves, present an increased health risk relative to typical conditions elsewhere.

4.13.3.3 Surface Water

The EA baseline characterization studies conducted in 2007/2008 included a comprehensive water quality monitoring program in Lake Ontario. Although occasional individual sample exceedances were noted as a result of natural variation or anthropogenic influences, most of the lake water quality in the RSA and LSA meets the MOE Provincial Water Quality Objectives (PWQO) and Canadian Council of Ministers for the Environment (CCME) Canadian Environmental Quality Guidelines (CEQG) limits. Within the LSA, water for potable purposes is drawn from the lake at the Bowmanville Water Treatment Plant and the Oshawa Water Treatment Plant. Treated water leaving these plants is monitored for a wide range of chemical and biological components prior to entering the drinking water system. Water available for public consumption is required to conform to the Ontario Drinking Water Quality Standards set out by the MOE.

In terms of recreational use of the lake water (e.g., swimming), the primary concern is bacteria. Under existing conditions there is a very low probability that the water temperature increase due to the DNGS thermal plume affects *E. coli* growth in Lake Ontario. Therefore, no adverse effects on recreational users of Lake Ontario likely occur as a result of the operation of DNGS.

4.13.3.4 Groundwater Quality

Groundwater within the DN site is not used for potable purposes, given its industrial setting. Accordingly, groundwater quality was evaluated in terms of Ontario non-potable standards and found to meet these criteria. Nitrate, likely from fertilizers, was detected in shallow water table wells in the area of agricultural fields; and tritium was detected at levels much less than Ontario Drinking Water Quality Standards in most of the shallow wells across the site, but was generally absent from deeper wells.

In general, the groundwater on site eventually discharges to Lake Ontario where it contributes only a small fraction of the total discharge to Lake Ontario, and does not have a measurable effect on overall lake water quality.

4.13.3.5 Socio-Economic Environment

For the purposes of a discussion of conditions in the Socio-economic Environment that are factors in physical well-being, the following elements of the human and physical aspects of communities were considered.

Health and Safety Facilities and Services (Fire Protection, Policing, Health Care)

Fire services are mandated by the provincial government to offer a specific level of service to the communities in which they serve. In the larger urban centres, fire departments are staffed by full and part-time fire fighters. In smaller communities, the crew of a fire department typically comprises a mix of full-time and volunteer fire fighters. The larger fire services also provide specialized hazardous materials-related (HAZMAT) response; this is particularly true of the City of Toronto Fire Services which operates a Chemical, Biological, Radiological and Nuclear (CBRN) Team in conjunction with the Toronto Police Service. The latter is made up of officers with specialized training to deal with unique situations including nuclear-related emergencies.

The DN site operates a fully staffed, trained and equipped Emergency Response Team (ERT). The Municipality of Clarington's Emergency and Fire Services can be called upon in the event of a medical emergency at the DNGS and would respond to incidents involving DN site-related vehicles off the DN site.

The Durham Regional Police Service (DRPS) provides law enforcement throughout Durham Region, which is the largest portion of the RSA. The City of Toronto, York Region, City of Kawartha Lakes, and the City of Peterborough / Peterborough County all have their own police services. Law enforcement is provided to the smaller communities in Northumberland and Peterborough Counties by the Ontario Provincial Police. Through an agreement with OPG, the DRPS provides a dedicated Nuclear Site Response Team at the DN site. However, OPG is currently transitioning to its own Nuclear Response Force composed of professionally-trained officers.

Residents within the RSA are served by two Local Health Integration Networks (LHINs). Overall, hundreds of facilities (addiction centres, community care access centres, community health centres, community support services, hospitals, long term care facilities and mental health facilities) serve the population of the RSA.

Lakeridge Health operates hospitals in the RSA including in Bowmanville, Port Perry, Oshawa and Whitby. Other hospital corporations also operate facilities in the RSA including in Ajax and eastern Toronto, in Uxbridge and Markham/Stouffville and in Peterborough and Cobourg. Memorial Hospital in Bowmanville maintains a close relationship with the DN site. This facility is equipped with radiation decontamination equipment, regularly stocked by OPG which also provides radiation protection support when required.

Durham Region also convenes the Durham Nuclear Health Committee that serves as a forum for the discussion of health issues relating to the Darlington and Pickering nuclear sites. The Region, local area municipalities, OPG and citizens are represented on this committee. In addition, the Regional Health Department answers questions from the general public on health and safety matters and operates a health information hot-line.

Municipal Infrastructure and Services

The responsibility for water supply and wastewater management in major urban centres across the RSA lies with the upper tier municipalities, including the City of Toronto, the Regions of York and Durham, the City of Peterborough, the County of Peterborough and the County of Northumberland.

Within the LSA, water supply and treatment are the responsibility of the Region of Durham. In the Municipality of Clarington, water treatment and supply facilities are located in Bowmanville, Newcastle and Orono. Each of these facilities currently has and is projected to have excess capacity.

The management of sewage (wastewater) in the LSA is the responsibility of Durham Region. Within Clarington, there are two wastewater treatment facilities (Bowmanville and Newcastle), that, like water supply, have large excess capacity. Currently, there are about 700,000 imperial gallons/day (0.7 MIGD) of excess capacity between these facilities.

Overall management and disposal of municipal solid waste in Ontario is the responsibility of the upper tier municipalities. Waste collection services are typically carried out by each lower tier municipality.

Housing

The housing stock in a community, including its quality and diversity, is a fundamental physical element that directly affects well-being of residents of that community. Housing encompasses individual dwellings or residences and their broader neighbourhoods and communities. A dwelling or place of residence provides the basic shelter and sanitary facilities necessary for physical health. Adequate housing provides privacy and security, each having a symbolic value which contributes to psychological health and a sense of personal safety.

Of the more than 600,000 private dwellings in the RSA, almost 70% of them are located in Durham Region and the City of Toronto. In 1996, the majority of occupied private dwellings in the RSA were single detached houses (61%), which was almost twice as many as the City of Toronto (31.7%). In general, there has also been an increasing trend to own dwellings rather than rent property across the RSA, Toronto and Ontario.

In the LSA, there was a 4.2% increase in total private dwellings from 2001 to 2006. The Municipality of Clarington has experienced more residential growth over the past five years than most municipalities across the RSA, and virtually all of this growth in housing has been in the urban areas. With only a very small rental stock, there is substantially less diversity in the housing mix in Clarington compared to other municipalities in Ontario (e.g., rental stock in Ontario represents about 30% of total occupied dwellings).

Downtown Oshawa has been designated as an urban growth centre by the Province of Ontario. As such, housing growth in Oshawa has largely occurred within the downtown area and the existing urban boundaries, with greater levels of intensification in Oshawa south of Taunton Road.

4.13.4 Mental Well-Being

Health Canada (HC 2009) states that mental health is a crucial dimension of overall health and an essential resource for living. It influences how we feel, perceive, think, communicate and understand. Psychosocial factors are the basic social, psychological and cultural aspects of human interactions and their effect on mental well-being. These factors primarily relate to the emotional well-being of residents as individuals and form a complex network that can affect the health of individuals and communities.

4.13.4.1 Mental Well Being of Public

The mental well-being aspects of human health are those that may affect the psychological behaviour of members of the public. Queries which addressed various aspects of mental well-being of residents and communities were included in the program of public attitude research that was conducted in the course of establishing existing conditions in the Socio-economic Environment. Through that program, the following broad indicators were identified as relevant parameters in the context of the NND Project for gauging people's overall sense of mental well-being.

Feelings of Personal Health

Seventy-eight percent of the public attitude research respondents described their feeling of personal health as either "excellent" or "good". One-quarter of the respondents rated their personal health as "excellent' while very few (4%) rated it as "poor". In general, younger and more affluent respondents tended to provide higher ratings of their personal health than others.

Based on the analysis of socio-economic conditions and public attitude surveys, Clarington and Oshawa provide excellent access to health care and recreational facilities and the appropriate level of municipal infrastructure and facilities to ensure that people living in these communities experience a high level of personal health.

Sense of Personal Safety

Consistent with their feelings of personal health, 78% of the respondents also described their sense of personal safety as "excellent" or "good". One-third of respondents indicated the highest rating of "excellent" and very few respondents indicated a "poor". Clarington respondents indicated a higher rating (44% "excellent") than those from Oshawa (25%). This pattern suggests that the level of urbanization is likely to be a factor in people's sense of safety.

In general, social and community issues were identified by LSA respondents (43%) as having the most positive influence in their sense of personal safety; and "crime" was identified most frequently (47%) as having the most negative influence.

Satisfaction with Community

Almost all respondents are either "very" or "somewhat satisfied" with living in their community. Indeed, 53% of the LSA respondents are "very satisfied".

Attitude Towards the DN Site

Based on the results of the public attitude research, proximity to the DN site is not a major factor in people's attitudes towards key aspects their community and is not a significant influence on their feelings of personal health; sense of personal safety; their use and enjoyment of property; or their consideration of influences on community character or cohesion. Further, a strong majority of LSA respondents (85%) are confident in the safety of the existing DN site and its ongoing operations. One-third or more are "very confident". Overall, very few respondents think about the station "very often" (10%). In contrast, more respondents "never" think about the station on a daily basis (33%). In total 22% of the LSA respondents thought about living near the nuclear site "often" or "very often". Within the LSA, Clarington respondents are more likely to think about living near the DN site than Oshawa respondents (16% Clarington vs. 7% Oshawa).

4.13.4.2 Mental Well-Being of Workers

OPG has extensive health and safety programs, policies and procedures in place. These programs help to ensure workers' sense of well-being and security. These may include programs encouraging healthy living (such as information for employees working shifts that may involve rotating night and day work), access to onsite health and safety representatives, and ergonomics assessments.

4.13.5 Social Well Being

The social well-being aspects of health are those that may affect the social behaviour of workers or members of the public in the context of their community. Accordingly, a number of specific elements of the human and physical makeup of communities that are factors in social well-being are described in the following pages. The general social well-being of members of the public (community cohesion) as evaluated through the public attitude research was also considered.

4.13.5.1 Social Well-Being of Public

Population and Demographics

The population of a community is an important determinant of its well-being. Population levels, including density and demographic characteristics, influence several community aspects either directly or indirectly. For example, population levels determine the availability and quality of other human components in a community (i.e., education, health and safety, social services) and the availability and quality of a community's physical and social components (i.e., housing, municipal infrastructure, transportation infrastructure and community and recreational facilities). The demographic make-up of a community, particularly age and gender, are also important characteristics which influence community well-being as they indicate the presence of vulnerable groups in a community (e.g., seniors, ethnic groups) and influence its cohesiveness. Age and gender characteristics also influence participation levels in community and recreational activities.

The population in the LSA is approximately 190,600 persons. This number grew by approximately 6.8% between 1996 and 2006 with most of the growth occurring in the urban areas of the Municipality of Clarington. Roughly equal proportions of this total are men and women, and the majority of the population is between 25 and 64 years of age. Between 1996 and 2006, the LSA population aging trends were similar to those in the RSA and Ontario. The proportion of children and younger adults in the total population decreased, while the share of adults aged 45 and over significantly increased.

Respondents to the public attitude research indicated that the low population levels and densities that contribute to a small town feel were considered by many (9% in LSA and 11% in RSA) as an important attribute that supports community well-being, while increased development, expansions of subdivision and overpopulation were seen as threats to community well-being by 18% of LSA and 23% of RSA respondents.

Employment and Income

Employment provides income that people use to achieve their personal financial objectives which define their style and quality of life, and influences the human, physical and social aspects of a community, municipality or region.

The employment rate in the LSA has risen from 60.3% in 1996 to 62.4% in 2006, with a corresponding decrease in unemployment from 9.8% to 7.0%. This trend is observed throughout both the Municipality of Clarington and the City of Oshawa. It is notable that this pattern is the opposite of that experienced across the RSA, where employment rates decreased between 1996 and 2006 and unemployment rates have been increasing.

Income derived from employment, business activity or from tourism is considered a financial asset and a major determinant of overall community well-being. It provides the financial means for residents to undertake a variety of educational, social and community activities that strengthen a community's human and social aspects.

In 2006, the average household income in the RSA was approximately $78,200, similar to the Ontario average yet lower than in the City of Toronto. In 2006, York and Durham Regions had the highest average household income among RSA municipalities. Over the past 10 years, average household incomes have increased across each RSA municipality, the City of Toronto and Ontario as a whole. In 2006, the average household income in the LSA was approximately $74,000, slightly lower than the RSA and Ontario averages.

Community and Recreational Facilities and Programs

The social and community activities in which people participate and the facilities or amenities that they draw upon in pursuit of their personal and community well-being objectives, are important factors in overall social well-being.

Residents of Clarington and Oshawa have access to a wide variety of public and privately operated community and recreational facilities and amenities that contribute to their quality of life. In general, the more urbanized areas (e.g., Oshawa and Bowmanville) have the largest concentrations of such features in the LSA.

The DN site offers several sports fields for use by local residents. These facilities are maintained by the Municipality of Clarington through agreement with OPG. The Waterfront Trail also includes a length of approximately 7.5 km within the DN site.

Interviews with people using the recreational features at the DN site in 2008 indicated that the vast majority of users are from the LSA municipalities (70%). Despite the fact that these recreational facilities are located in close proximity to a nuclear facility, very few people surveyed commented on the nuclear presence at the site.

Community Cohesion

Community cohesion refers to people's sense of belonging to a self-defined community and is considered a social asset. Public attitude research indicated that a sense of community, the friendliness of neighbours, a sense of caring in the community for others, along with cultural diversity and acceptance were attributes that supported community well-being.

The results of the public attitude research show that there is a strong sense of belonging and most people feel that there is a common vision among residents in the LSA (76% "very" and "somewhat"). Roughly one-third of the respondents state that their community is "very cohesive". Assessments of community cohesion are similar regardless of the perceived distance from the DN site, employment by OPG, and most demographic characteristics. There are, however, some noticeable differences between municipalities. For example, within the LSA, Clarington respondents provide a higher rating (38% "very") than do Oshawa respondents (26%).

4.13.5.2 Social Well-Being of Workers

As noted above, employment is a major determinant of the financial health of a community and influences its human, physical and social aspects; and consequently its overall sense of community well-being. OPG is a major employer of workers from the RSA and LSA. Therefore, OPG, and the DN site in particular, contribute to overall community and personal well-being.

Currently, the majority (63.4%) of the approximately 2,800 workers employed at the DN site reside within Durham Region; of those, approximately 23% live in Oshawa, and about 53% live in Clarington. Therefore, it is likely that these workers would experience the same sense of social well-being and satisfaction with their communities as do other residents currently living in the LSA.

4.13.6 Valued Ecosystem Components

VECs were selected for each of the sub-components of the Human Health component to represent the broader range of receptors that could be affected by the Project. Each VEC was deemed to be an element of importance within the geographic extent of the Project works and susceptible to change and effect as a result of Project-related activities. The VECs and their rationale for selection are described in Table 4.13-1.

TABLE 4.13-1
VECs for Health-Human

Sub-component	VEC	Rationale for Selection
Health and Well-Being of the General Public	Members of the Public	The general public may be exposed to health risk as a result of the Project. Exposures and/or risk may be in the form of either or both radiological and non-radiological parameters.
Health and Safety of Workers	Workers on the NND Project	Workers may be exposed to health risk as a result of performing their duties relative to the Project. Exposures and/or risk may be in the form of either or both radiological and non-radiological parameters.

4.14 Health - Non-Human Biota

This Section provides an overview description of existing conditions in terms of how they may be factors in effects on non-human biota.

The detailed description of existing factors as they may affect populations of non human biota is presented in the *Ecological Risk Assessment and Assessment of Effects on Non-human Biota Technical Support Document, New Nuclear – Darlington Environmental Assessment*. That Technical Support Document (TSD) differs from those TSDs relating to other environmental components in that it includes a compilation of the various factors within each of the other environmental components, namely, Atmospheric, Surface Water, Geological and Hydrogeological, and Radiation and Radioactivity (in air and water), which are factors that are considered in the evaluation of effects on non-human biota.

The focus of the *Ecological Risk Assessment and Assessment of Effects on Non-human Biota TSD* is the potential effects of chemicals and ionizing radiation on non-human biota. The potential consequences of changes in those factors as a result of the NND Project and associated effects on non-human biota are addressed in Section 5.14. Sections 4.4 and 4.5 provide overviews of the existing conditions in non-human Aquatic and Terrestrial biota communities, respectively. Sections 5.4 and 5.5 describe the potential physical effects of the Project on non-human biota in the Aquatic and Terrestrial Environments, respectively.

The generic study areas described in Section 3.1.3 were considered for specific application in the evaluation of non-human biota issues with modifications made as appropriate. In general, the study areas defined for the Ecological Risk Assessment and Assessment of Effects on Non-human Biota are consistent with the study areas defined by the environmental components noted previously. The study areas are described below:

<u>Regional Study Area</u>

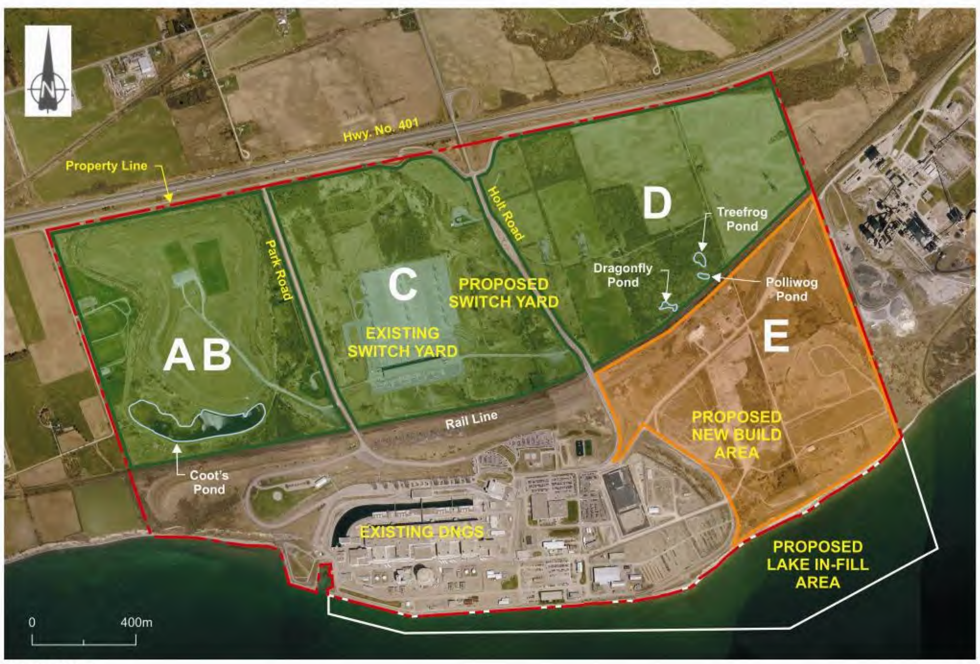
The RSA corresponds to the RSA applied for the Surface Water Environment. Surface water data from the RSA were used to characterize background surface water concentrations.

<u>Local Study Area</u>

The LSA corresponds to the LSA applied for the Surface Water Environment. Surface water data from the LSA were also used to characterize background surface water concentrations.

Site Study Area

The SSA was generally adopted without change from the generic SSA, however to capture the surface water environment, the Lake Ontario portion of the SSA has been extended approximately 2 km from the DN site boundaries in both directions along the shoreline and into the Lake from the shoreline to account for the potential range of locations for the cooling water intake and outfall diffuser(s). For the purposes of this assessment, the DN site was subdivided into assessment areas (referred to as polygons, see Figure 4.14-1). The polygons were largely defined by existing physical delineators (e.g., roads, railway) since these features also serve as meaningful physical boundaries for conditions with respect to non-human biota.



LEGEND:
A-E Indicates ERA polygons

Figure 4.14-1
Location of Polygons Used in the ERA

Date: September 2009
Project: 34500

SOURCE:
ADAPTED FROM SENES CONSULTANTS, ECOLOGICAL RISK ASSESSMENT, FIGURE 3.2-2, 2009

ONTARIO POWER GENERATION

4.14.1 Approach to the Ecological Risk Assessment and Assessment of Effects on Non-Human Biota

A standard approach to assessing the effects on non-human biota was used to determine the existing conditions with respect to populations of non-human biota. In order to establish existing environmental conditions for non-human biota, the data collected as part of the existing conditions studies for the following environmental components were analysed:

- Atmospheric;
- Surface Water (Quality);
- Radiation and Radioactivity;
- Geological and Hydrogeological;
- Aquatic; and,
- Terrestrial.

Specifically, monitoring or sampling data for air, surface water, groundwater, sediment, soil and biota were analysed and used to determine current radioactive and non-radioactive (or chemical) constituent levels. The constituent levels measured in the environment as part of the assessment of existing effects for the above-mentioned environmental components, were used to determine whether there were potential ecological effects on non-human biota in the existing environment.

The methodology used in this assessment follows standard procedures for ecological risk assessment considering pathways analysis and constituent uptake by biota.

The first step was the selection of ecological receptors from the list of VECs identified in the Terrestrial and Aquatic Environments (Table 4.14-1). All VECs present at the site (i.e. the entire bio-inventory) were not evaluated, rather, a smaller subset of ecological receptors that are representative of the various feeding habits and characteristics of the VECs present at the site were selected. Thus, the selected ecological receptors are representative of various levels of ecological hierarchy that may be located in the most exposed areas. These ecological receptors were selected as representative species to allow for an analysis of the constituent uptake through the food chain, also referred to as a "conceptual model". Conceptual models representing the different biota which may be affected were developed for different portions of the DN site (the conceptual model for the Northwest Landfill Area (Polygon AB) is provided in Figure 4.14-2). It should be recognized that the Project will alter the site, in terms of habitat, such that some of the areas evaluated will not exist into the future as they do currently.

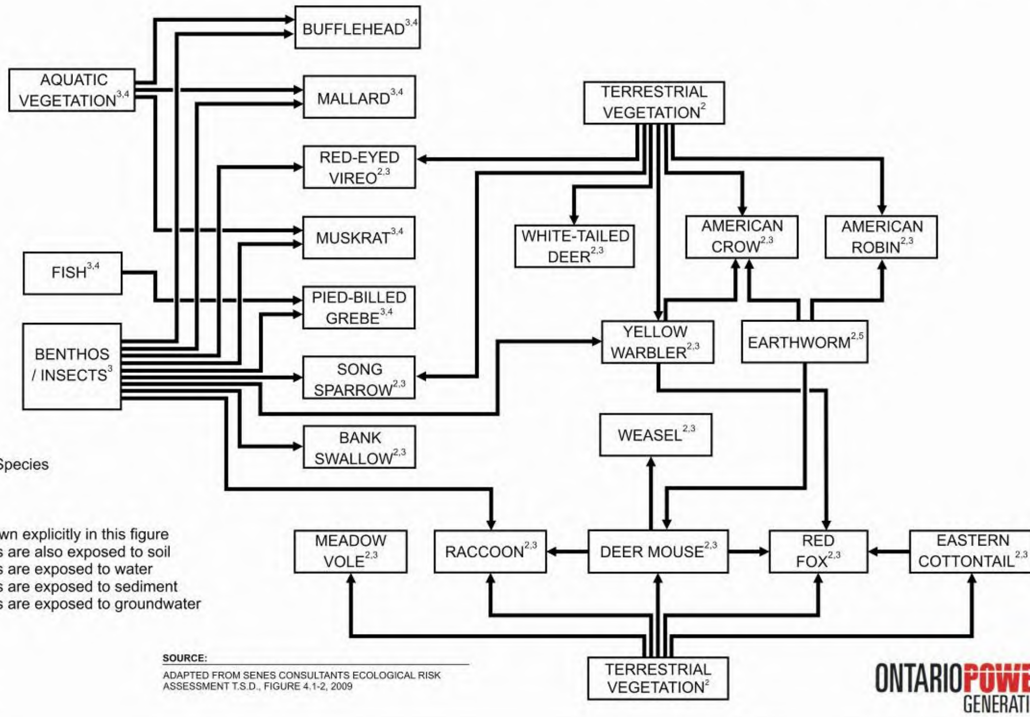
TABLE 4.14-1
Ecological Receptors Selected for the Assessment of Effects on Non-Human Biota

Environmental Subcomponent	Ecological Receptor
Terrestrial Environment	
Terrestrial Vegetation	Terrestrial Vegetation (various)[a]
Insects and Terrestrial Invertebrates	Earthworm[b]
Birds and Waterfowl	American Crow
	American Robin
	Bank Swallow
	Bufflehead
	Mallard
	Pied-billed Grebe
	Red-eyed Vireo
	Song Sparrow
	Yellow Warbler
Mammals	Deer Mouse
	Eastern Cottontail
	Meadow Vole
	Muskrat
	Raccoon
	Red Fox
	Short-tailed Weasel
	White-tailed Deer
Amphibians and Reptiles	Midland Painted Turtle, Northern Leopard Frog, Green Frog and American Toad[c]
Aquatic Environment	
Benthic Invertebrates	Benthic Invertebrates (various)[d]
Aquatic Vegetation	Aquatic Plants (various)[e]
Fish	Forage Fish [f]
	Predator Fish [f]

Note:
a - Terrestrial Vegetation is a surrogate for individual species (i.e. Sugar Maple and Canada Bluejoint and Canary Reed Grasses) since there is a lack of information to evaluate on an individual basis.
b - Earthworm is a surrogate for all insects and invertebrates (i.e. dragonfly, butterfly) since there is a lack of information to evaluate on an individual basis.
c - TRVs are not available for individual species (i.e. Green Frog and Northern Leopard Frog, Midland Painted Turtle) and so these ecological receptors are analyzed as 'Amphibians and Reptiles'.
d - TRVs and transfer factors are not available for individual species and so benthic invertebrates are analyzed as 'Benthic Invertebrates'.
e - TRVs are not available for individual species (i.e. Pond weed, Giant Bur-reed/Greenfruit Bur-reed) and so these ecological receptors are analyzed as 'Aquatic Plants'.
f - Individual fish species are evaluated as 'forage fish' or 'predator fish' as TRVs are not available for individual species.

Figure 4.14-2

A Schematic Presentation of a Food Web for Terrestrial Receptors



LEGEND:

Indicating Species

NOTE:

1. Air intake is not shown explicitly in this figure
2. Ecological receptors are also exposed to soil
3. Ecological receptors are exposed to water
4. Ecological receptors are exposed to sediment
5. Ecological receptors are exposed to groundwater

Date: September 2009

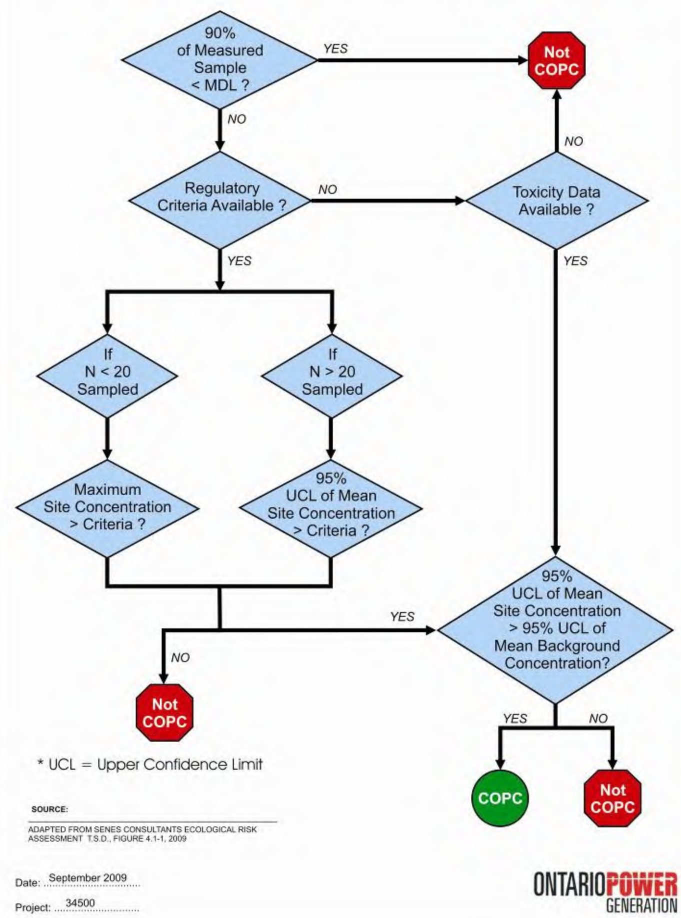
Project: 34500

SOURCE:
ADAPTED FROM SENES CONSULTANTS ECOLOGICAL RISK ASSESSMENT T.S.D., FIGURE 4.1-2, 2009

ONTARIO POWER GENERATION

The second step was the selection of constituents of potential concern (COPCs) for non-radiological constituents. This involved a screening of the constituent concentrations measured in the environment as illustrated in Figure 4.14-3. The measured data were compared against available criteria within each media (e.g., water quality, sediment quality, soil quality). Where no criteria were available, the concentrations were compared against available toxicity data and the variability in natural background levels. This step resulted in a list of COPCs that is relevant to the DN site as it exists today. Not all of the constituents identified in the COPC screening will be relevant to the Project as it is defined (*Scope of the Project for EA Purposes TSD*). The environmental measurements collected generally include a suite of metals analysis, many of which will not be associated with the Project.

Figure 4.14-3
Selection Procedure for Constituents of Potential Concern



The COPC screening for the existing conditions identified:

- Lake Ontario surface water – hydrazine;
- Coot's Pond surface water – boron, cobalt, iron, hydrazine, manganese and strontium;
- Lake Ontario sediment – cadmium, copper, lead and selenium;
- Coot's Pond sediment – copper; and
- DN site soil – strontium and zirconium.

Seven radionuclides were selected to be used in the risk assessment due to their prevalence in the environment, historical concerns regarding environmental concentrations and relevance to nuclear power generation. These radionuclides were: C-14, H-3, Sr-90, Co-60, Cs-134, Cs-137 and I-131.

The third step was the development of the Screening Index values (SIs) for the indicator species for each COPC. In simple terms, the SI is the ratio represented by an estimated exposure level (or an environmental concentration) divided by a concentration deemed unlikely to have a substantial ecological effect. For conventional constituents, these are termed toxicity reference values (TRVs). For radiological constituents, reference dose rates below which there is unlikely to be an effect on populations of non-human biota were used in calculating the SI. The TRVs and reference dose rates form the criteria for the assessment. Where an estimated exposure level is less than the corresponding TRV or reference dose rate, effects on biota are not expected.

There are various levels of assessment considered in the evaluation of effects on non-human biota. A Tier 1 assessment is generally a qualitative assessment, whereas a Tier 2 assessment is a semi-quantitative evaluation using site-specific data and existing site information and, in general, includes very conservative assumptions. A Tier 3 assessment is the least conservative of the assessments and uses data from field surveys, less conservative assumptions and more detailed modelling. Additional details for the different types of assessment are provided in the *Ecological Risk Assessment and Assessment of Effects on Non-Human Biota TSD.* A large quantity of surface water, and sediment and soil quality data were collected as part of the baseline programs, therefore, a Tier 2 assessment was conducted for the existing conditions (baseline) at the DN site. In addition, population information and data (empirical or observational) are also considered in the effects assessment. Field surveys were used in the assessment of existing conditions to provide a line of evidence to the SI values that were above 1 from the Tier 2 assessment.

4.14.2 Regional and Local Study Areas

The effects of the Project on non-human biota are not expected to extend beyond the SSA, therefore the assessment focuses on the SSA.

4.14.3 Site Study Area

The polygons established for the assessment of effects on non-human biota are illustrated on Figure 4.14-1. Each polygon represents somewhat different terrestrial and aquatic habitats; therefore, different conceptual models were developed for each polygon as well as for Lake Ontario. This is described in more detail in the *Ecological Risk Assessment and Assessment of Effects on Non-Human Biota TSD.*

Non-Radiological Conditions

Evaluation of Potential Risks in the Aquatic Environment

Hydrazine was measured in Lake Ontario and Coot's Ponds at levels below the method detection limit (MDL). However, the lowest MDL for hydrazine which is possible to achieve with conventional analytical techniques was above a published no effects level for fish eggs. The assessment determined that the hydrazine concentrations are below TRVs for the aquatic species selected for this assessment. Thus, hydrazine concentrations measured at the MDL in Lake Ontario and Coot's Pond are not a cause for concern in the existing environment.

Aquatic exposure to, boron, cobalt, iron, manganese and strontium was assessed for Coot's Pond. The assessment determined that there were no effects to aquatic receptors in the existing environment. A weight-of evidence approach was used in addition to the SI values to confirm that no adverse effects in aquatic biota were occurring in Coot's Pond.

Evaluation of Potential Risks in the Sediment Environment

The assessment determined that there were no adverse effects in the sediment environment for exposures in Lake Ontario to cadmium, lead or selenium; and no effects of copper in the sediment environment in Coot's Pond.

Evaluation of Potential Risks for Amphibians and Reptiles

Potential risks to amphibians and reptiles in Coot's Pond and Treefrog Pond were evaluated. It was considered that Lake Ontario does not have the appropriate habitat to support reptiles and amphibians, therefore, these species were not considered in Lake Ontario. The calculations were based on a comparison of measured water concentrations to TRVs for amphibians and reptiles. A weight-of-evidence approach was used in addition to the SI values to confirm that no adverse effects in amphibian and reptile populations were occurring in Coot's Pond.

Evaluation of Potential Risks for Terrestrial Ecological Receptors

No adverse effects for terrestrial ecological receptors associated with strontium and zirconium exposure were identified. Similarly, no potential risks were identified for waterfowl exposed to cadmium, copper, lead or strontium in Lake Ontario, or copper in Coot's Pond.

Radiological Conditions

The Tier 2 radiological analysis was based on maximum radiological concentrations measured in air, soil, sediment, water and biota across the site. Most of the samples had reported concentrations that were less than detection limits.

The baseline levels of radionuclides in the environment result in only very small doses to non-human biota. These are well below the reference dose rates for the Tier 2 analysis and all SI values were less than 1, indicating there is no ecological risk from radionuclides to biota at the DN site.

5. ASSESSMENT AND MITIGATION OF LIKELY ENVIRONMENTAL EFFECTS

5.1 Introduction

This Chapter identifies Project-environment interactions and likely environmental effects of the Project. It deals with those effects that are deemed plausible and measurable, with the measure of plausibility being a change in the environment that is detectable and quantifiable compared with existing (baseline) conditions using appropriate and reasonable measurement criteria and parameters. A predicted change that is trivial, negligible or indistinguishable from background conditions is not considered to be measurable.

The evaluation includes assessments of effects associated with the works and activities of the Project during the Site Preparation and Construction, and the Operation and Maintenance phases. Potential mitigation measures and likely residual effects after mitigation, if any, are also identified.

5.1.1 Application of Assessment Methodology

The purpose of this Chapter is to determine if any residual adverse effects attributable to the Project will remain following mitigation. As described in greater detail in Chapter 3, this determination involves the following:

- Identification of potential Project-environment interactions;
- Evaluation of those interactions likely to measurably change the environment;
- Assessment of likely effects (of changes in the environment) on applicable VECs;
- Consideration of mitigation measures for adverse environmental effects; and
- Identification of residual adverse effects that may remain following mitigation.

Any identified residual adverse effects are considered further in terms of their significance in Chapter 9.

5.1.2 Project Environmental Interactions

The methodology applied for assessment of effects of the Project is described in Section 3.2.5. As noted, the assessment process began with a screening step to consider if and where there may be a plausible interaction between the Project and the environment. Any such potential interactions are illustrated graphically in Table 5.1-1 in a framework of the individual Project works and activities and the sub-components of the environmental components applied for the EA. These potential interactions became the focus for the assessment.

5.1.3 VECs and Pathways

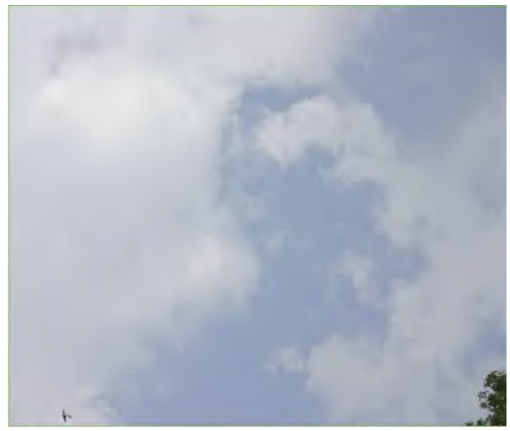
The measurement of effects is based on effects on the VECs (and as applicable, VEC Indicators) that were identified for each environmental component in Chapter 4. No VECs were identified for some environmental components, notably; Atmospheric Environment, Surface Water Environment, Geological and Hydrogeological Environment, and the Radiation and Radioactivity Environment. These environmental components are pathways by which effects are transferred to other environmental components. As such, the changes in these components are considered as they are relevant to others that represent the receiving environment.

TABLE 5.1-1
Potential Project-Environment Interactions

Project Works & Activities New Nuclear-Darlington	Atmospheric Environment		Surface Water Environment				Aquatic Environment		Terrestrial Environment						Geological and Hydrogeological Environment			Radiation & Radioactivity Environment					Land Use		Traffic & Transportation		Physical and Cultural Heritage Resources		Socio-Economic Environment				Aboriginal Interests			Health		
	Air Quality	Noise	Lake Circulation	Lake Water Temperature	Site Drainage and Water Quality	Shoreline Processes	Aquatic Biota	Aquatic Habitat	Vegetation Communities and Species	Bird Communities and Species	Insects	Amphibians and Reptiles	Mammal Communities and Species	Landscape Connectivity	Soil Quality	Groundwater Quality	Groundwater Flow	Radioactivity inAtmospheric Environment	Radioactivity in Surface Water and Aquatic Environment	Radioactivity in Terrestrial Environment	Radioavtivity in Geological and Hydrogeological Environment	Radioactivity in Humans	Land Use	Landscape and Visual Setting	Transportation System Operations (Road, Rail, Marine)	Transportation System Safety (Road, Rail, Marine)	Archaeology	Built Heritage/Cultural Landscapes	Human Assets	Financial Assests	Physical Assets	Social Assests	Aboriginal Communities	Traditional Land and Resource Use	Ceremonial Sites and Significant Features	Health and Well-Being of the General Public	Health and Safety of Workers	Non-Human Biota
SITE PREPARATION AND CONSTRUCTION PHASE																																						
Mobilization and Preparatory Works	◆	◆					◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆						◆	◆	◆	◆	◆	◆	◆	◆	◆	◆				◆	◆	◆
Excavation and Grading	◆	◆				◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆				◆		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆	◆
Marine and Shoreline Works	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆					◆	◆	◆						◆	◆	◆	◆	◆		◆	◆	◆	◆		◆		◆	◆	◆
Development of Administration and Physical Support Facilities	◆	◆								◆														◆					◆	◆		◆					◆	◆
Construction of Power Block	◆	◆								◆			◆							◆		◆	◆	◆					◆	◆		◆				◆	◆	◆
Construction of Intake and Discharge Structures	◆	◆	◆	◆	◆	◆	◆	◆		◆																			◆	◆		◆				◆	◆	◆
Construction of Ancillary Facilities	◆	◆								◆													◆	◆					◆	◆		◆				◆	◆	◆
Construction of Radioactive Waste Storage Facilities	◆	◆																					◆	◆					◆	◆		◆				◆	◆	◆
Management of Stormwater				◆	◆	◆	◆	◆				◆			◆	◆	◆				◆						◆	◆									◆	◆
Supply of Construction Equipment, Material and Operating Plant Components	◆	◆							◆	◆		◆	◆	◆									◆	◆	◆	◆			◆	◆	◆	◆					◆	◆
Management of Construction Waste, Hazardous Materials, Fuels and Lubricants	◆	◆																											◆	◆	◆	◆					◆	◆
Workforce, Payroll and Purchasing	◆	◆							◆	◆	◆	◆	◆										◆		◆	◆			◆	◆	◆	◆	◆					◆
OPERATION AND MAINTENANCE PHASE																																						
Operation of Reactor Core																						◆															◆	
Operation of Primary Heat Transport System																						◆															◆	
Operation of Active Ventilation and Radioactive Liquid Waste Management Systems					◆											◆		◆	◆	◆	◆	◆		◆					◆		◆					◆	◆	◆
Operation of Safety and Related Systems																																						
Operation of Fuel and Fuel Handling Systems																						◆														◆	◆	
Operation of Secondary Heat Transport System and Turbine Generators	◆	◆																											◆	◆		◆						◆
Operation of Condenser and Condenser Circulating Water, Service Water and Cooling Systems	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆							◆		◆			◆	◆	◆					◆	◆	◆	◆				◆	◆	◆
Operation of Electrical Power Systems	◆	◆							◆	◆	◆	◆	◆																◆	◆		◆						◆
Operation of Site Services and Utilities	◆	◆							◆	◆				◆	◆	◆	◆							◆					◆	◆		◆						◆
Management of Operational Low and Intermediate-Level Waste	◆	◆																◆		◆		◆							◆	◆		◆				◆	◆	◆
Transportation of Operational Low and Intermediate-Level Waste to a Licensed Off-site Facility	◆	◆																		◆		◆							◆	◆		◆				◆	◆	◆
Dry Storage of Used Fuel	◆	◆																		◆		◆							◆	◆	◆	◆				◆	◆	◆
Management of Conventional Waste	◆	◆			◆																								◆	◆		◆					◆	◆
Replacement/Maintenance of Major Components and Systems	◆	◆	◆	◆	◆	◆												◆	◆	◆	◆	◆		◆					◆	◆		◆				◆	◆	◆
Physical Presence of the Station										◆				◆			◆						◆	◆					◆	◆	◆	◆				◆		
Administration, Purchasing and Payroll	◆	◆							◆	◆	◆	◆	◆										◆		◆	◆			◆	◆	◆	◆						◆

5.2 Atmospheric Environment

This Section provides an overview description of the potential effects of the Project on the Atmospheric Environment. The detailed assessment of environmental effects in the Atmospheric Environment is presented in the *Atmospheric Environment – Assessment of Environmental Effects Technical Support Document, New Nuclear – Darlington Environmental Assessment*.



The Atmospheric Environment comprises two environmental sub-components: Air Quality and Noise. Air Quality and Noise represent features that can be affected by the Project and as such would be pathways or mechanisms for transfer of an effect to another environmental component.

5.2.1 Potential Project-Environment Interactions

Each Project work and activity was considered to determine if there was a plausible mechanism for it to interact with the individual sub-components of the Atmospheric Environment. The potential interactions are illustrated as dots in the matrix on Table 5.2-1. As shown, almost all works and activities associated with site preparation and construction have the potential to interact with the Atmospheric Environment through emissions to air and/or the generation of noise. However, several works and activities are bounded by others with greater emissions to air and/or noise. There are also some interactions, although fewer of them, during the Operation and Maintenance phase.

Each potential interaction was evaluated to determine if it was likely to result in a measurable change to the current (i.e., baseline) conditions in the applicable sub-components. The works and activities that were considered likely to result in a measurable change are summarised in Table 5.2-1.

TABLE 5.2-1
Project Works and Activities Likely to Measurably Change the Atmospheric Environment

Project Works and Activities	Rationale
SITE PREPARATION AND CONSTRUCTION PHASE	
Excavation and Grading	Large source of dust, vehicle exhaust and noise releases during the Site Preparation and Construction phase.
Marine and Shoreline Works	Large source of dust, vehicle exhaust and noise releases during the Site Preparation and Construction phase.
Construction of the Power Block	Large source of dust, vehicle exhaust and noise releases during the Site Preparation and Construction phase.
Supply of Construction Equipment and Material and Plant Operating Components.	Source of vehicle emissions and dust from concrete manufacturing. This activity will occur simultaneously with the Construction of the Power Block and Development of Ancillary Facilities.
Workforce, Payroll and Purchasing	Source of vehicle emissions due to construction workforce traffic.
OPERATION AND MAINTENANCE PHASE	
Operation of Secondary Heat Transport System and Turbine Generator	Steam generator emissions will increase concentrations of steam generator chemicals above baseline and have the potential to change the atmospheric and noise environments.
Operation of Condenser and Condenser Circulating Water, Service Water and Cooling Systems	Release of cooling tower treatment chemicals, water vapour and noise from the cooling towers will increase concentrations above baseline and could change the atmospheric and noise environments.
Operation of Electrical Power Systems	Releases of combustion products from the testing of emergency and stand-by power associated with the operation of NND could change the atmospheric and noise environments.
Operation of Site Services and Utilities	Ventilation (air and noise) emissions were determined to be negligible. Noise emissions associated with building ventilation at NND is anticipated to be similar to DNGS.
Administration, Payroll and Purchasing	Source of vehicle emissions due to workforce traffic.

Where a measurable change was considered likely, the interaction between the work and activity and the Atmospheric Environment was further evaluated to determine if the change in baseline conditions would represent an environmental effect.

5.2.2 Assessment Scenarios

The potential changes (and effects) in the Atmospheric Environment as a result of some Project works and activities will be bounded by (i.e., contained within) the envelope of changes and effects associated with other activities. Accordingly, assessment scenarios were developed to represent the outer bound of consequences in terms of air quality that could reasonably be expected as a result of the Project. These "assessment scenarios" were evaluated as representatives of all works and activities bounded within the envelope.

Two maximum emission scenarios were developed for construction-related activities. The first scenario considers the potential effects during the Site Preparation activities when the soil excavation is taking place. This is the maximum emission scenario for dust (suspended particulate matter – SPM, PM_{10} and $PM_{2.5}$) generation. The second emission scenario considers the Construction phase, when the maximum emissions from fuel combustion (primarily nitrogen oxides – NO_x) occur. In developing the emission estimates associated with the bounding scenarios, it was assumed that industry standard dust control measures would be maintained (e.g., Best Practices for the Reduction of Air Emissions from Construction and Demolition Activities (Cheminfo 2005)) with an associated effective level of dust control.

One operations-related scenario was evaluated. It includes the operation of four reactors (maximum build out scenario) and associated equipment (i.e., emergency generators, auxiliary boilers, steam generators), the regular operation of DNGS and St. Marys Cement facilities, on-site DNGS and NND operational staff traffic and off-site road traffic, which includes increases in traffic volumes from on and off-site sources based on 2026 traffic projections. This scenario assumes all excavation, grading and construction activities have been completed.

In addition, because the Project will be implemented in the future and over a period of several years, appropriate "future baseline" scenarios were developed against which to compare Project-related changes. These future baseline scenarios represent specific points in time and the air quality conditions that would prevail at those times given the expected evolution of known emission sources. For example, in modeling future baseline conditions, the current releases from DNGS and St. Marys Cement were assumed to remain constant, but the emissions from local traffic were increased by 2% per year from existing emissions account for typical population increases.

The maximum emission rates associated with the bounding assessment scenarios are presented in Table 5.2-2 (Site Preparation and Construction), Table 5.2-3 (Steam Generator Chemicals) and Table 5.2-4 (Fuel Combustion).

TABLE 5.2-2
Maximum Emission Rates
Site Preparation and Construction Phase

	Maximum Emission Rate (g/s) - Site Preparation and Construction						
Activity	**SPM**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_2**	**CO**	**Acrolein**
Material Handling	0.279	0.132	0.0705	-	-	-	-
Grading and Dozing	1.163	0.267	0.0611	-	-	-	-
Rock & Blasting	-	-	-	1.822	0.23	7.74	-
Crush & Screen	-	-	0.0048	-	-	-	-
Worker Parking Lot	0.265	0.09	0.0861	-	-	-	-
Parking Lot Tailpipe	0.001	0.001	0.0047	0.29	0.0046	2.855	0.0001
Unpaved Roads	18.28	4.801	0.3039	-	-	-	-
Haul Truck Tailpipe	0.012	0.012	0.0069	0.362	0.0085	0.093	0.00006
Paved Roads	0.172	0.033	0.0032	-	-	-	-
Paved Road Tailpipe	0.002	0.002	0.0068	0.401	0.0071	3.038	0.00012
Stationary Equip Tailpipe	-	-	0.2184	4.684	1.508	1.047	0.00674
Non-Road Tailpipe	0.031	0.031	0.044	0.915	0.248	0.387	0.00657
Concrete Batching	-	-	0.0585	-	-	-	-
Total	**20.21**	**5.368**	**0.869**	**8.47**	**2**	**15.16**	**0.014**

TABLE 5.2-3
Maximum Emission Rates for Steam Generator Chemicals
(Operation and Maintenance Phase)

	DNGS (g/s)		24-Hour Average (g/s)		Annual Average (g/s)	
	Start-up (per unit)[1]	Losses (per unit)[3]	DNGS[4]	EPR	DNGS[5]	EPR
Acetic acid	0.0300	4.08E-05	0.030	0.041	0.00025	0.00033
Ammonia[2]	6.235	0.726	8.41	11.32	2.92	3.93
Formic acid	0.00140	1.90E-07	0.0014	0.0019	4.61E-06	6.20E-06
Glycolic acid	0.0023	3.13E-06	0.0023	0.0031	1.88E-05	2.53E-05
Hydrazine[2]	0.184	2.50E-04	0.18	0.25	0.0015	0.0020

[1] Start-up emissions based on Darlington Emission Summary Dispersion Modelling Report (OPG 2008)
[2] Start-up emissions and losses for DNGS from OPG 2007
[3] Losses for acetic acid, formic acid and glycolic acid scaled based on hydrazine start-up / losses ratio
[4] Estimated assuming start-up of one unit for 24 hours plus general losses from other three units
[5] Estimated assuming on start-up (of one reactor) per year, with losses applied for the entire year.

TABLE 5.2-4
Maximum Emission Rates from Fuel Combustion
(Operations and Maintenance Phase)

Contaminant	24-hour (g/s)	Annual (g/s)
Acrolein	5.62E-05	8.28E-06
Carbon Monoxide	2.90E-02	3.32E-03
Nitrogen Oxides	7.7	1.22E-01
SPM	1.05E-01	2.67E-03
PM_{10}	1.05E-01	2.08E-03
$PM_{2.5}$	1.05E-01	1.65E-03
Sulphur Dioxide	1.8	4.18E-02

The same assessment scenarios for air quality were also used for consideration of changes in noise conditions. The maximum operating equipment complement during a year associated with each major phase of the project and the corresponding traffic year with the lowest overall background traffic was evaluated; thereby providing an estimate of the maximum noise impact at a given receptor. The scenarios considered Site Preparation, Construction and Operation and Maintenance phases of the Project.

5.2.3 Assessment Methods

Changes in air quality were predicted on the basis of air quality modeling. Appropriate and individual models were applied to characterise vehicle emissions, the distribution (i.e., dispersion) of contaminants in air, and conditions associated with cooling towers (e.g., plumes, drift, fog, icing). The predicted air concentrations were compared to existing conditions and Canadian and Ontario regulatory criteria for air quality and existing air concentrations to determine how the NND Project potentially impacts air quality at particular receptor locations.

Changes in noise conditions were predicted on the basis of modeling to calculate future noise levels at appropriate receptor locations resulting from the operating equipment complement associated with the assessment scenarios. The predicted noise levels were compared to regulatory criteria to determine how the NND Project potentially impacts existing noise conditions at the receptor, and to baseline sound levels to determine the incremental effect (i.e., changes to baseline conditions). The following four Project development and operational scenarios were modelled. Each scenario integrates all Project works and activities that may collectively contribute to change and effect in the Atmospheric Environment:

- Site Preparation - involving those activities associated with this phase, including soil excavation and haulage, and on-site grading and soil disposal;

- Site Preparation and Construction – including activities associated with the late stages of site preparation, plus construction of the first two reactors;

- Construction and Operation – considering operation of the first two reactors, plus construction of (up to) two additional reactors; and

- Operation – including activities associated with operation of four reactors, the maximum build-out scenario.

A no-build condition (i.e., assuming no NND Project) was also modelled for each of the above scenarios years to represent the baseline on which incremental effects of the Project were considered.

5.2.4 Assessment Criteria

5.2.4.1 Air Quality

Predicted changes in air quality as a result of the Project were evaluated against applicable criteria as described in Table 5.2-5 (ambient air quality) and Table 5.2-6 (air quality criteria for steam generator treatment chemicals). The location of the receptors, which were also used for the noise analysis, are given in Table 5.2.7 and shown in Figure 5.2-1.

TABLE 5.2-5
Ambient Air Quality Criteria

Constituent	Assessment Criteria	
	Guideline/Criteria	Reference (see footnote)
Suspended Particulate Matter (SPM)	120 µg/m^3 (24-hour average) 60 µg/m^3 (annual average) 70 µg/m^3 (annual average)	1 3 3
Particulate Matter <10 µm (PM_{10})	50 µg/m^3 (24-hour average)	1
Particulate Matter <2.5 µm ($PM_{2.5}$)	30 µg/m^3 (24-hour average – 98th percentile over 3 years)	2
Nitrogen Dioxide (NO_2)	400 µg/m^3 (1-hour average) 200 µg/m^3 (24-hour average) 100 µg/m^3(annual average)	1,3 1,3 3
Sulphur Dioxide (SO_2)	690 µg/m^3 (1-hour average) 900 µg/m^3 (1-hour average – acceptable) 275 µg/m^3 (24-hour average) 300 µg/m^3 (24-hour average – acceptable) 60 µg/m3 (annual average)	1 3 1 3 3

TABLE 5.2-5 (Cont'd)
Ambient Air Quality Criteria

Constituent	Assessment Criteria	
	Guideline/Criteria	Reference (see footnote)
Carbon Monoxide (CO)	36,200 µg/m³ (1-hour average)	1
	35,000 (1-hour average – acceptable)	3
	15,700 µg/m³ (8-hour average)	1
	15,000 µg/m³ (8-hour average - acceptable)	3
Acrolein[4]	0.08 (24-hour average)	1
Steam Generator Chemicals	See Table 5.2-6	

[1]Ontario Ministry of the Environment 2008 a, b
[2] CCME 2000
[3] Federal-Provincial Committee on Air Pollution (FPCAP) 1976.
[4] Acrolein is a surrogate for VOCs and PAHs released due to fuel combustion (see Section 4.1.2.4 of SENES 2008b)
MAL – Maximum Acceptable Level
POI – Point of Impingement
AAQC – Ambient Air Quality Criteria
MOE – Ministry of the Environment

TABLE 5.2-6
Air Quality Criteria
(Steam Generator Treatment Chemicals)

Contaminant	MOE Criteria Standards, POI Guidelines, AAQC and/or JSL (µg/m³)				Derived Annual AAQC µg/m³
	POI/AAQC ½ hour	POI/AAQC 24 hour	JSL 1/2 hour	JSL 24 hour	
Acetic acid	2500	2500	~	~	500
Ammonia[2]	300	100	~	~	100[2]
Formic acid	1500	500	~	~	100
Glycolic acid[3]	~	~	12	4	0.8
Hydrazine[1]	1[1]	~	~	~	0.01[4]

[1]POI criterion exists for hydrazine, MOE ½ hour 'allowable limit' as per OPG's current approved Certificate of Approval (Air) (OPG 2008)
[2] derived from IRIS database (U.S.EPA 2007)
[3] Jurisdictional Screening Level (JSL) List, MOE 2008c
[4] Texas Commission on Environmental Quality, 2008

Figure 5.2-1

Receptor Locations

LEGEND:

- Receptors Location
- Truck Haul Routes
- Approximate OPG Property Boundary

SOURCE:
ADAPTED FROM SENES CONSULTANTS, ATMOSPHERIC ENVIRONMENT, ENVIRONMENTAL EFFECTS T.S.D., FIGURE 5.4-1, 2009

Date: September 2009

Project: 34500

ONTARIO POWER GENERATION

TABLE 5.2-7
Receptor Locations Description

Socio-Economic Sub-Component	Receptor ID	Suggested Receptor Location
Residents and Communities (Existing Conditions)	R15	Nearest Existing Resident (West) on Solina Road
	R16	Nearest Existing Resident (East) on Waverly Road
	R17	Nearest Existing Resident (Northeast) on Maple Grove Road
	R18	Nearest Existing Resident (North) on Holt Road
	R19	Nearest Existing Resident (Northwest) on Rundle Road
	R20	Nearest Existing Resident (East) on South Service Road
	R21	Nearest Existing Resident (East) on Green Road north of 401
	R22	Nearest Existing Resident (East) at base of Waverly Road
	R23	Almet Farms Limited on Holt Road North of Baseline Road
Residents and Communities (Future Conditions)	R24	Nearest Future Resident (Courtice)
	R25	Nearest Future Resident (Bowmanville)

5.2.4.2 Noise

The predicted noise levels associated with on-site stationary sources (e.g., cooling towers, standby generators) were compared to the criteria in Table 5.2-8 from the MOE Publication NPC-205 (MOE 1995b). This publication states that the criteria to be applied at the receptor location shall be the higher of the background noise from sources not associated with the Project, or the minimum level in the table. As discussed in Section 4.2.5 the noise environment at the nearest residential area to the DN site is classified as a “Class 1 Area”.

The combined noise levels from stationary sources and mobile sources (e.g., construction equipment, traffic) were also evaluated. The criteria for evaluating noise from mobile sources at residences are traditionally intended for land-use planning purposes and many of the receptor locations already exceed these standards due to their proximity to Highway 401. Therefore, the modeling results for combined stationary sources and mobile sources were compared against future noise levels assuming the Project did not occur (future no-build). The qualitative criteria indicated in Table 5.2-9 were used to considering the magnitude of the incremental noise levels. The table was slightly modified to add an incremental sound level of 3 dB that is commonly accepted as an incremental change that is imperceptible to the human ear.

The receptor locations considered for the noise assessment are the same as those considered for the air quality evaluation. They are shown on Figure 5.2-1.

TABLE 5.2-8
Minimum Sound Level Limits by Time of Day – Stationary Sources

Time of Day	One Hour L_{eq} (dBA)	
	Class 1 Area	Class 2 Area
07:00 - 19:00	50	50
19:00 - 23:00	47	45
23:00 - 07:00	45	45

Note:
MOE 1995b
L_{eq} - energy equivalent sound level
The limit at a receptor for steady noise from a stationary source is the higher of either the one-hour L_{eq} resulting from existing volumes of road traffic and any industry which is not under investigation for noise excess, or the appropriate level provided in this table.

TABLE 5.2-9
Qualitative Criteria for Assessing Noise Effects

Increase Over Background Sound Level (dBA)	Change in Subjective Loudness	Impact Rating
Up to 3 dB	Hardly Perceptible	Marginal to none (i.e., not measurable)
4 to 5 dB	Noticeable	Low
6 to 10 dB	Almost twice as loud	Moderate
11 + dB	More than twice as loud	High

5.2.5 Assessment of Likely Effects on Air Quality

Based on the modeling carried out, the likely changes in air quality as a result of the Project, including aesthetic conditions associated with operation of cooling towers, are predicted to be minimal at residential receptor locations. These changes are summarised below.

Particulate Matter

During the site preparation activities, the predicted maximum 24-hour concentrations of SPM at the residential receptors are all below the 120 µg/ m^3 Ambient Air Quality Criterion (AAQC). Potentially measurable changes (i.e., >10% of background) are predicted at nearby receptor locations, but all concentrations return to background within 1,800 m of the DN site. Some exceedances of the 24-hour SPM concentrations are predicted during the construction activities at the nearest residential locations east and west of the DN Site at R15 and R20. These exceedances can be attributed, in large part to relatively high baseline concentrations of SPM. For example, the maximum SPM concentration at receptor R20 is predicted to be 163.2 ($\mu g/m^3$) under the future no-build assumption, that is if the Project did not occur. With the Project, SPM concentrations, increase only 0.4 $\mu g/m^3$ which is less than the 10% increment noted above. The increase due to the construction activities at R15, however, is more attributable to the Project. The maximum SPM under the future no-build scenario is 77.5 $\mu g/m^3$, increasing to a maximum of 170.4 $\mu g/m^3$ during construction. This predicted increase of over 90 $\mu g/m^3$ is associated with site preparation activities in the north-west portion of the DN site, which would occur for a period of less than 2 years (i.e., surplus soil placement in the Northwest Landfill Area).

It is to be noted that the maximum predicted SPM concentration (described above at receptor R15) would occur only under worst-case meteorological conditions; and it is predicted to exceed the criterion only very infrequently (less than 0.6% of the time which is less than 5 days over 2 years). The incremental change between construction and operations and the future no-build scenarios is less than 6.0 $\mu g/m^3$ at all receptors, which is less than 10% of background and is not considered measurable. Similarly, during the Operation and Maintenance phase, incremental SPM concentrations are less than 8 $\mu g/m^3$ at all receptors. This comparison suggests that SPM concentrations at the residential receptors are more strongly influenced by traffic volumes than by construction and operations activities.

Potentially measurable increases of PM_{10} will also occur at the nearest residential receptors during site preparation activities. However with the exception of R15, R17, R19 and R20 the predicted maximum PM_{10} concentrations are below the 24-hr MOE interim criterion of 50 $\mu g/m^3$. PM_{10} concentrations at R15, R17, R19 and R20 are predicted to exceed the interim criterion only infrequently during the 2-year site preparation period (1%, 0.3%, 0.05% and 0.2% of the time, respectively). It should be noted that all of the predicted PM_{10} concentrations include a conservative 90^{th} percentile upwind background concentration. Use of a more typical background concentration (i.e. 70^{th} percentile) would result in the PM_{10} criterion being exceeded at only R15 (0.3% of the time) and R20 (0.05% of the time). Under the Construction and Operation and Operation and Maintenance phases, there are no predicted exceedances of the interim PM_{10} criterion. Potentially measurable changes in 24-hour predicted maximum concentrations are predicted at some locations but all return to background within 1,800 m of the DN site.

The maximum predicted $PM_{2.5}$ concentrations are below the 24-hr Canada Wide Standard (CWS) of 30 $\mu g/m^3$ in all cases except at R15 during site preparation activities. The maximum predicted concentration at this location of 34 $\mu g/m^3$ is only marginally above the CWS, and includes an conservative upwind background contribution of 19 µg/m^3. The criterion is predicted to be exceeded 0.05% of the time with this relatively high background. Use of a more typical background of 10 µg/m^3 (70th percentile) would result in no exceedance of the CWS. On an annual basis there were no potential measurable changes in average concentrations of $PM_{2.5}$ during site preparation, construction and operations. The incremental changes in average annual concentrations of $PM_{2.5}$ well all less than 0.3 µg / m^3 and well within the assessment criteria.

Criteria Contaminants (NO_2, SO_2, CO)

With the exception of the site preparation activities, the predicted NO_2 concentrations for all time frames are the 1-hour and 24-hour AAQC and annual Air Quality Objectives (AQOs). The maximum predicted 1-hour average NO_2 during site preparation activities at is infrequently (less than 1 hour per year – 0.002% of the time) predicted to exceed the 1-hour AAQC. Predicted NO_2 concentrations for all other time frames are within the AAQC and AQOs. In all cases for all time frames, predicted SO_2 and CO concentrations are below the applicable AAQC and AQOs. Potentially measurable changes in concentrations are predicted at some receptor locations for both NO_2 and SO_2, however all return to background within approximately 800 m to the north and 2,000 m to the east and west of DN site.

Acrolein

During combined site preparation and construction activities; and construction and operation activities, the maximum predicted 24-hour concentrations of acrolein exceed the AAQC at some or all residential receptors, largely due to the relatively high upwind background acrolein concentration, which is 80% of the AAQC. The maximum predicted 24-hour concentrations of acrolein are below the respective AAQC during operations at the residential receptors and no measurable changes in acrolein are anticipated at any receptors during this phase.

Steam Generator Chemicals

The predicted maximum 24-hour concentrations of steam boiler chemicals are below their respective 24-hour AAQCs at the nearest residential receptors. A 24-hour AAQC is not available for hydrazine. The annual average predicted concentrations of all steam boiler chemicals are less than 1% of the derived annual criteria, with the exception of hydrazine which was less than 5% of the annual criteria.

Since hydrazine is a suspected carcinogen and no 24-hour criterion is currently available, hydrazine will be considered for effects on human health and non-human biota (see Sections 5.13 and 5.14, respectively).

Fogging (Associated with Cooling Towers)

For both mechanical draft cooling tower configurations, fogging could occur on the DN site for up to about 20 hours per year and for about 15 hours per year in the vicinity of Highway 401. There are no predicted fogging events for the natural draft cooling tower configurations. As noted in Section 4.2.2.1, fog occurs in Toronto approximately 27 days per year and 26 days per year in Trenton. Therefore, an added period of fog of less than one day (<4%) is not considered a meaningful change. It is also reasonable to expect that the meteorological conditions that may result in fogging due to the cooling tower operation would be similar to the conditions which cause natural fogging along the north shore of Lake Ontario and as such, the added period of fog would be coincidently with, rather than additive to, normal fog conditions.

Icing (Associated with Cooling Towers)

Icing may occur during a fog condition when the temperature is below $0^{o}C$. Because the prevailing winds (particularly in the winter) are from the northwest, icing conditions are predicted to occur only southeast of the cooling towers, and for only about 1-2 hours per year. No icing of Hwy. 401 is predicted. There are no predicted icing events for the natural draft cooling tower configurations. On average (1953-2001), there are between 17 (Toronto) and 22 (Trenton) hours of freezing rain per year along the north shore of Lake Ontario (Environment Canada 2008). The additional 1-2 hours per year of icing, most of which would occur on the DN site and Lake Ontario, is not considered a measurable change to existing conditions.

Plumes (Associated with Cooling Towers)

A vapour plume associated with cooling towers would extend over Bowmanville less than 1% of the time over the course of a year. In general the longest plumes are southeast and west of the DN site and there is a greater frequency of longer plumes in the winter months. Plumes can occasionally extend up to 10,000 m in length. For example, in the winter, plumes of over 3,500 m in length could occur 60% of the time, whereas in the summer, this would likely occur less than 10% of the time.

Plume heights of approximately 800 m will occur approximately 80% of the time for the mechanical draft towers and 90% of the time for the natural draft towers. Visible plumes approaching 1000 m in height will occur approximately 20% of the time. For all cooling tower configurations the frequency of plume shadow length is similar. The plume shadow length is greater than 6,000 m less than 10% of the time.

Water Deposition

Water deposition due to plume drift is predicted to occur within the SSA. The linear configuration of the mechanical draft cooling tower results in the highest predicted water deposition rates with up to 200 g/m^2/month adjacent to the tower, which is about 2 mm/yr. The average annual precipitation at the Toronto Pearson Airport was 780.8 mm/yr or 65,066 g/m^2/month (EC 1993). As such, regardless of the configuration, the water deposition rate, even adjacent to the tower, would be negligible.

Salt Deposition (Associated with Cooling Towers)

The linear configuration of the mechanical draft cooling towers also result in higher predicted salt deposition rates than the natural draft cooling towers. Salt deposition rates of 1-2 g/m^2/month can occur within about 500 m of the mechanical draft cooling towers. This drops to less than 0.1 g/m^2/30 days within about 1,300 m of the towers. Predicted salt deposition rates are less than 0.05 g/m^2/month for the natural draft towers at all locations.

5.2.5.1 Likely Effects on VECs

The VECs for the Atmospheric Environment are pathways to human health, non-human biota and VECs in other environmental components. Accordingly, predicted conditions in Air Quality are: i) compared to the applicable assessment criteria (see Section 5.2.4.1) to determine effects in the Atmospheric Environment and ii) considered within other applicable environmental components to determine the consequential effects of Air Quality on VECs in those components.

Likely environmental effects as a result of predicted changes in Air Quality are described as follows.

With limited exception, the concentrations of the modeled contaminants in air are below their respective regulatory criteria. The exceptions, SPM, PM_{10} and $PM_{2.5}$ at a couple of receptor locations during site preparation activities and acrolein as a result of an elevated background condition, are described above. Based on the results of the modeling which considered very conservative bounding assessment scenarios, the changes in Air Quality as a result of the Project are not considered to represent an adverse environmental effect in the Atmospheric Environment. Accordingly, no further evaluation of the effects of the Project on Air Quality (non-radiological) is warranted.

Although not predicted to exceed regulatory criteria, measurable increases in concentrations of contaminants in the atmosphere are predicted to occur at on-site and off-site receptor locations. As they may be relevant, these increases are considered further as potential pathways to Human Health (Section 5.13), Non-Human Biota (Section 5.14) and VECs in the Terrestrial Environment (Section 5.5) and the Socio-economic Environment (Section 5.11).

Changes in conditions in the Atmospheric Environment associated with operation of cooling towers include meteorological (e.g., fogging, icing, water deposition), aesthetic (visual effects of vapour plumes) and physical (salt deposition). These changes are not considered to represent an adverse environmental effect of the Project in the Atmospheric Environment. Accordingly, no further evaluation of effects of the Project on the Atmospheric Environment associated with operation of cooling towers is warranted.

Changes in the Atmospheric Environment associated with operation of cooling towers are, however, considered further in terms of pathways to VECs in the Terrestrial Environment (Section 5.5) and in Land Use (Section 5.8).

5.2.5.2 Mitigation Measures

In developing the assessment scenarios and emission estimates, and when considering likely environmental effects on Air Quality, it was assumed that appropriate design features to pre-empt possible environmental effects will be incorporated into the Project based on Good Industry Management Practices and direct OPG experience. Accordingly, the following specific "in-design" mitigation measure was considered in evaluating the likely environmental effects:

- A Dust Management Program will be implemented during the Site Preparation and Construction Phase of the Project to control dust emissions at their source. Examples of typical dust management strategies include application of dust suppressants; stabilization of completed soil surfaces; and suspension of dust-generation activities during periods of inclement weather.

Should mitigation measures be necessary to address likely effects on VECs in other environmental components, they will be described in the applicable sections of this EIS.

5.2.5.3 Residual Adverse Effects

No residual adverse effects on Air Quality (non-radiological) are predicted in the Atmospheric Environment as a result of the Project. Residual effects in other environmental components as they may result from air quality as a pathway will be described in the appropriate sections of the EIS.

Neither the extent nor the uncertainty of environmental effects of the Project on Air Quality are likely to be exacerbated by climate change. The inherent conservatisms in the calculated concentrations effectively consider uncertainties in the predictions of airborne contaminants, including as a result of climate change. Potential consequences of climate change in the

Atmospheric Environment are likely to be evidenced in warming temperatures, and generally reduced precipitation and soil moisture levels. While in theory, these changes may be expected to contribute to increased particulate in air concentrations, in practice, the above-noted Dust Management Program will be applied as necessary to consider actual ambient atmospheric conditions to ensure particulate is controlled. It is also noted that predicted increases in particulate occur during the site preparation activities only, which will be complete long before climate change might contribute to increased environmental effects of the Project.

5.2.6 Assessment of Likely Effects on Noise

As noted above, four stages in NND development and operations were modelled for noise generation.

During site preparation activities, the maximum one-hour daytime sound level (which will occur at receptor location R15) is predicted to be 9.5 dB higher than the predicted minimum daytime background level of 51.7 dBA. The average daytime sound level is predicted to increase by 8.1 dB to 61.4 dBA. As indicated in Table 5.2-9, these are classed as Moderate. Night-time sound levels will generally be unaffected. No other residential receptors will experience an increase in sound level of > 3 dB, the threshold for perception.

During the combined Site Preparation and Construction phase scenario, three residential receptor locations (R9, R16 and R20) will experience maximum one-hour daytime and night-time sound levels increases of greater than 3 dB as worker shifts are changing. However, when considered over the average daytime and night-time periods, these increases will not be measurable (i.e., would be <3 dB). The predicted maximum one-hour night-time sound level increase at receptor location R20 is 4.3 dB, which is a low impact and only marginally measurable.

The third modeled scenario involves the operation of two reactors and ancillary facilities plus construction of two additional reactors and facilities. The location with the greatest predicted increase in noise is receptor R20 during the night-time, when the predicted one-hour sound level increase is 5.2 dB. This prediction includes the very conservative assumption that the entire worker shift change of approximately 4,000 workers will take place during this one-hour period. In reality, this will not occur; therefore, the actual increase will be less than predicted. When the activities associated with Scenario 3 are considered over the average daytime and night-time periods, the sound level increases would not be measurable (i.e., < would be than 3 dB).

During full operation of four reactors, receptor location R20 will experiences a night-time maximum one-hour increase in sound level of 3.3 dB. When considered over the average daytime and night-time periods, the sound increases associated with this scenario would not be measurable (i.e., < would be than 3 dB).

5.2.6.1 Likely Effects on VECs

The VECs for the Atmospheric Environment are pathways to human health, to non-human biota and to VECs in other environmental components. Accordingly, predicted Noise conditions are: i) compared to the applicable assessment criteria (see Section 5.2.4.2) to determine effects in the Atmospheric Environment and ii) considered within other applicable environmental components to determine the consequential effects of air quality on VECs in those components.

Noise conditions in the vicinity of the residential receptors are largely related to background traffic, and to a lesser extent, the operations at St. Marys Cement. A moderate increase in sound levels is predicted during site preparation activities at the closest residence west of the DN Site. This will be of limited duration and only occur during the day. The predicted increases in sound levels at the other residential receptors are negligible during all phases of the Project and are not considered to represent an adverse environmental effect in the Atmospheric Environment. Accordingly, no further evaluation of effects of the Project on the Atmospheric Environment associated with noise is warranted.

Some measurable increases to existing noise levels are predicted at off-site receptor locations and these increases are considered further in terms of pathways to Human Health (Section 5.13), Non-Human Biota (Section 5.14) and VECs in the Terrestrial Environment (Section 5.5) and the Socio-economic Environment (Section 5.11).

5.2.6.2 Mitigation

In developing the assessment scenarios and sound generation estimates, and when considering likely environmental effects as a result of noise, it was assumed that appropriate design features to pre-empt possible environmental effects will be incorporated into the Project based on Good Industry Management Practices and direct OPG experience. Accordingly, the following specific “in-design” mitigation measure was considered in evaluating the likely environmental effects:

- Implementation of a Noise Management Plan during the Site Preparation and Construction phase of the Project. The Plan will be based on practices typical of major construction projects and operating plants and will include, for example, measures to control sound generation at source, to alert area residents of specific noise generating activities (e.g., blasting), requirements to maintain construction and operating equipment in proper mechanical condition, and the need to comply with applicable noise standards and regulations.

Should mitigation measures be necessary to address likely effects on VECs in other environmental components, they will be described in the applicable sections of the EIS.

5.2.6.3 Residual Adverse Effects

No residual effects in terms of Noise conditions are predicted in the Atmospheric Environment as a result of the Project. Residual effects in other environmental components as they may result from noise as a pathway will be described in the appropriate sections of this EIS.

5.3 Surface Water Environment

This Section provides an overview description of the potential effects of the Project on the Surface Water Environment. The detailed assessment of environmental effects in the Surface Water Environment is presented in the *Surface Water Environment – Assessment of Environmental Effects Technical Support Document, New Nuclear – Darlington Environmental Assessment*.

The Surface Water Environment comprises four environmental sub-components: Lake Circulation, Lake Water Temperature, Site Drainage and Water Quality, and Shoreline Processes.

5.3.1 Potential Project-Environment Interactions

Each Project work and activity was considered to determine if there was a plausible mechanism for it to interact with the individual sub-components of the Surface Water Environment. The potential interactions are illustrated as dots in the matrix on Table 5.1-1.

Each potential interaction was evaluated to determine if it was likely to result in a measurable change to the current (i.e., baseline) conditions in the applicable sub-components. The works and activities that were considered likely to result in a measurable change are summarized in Table 5.3-1.

TABLE 5.3-1
Project Works and Activities Likely to Measurably Change the Surface Water Environment

Project Works and Activities	Rationale
SITE PREPARATION AND CONSTRUCTION PHASE	
Marine and Shoreline Works	A portion of the bluffs creating the foreshore and contributing an ongoing source of sediments to the nearshore environment will be removed. Rock and soil placement is likely to affect water quality (e.g., turbidity), will cover/remove lake substrates, and will alter local bathymetry and physical characteristics of the shoreline resulting in offshore deflection of currents and sediments. The development of the lake infill area and subsequent formation of an artificial embayment fronting Darlington Creek will potentially increase water temperatures and algae production and entrapment in Lake Ontario near the mouth of the Creek.
Construction of Intake and Discharge Structures	Rock and soil removal and/or placement are likely to affect water quality (e.g., turbidity) and lake bottom substrates (i.e., disturbance/removal).
OPERATION AND MAINTENANCE PHASE	
Operation of Active Ventilation and Radioactive Liquid Waste Management Systems	Operation of the Radioactive Liquid Waste Management System will introduce liquid effluents to receiving waters.
Operation of Condenser, Condenser Circulating Water, Service Water and Cooling Systems	These systems will withdraw and return (at increased temperature) large volumes of water from Lake Ontario, thereby altering the existing flow dynamics, thermal regime, and quality characteristics in the Lake.
Replacement/Maintenance of Major Components and Systems	The periodic chemical cleaning of systems and components (e.g., steam generators) is likely to include discharge of effluent to Lake Ontario that may alter water quality; and periodic shutdown of systems (e.g., condenser circulating water and service water) will change the flow dynamics and thermal regime in the Lake.

Where a measurable change was considered likely, the interaction between the Project work and activity and the Surface Water Environment was further evaluated to determine if the change in baseline conditions would represent an environmental effect.

5.3.2 Assessment Scenarios

To a large extent, likely changes and effects in the Surface Water Environment will be directly related to Project works and activities that involve the exchange of water between the facility and Lake Ontario. These exchanges will predominately be as a result of the operations of condenser circulating water (i.e., once-through cooling option and cooling tower option) and service water systems. Assessment scenarios were developed to represent a bounding condition for these systems. These scenarios were considered to provide a conservative case for assessment of effects. The scenarios are summarized below.

5.3.2.1 Once-Through Lakewater Cooling Option

The NND once-through lakewater cooling system is assumed to be similar to the DNGS system, recognizing that modifications are required to accommodate the larger amount of waste heat from the new facility. The design of the NND intake was assumed to be a scaled-up version of the existing DNGS intake. It is expected that the performance of the new intake in terms of velocities will be similar to that of the existing DNGS intake, which has a design average intake velocity of 0.15 m/s (0.5 ft/s). It follows then that the effects associated with the new intake can be assessed by examining the effects that have been observed for the existing intake structure. The new intake was scaled up based on a proposed NND inflow of 250 m^3/s and an existing DNGS inflow of 150 m^3/s. This represents an increase in flow of approximately 67%. It is expected that an increase in the porous area of the intake structure of 67% will result in similar velocities when compared to the existing intake structure. For the purposes of this assessment, it was assumed that "similar performance" is measured in terms of the intake velocities and dispersion/dilution of the thermal plume at the surface.

For EA purposes, the NND diffuser was also assumed to be similar to the DNGS diffuser in size and configuration. Due to the bathymetry at the NND location, the depth will range from 10 m at the nearshore end to 20 m at the offshore end (the DNGS diffuser is located at a relatively constant depth of 10-12 m). The flow rate from NND will be significantly higher than at DNGS, therefore, to maintain a reasonable exit velocity, the diameter of discharge ports was increased by 41% (doubled port area). The overall length of the NND diffuser will be the same as the DNGS diffuser. The NND diffuser will be located as far east as possible to minimize the distance to the nearest water intake and also maximize the distance between the two diffusers.

A total flow of 250 m^3/s representing the combined cooling water and service water requirements for the once-through option is applied as the bounding case. However, the assessment also considers an alternative case with reduced cooling water flow and higher temperature discharge.

Based on a maximum electrical generating capacity of 4,740 MW (3-EPR option), the waste heat load to Lake Ontario will be 9,480 MW (double electrical generating capacity). Using the assumed flow of 250 m^3/s, this waste heat load would correspond to a temperature increase of approximately 9°C through the cooling water system.

5.3.2.2 Cooling Tower Option

The cooling tower option will withdraw and discharge substantially smaller quantities of water from Lake Ontario than will the once-through cooling option. The cooling tower (make-up water) intake will be considerably smaller than the intake for the once-through cooling. It was assumed to be located at a minimum depth of 10 m. The location of the cooling water intake was assumed to be the same as for the once-through option. The intake pipe will be trenched into the lake bottom and therefore the area of disturbance will be along the entire length of the intake pipe.

A single port outfall is assumed for the cooling tower option. It will be placed at a water depth of 12 m at a location to minimise interaction with the intake and oriented such that the flow is directed offshore. It will be 1 m off the bottom to avoid bottom contact and minimize sediment scour, and oriented 45º above horizontal to maintain adequate dilution during various buoyancy conditions. The outfall pipe will be trenched into the lake bottom and therefore the area of disturbance will be along the entire length of the outfall pipe.

The total flow withdrawn from Lake Ontario for the cooling tower option will be approximately 6 m^3/s. The towers will operate on a “four cycle” system meaning that 75% (4.5 m^3/s) of the water will be lost to evaporation in the cooling towers. The remaining 25% (1.5 m^3/s) will “bleed-off” from the cooling tower and returned to Lake Ontario.

The discharge temperature from a cooling tower is primarily dependant on local meteorological conditions and varies with season. The expected daily discharge temperature was estimated using 10 years of meteorological data collected at Trenton (April 2006 to March 2007) and the analysis considered four months (February, May, August and November) to represent the four seasons. The analysis also considered representative “maximum” and “minimum” conditions.

5.3.2.3 Characterisation of Plant Effluents

The chemical constituents and their concentrations (which are proprietary and vendor/technology-specific) in the various liquid effluent discharges from the plant, including the presence and type of water treatment systems for discharges, are currently not known in sufficient detail to conduct a water quality assessment for the individual parameters. However, dilution factors within Lake Ontario for the cooling water systems were calculated to support a screening level assessment.

5.3.3 Assessment Methods (Modelling)

An evaluation of the potential hydrodynamic, thermal and water quality effects of the NND was carried out through a number of iterative steps. Each subsequent step was more detailed than the previous step and considered the larger base of information as it became available or key physical processes as they were identified. This iterative approach responded to the complexity of the Project and the subject matter, and was necessary to support the timing requirements of parallel EA-related studies (e.g., on human health which required these data to evaluate contaminant dilution in the vicinity of water treatment plant intakes).

A preliminary understanding of the type and extent of anticipated thermal and hydrodynamic effects from the NND intake and diffuser was developed using the known effects of the existing DNGS intake and diffuser as an analogue. The existing effects of the DNGS were determined through a review of existing monitoring data and performance studies of the DNGS diffuser, rather than through a modelling exercise.

Subsequently, a Screening Level Assessment (SLA) was conducted. This involved an evaluation of the near-field performance of the NND discharge diffusers using a Windows-based application (Visual Plumes) which simulates surface water jets and plumes. The Visual Plumes modelling was validated by modelling the DNGS diffuser and comparing the results to existing monitoring data and operational performance studies. Sensitivity analyses of the Visual Plumes modelling were carried out to provide insight into the influence of changes in current speed, depth, temperature, buoyancy and flows.

The far-field dispersion of contaminants was determined in the SLA using a 2-D Gaussian plume model. For the once-through lakewater cooling option, the far-field plume was represented by the additive concentrations of 90 individual plumes (one from each port) which provided a more appropriate representation of the diffuser plume than could be accomplished using a single point source. The dispersion model was implemented using a virtual source that allowed the far-field effects to consider the initial dilution provided by the diffuser or outfall (otherwise, the model would represent the outfall as a point source and not recognize that the initial dilution and spreading). The dispersion model was used to determine dilution factors at the considered drinking water intakes, which is of relevance to the assessment of potential effects on human health (see Section 5.13.1.4).

It was recognised that although it was suitable for a SLA, the 2-D Gaussian Plume model did not consider the effects of factors such as current reversals, changes in bathymetry and shoreline (including St. Marys Wharf), thermal stratification and the effect of the existing DNGS diffuser. Therefore, as a subsequent iterative step a detailed 3-D hydrodynamic model (MIKE 3) was developed to provide a more thorough representation of the complex hydrodynamics of the Lake Ontario near the DN site. The 3-D hydrodynamic model was used to verify the assumptions and simplifications of the SLA using a steady-state application of the model, and complete long-term simulations using a dynamic application of the model. The MIKE 3 modelling results provide confidence that the SLA dilution factors at drinking water intakes are conservative (i.e., low).

5.3.4 Assessment Criteria

Predicted changes in the parameters relevant to conditions in the Surface Water Environment were evaluated against applicable criteria described in Table 5.3-2. The criteria were applied for evaluation of the changes in conditions as well as the likely effects that would result from the changes.

TABLE 5.3-2
Evaluation Criteria for Surface Water Environment

Surface Water Sub-component	Evaluation Criteria
Site Drainage and Water Quality	• *Municipal/Industrial Strategy for Abatement (MISA)* Storm Water Control Protocol • *MISA* Limits • MOE Industrial Sewage Works Certificate of Approval (C of A) • Typical storm water runoff quality data • Ontario Ministry of Environment (MOE) Stormwater Management Planning & Design Manual • MOE *Provincial Water Quality Objectives (PWQOs)* • MOE *Ontario Drinking Water Standards (ODWSs)* • Canadian Council of Ministers of the Environment (CCME) *Canadian Environmental Quality Guidelines (CEQG)* • Professional Judgement
Lake Circulation	• Percent change compared to existing conditions • Professional Judgement • MOE Permit To Take Water (PTTW)
Water Temperature	• *CCME CEQG* • MOE *PWQOs* • MOE C of A for DNGS • Professional Judgement
Shoreline Processes	• CCME *CEQG* for Total Suspended Solids (TSS) • MOE *PWQOs* for TSS • Municipal and Industrial Strategy for Abatement (MISA) limits for TSS • Professional Judgement

5.3.5 Assessment of Likely Effects on Lake Circulation

Likely effects on Lake Circulation will be as a result of specific aspects of the following works and activities.

Marine and Shoreline Works

Lake infilling and stabilization of the shoreline in front of DNGS and NND will create an artificial embayment between the infill area and the St. Marys Cement property. Due to the increased protection from the west resulting from the infilled area, the embayment which is already relatively sheltered as a result of the St. Marys Cement wharf will become even more sheltered from long-fetch waves from the west and southwest. As a result, it is predicted that current velocities and lake water exchange between offshore waters and nearshore waters will be reduced within the embayment area, potentially resulting in a Low Natural Dispersion Area (LNDA) for periods of the year.

Operation of Condenser, Condenser Circulating Water, Service Water and Cooling Systems

Once-Through Lakewater Cooling Option

Previous studies have established that there is a deflection of the alongshore currents as the result of the operation of the existing DNGS intake and diffuser. It is expected that a similar deflection will result from the operation of the NND intake and diffuser. Based on the historical studies conducted to quantify the effects of the DNGS withdrawal and discharge of cooling water (as referenced in Golder Associates 2008a) and the currently proposed distance between the DNGS and NND intakes and discharges, it is expected that there will be minimal interaction between the two systems with respect to thermal plumes and minimal recirculation of discharge water into the cooling water intakes.

Cooling Tower Option

The intake and discharge flows associated with the cooling tower option are not substantial with respect to lake circulation compared to the volume of water passing the NND site and to ambient currents. As such, it is anticipated that there will be no meaningful change on local current patterns expected as the result of the operation in the cooling towers at NND.

Replacement/Maintenance of Major Components and Systems

If refurbishment or maintenance activities result in the shutdown of one or more reactors, the flow from the discharge diffuser could decrease for each unit shutdown. The resultant change to lake circulation would be less than (i.e., bounded by) the changes to circulation resulting from all units in operation.

5.3.5.1 Likely Effects on VECs

The VECs for the Surface Water Environment are pathways to human health, non-human biota and to VECs in other environmental components. Accordingly, predicted changes in Lake Circulation are: i) compared to the applicable assessment criteria (see Section 5.3.4) to determine effects in the Surface Water Environment and ii) considered within other applicable environmental components to determine the consequential effects on VECs in those components.

Likely environmental effects as a result of predicted changes in lake circulation are described as follows.

Changes to Lake Ontario current circulation patterns in the LSA are likely as a result of alterations to the shoreline associated with lake infilling and a deflection of alongshore currents associated with operation of a once-through lakewater cooling system. These changes in and of themselves are not considered an adverse effect of the Project in terms of lake circulation. However, the changes are considered further in terms of their likely consequential effect on Lake Water Temperature (Section 5.3.2), Lake Water Quality (Section 5.3.3) and Shoreline Processes (Section 5.3.4).

Potential effects related to withdrawal of cooling water and entrainment and impingement of aquatic biota are considered further in terms of pathways to VECs in the Aquatic Environment (Section 5.4).

5.3.5.2 Mitigation Measures

Because there are no adverse effects on Lake Circulation predicted as a result of the Project, no mitigation measures are identified for the Surface Water Environment. Should mitigation measures be necessary to address likely effects on VECs in other environmental components, they will be described in the applicable sections of this EIS.

5.3.5.3 Residual Adverse Effects

No residual adverse effects on Lake Circulation are predicted in the Surface Water Environment as a result of the Project. Residual effects in other environmental components as they may result from lake circulation as a pathway will be described in the appropriate sections of this EIS.

Potential consequences of climate change in the Surface Water Environment are likely to be evidenced in changing temperatures and water levels (i.e. water level may decrease by as much as 0.5 m; see Section 6.4). It is noted that the water level in Lake Ontario is controlled for navigation purposes. Neither the extent nor the uncertainty of environmental effects of the Project on Lake Circulation is likely to be exacerbated by climate change.

5.3.6 Assessment of Likely Effects on Lake Water Temperature

Likely effects on Lake Water Temperature will be as a result of specific aspects of the following works and activities.

Marine and Shoreline Works

A reduction in lake water exchange between cooler offshore waters and the new embayment will likely result in warmer water temperatures than currently exist at the mouth of Darlington Creek. Increased water temperature in the embayment is expected to be primarily the result of atmospheric heat exchange.

Operation of Condenser, Condenser Circulating Water, Service Water, and Cooling Systems

Once-Through Lakewater Cooling Option

Based on the SLA, under average annual conditions the maximum expected temperature increase at the surface at the edge of the turbulent mixing zone is less than 0.7ºC (dilution factor of 13.6 and assuming the ambient surface temperature is the same as the ambient bottom temperature). At the centerline of the jet of the turbulent mixing zone, the maximum expected temperature rise above ambient is expected to be approximately 1.3ºC (dilution factor of 7.1 and assuming the ambient surface temperature is the same as the ambient bottom temperature). These temperature increases would be less if the lake bottom temperature is lower than the surface temperature. These temperature effects are expected to extend a maximum of 50 m from the diffuser (under the modelled average annual case).

The assessment of the alternative discharge scenarios (i.e., considering a reduced discharge rate and higher discharge temperature) showed that the expected temperature increase at the edge of the turbulent mixing zone will be generally similar to that expected for the assumed discharge flow, temperature and design. However, higher temperatures can be expected within the turbulent mixing zone, especially near the diffuser ports. These results indicate that the effects on water temperature for the alternative discharge scenarios are similar to the base case conditions.

The above noted effects could be larger under certain environmental conditions (e.g., current speeds and ambient temperatures). However, based on the preceding, the near-field modelling completed indicates that the thermal effects (magnitude and extent) in the vicinity of the new diffuser are analogous to the effects measured at the existing diffuser. The assessment also indicated that the thermal plumes (as defined by a 2ºC increase from ambient) from the existing and new diffusers do not overlap.

Cooling Tower Option

The cooling tower effluent temperature is expected to be within 10ºC of the intake temperature at least 80% of the time. Under average annual conditions, the maximum expected temperature increase at the surface is less than 0.7ºC at the edge of the turbulent mixing zone (dilution factor of 10.6 and assuming the ambient surface and bottom temperatures are the same). At the centerline of the jet, the temperature rise above ambient is expected to be less than 1.5ºC also assuming the ambient surface and bottom temperatures are the same. These temperature effects are expected to extend a maximum of 15 m from the discharge under the modelled average annual case.

Under extreme conditions, the effluent temperature may exceed the ambient water temperature by 16.9ºC resulting in a positively buoyant plume. Under these conditions (dilution factor of 10.3) the temperature increase at the edge of the turbulent mixing zone is expected to be within 1.7ºC of the ambient water temperature (assuming the ambient surface and bottom temperatures are the same). Once again, these temperature effects are expected to extend a maximum of 15 m from the discharge under the modelled average annual case.

Replacement/Maintenance of Major Components and Systems

If refurbishment or maintenance activities result in the shutdown of one or more reactors, the flow and heat from the discharge diffuser could decrease for each unit shutdown. The resultant changes in lake water temperature would be less than (i.e., be bounded by) all units in operation.

5.3.6.1 Likely Effects on VECs

The VECs for the Surface Water Environment are pathways to human health, non-human biota and VECs in other environmental components. Accordingly, predicted changes in Lake Water Temperature are: i) compared to the applicable assessment criteria (see Section 5.3.4) to determine effects in the Surface Water Environment: and ii) considered within other applicable environmental components to determine the consequential effects on VECs in those components.

Likely environmental effects as a result of predicted changes in Lake Water Temperatures are described as follows.

Warmer water temperatures than currently exist in Lake Ontario at the mouth of Darlington Creek are likely to result from the creation of the embayment between the infill area and the St. Marys Cement property. These changes in and of themselves are not considered to represent an adverse environmental effect in the Surface Water Environment. Accordingly, no further evaluation of the effects of temperature change in the Surface Water Environment is warranted.

However, changes in Lake Water Temperature are considered further in terms of pathways to VECs in the Aquatic Environment (Section 5.4).

Thermal discharges associated with the operation of the service water and cooling water systems will likely result in a measurable change in water temperatures in the turbulent mixing zone of the discharge diffuser. Under the modelled average annual case, the change is typically confined to less than 50 m and 15 m east and west, respectively of the discharges for the once-through cooling option and the cooling tower option, respectively. These changes in and of themselves are not considered to represent an adverse environmental effect in the Surface Water Environment. Accordingly, no further evaluation of the effects of temperature change in the Surface Water Environment is warranted.

However, changes in Lake Water Temperature are considered further in terms of pathways to VECs in the Aquatic Environment (Section 5.4).

5.3.6.2 Mitigation Measures

In developing the assessment scenarios for the once-through lakewater cooling and cooling tower options, it was assumed that appropriate design features to pre-empt possible environmental effects will be incorporated into the Project based on industry practice and direct OPG experience. Accordingly, the following specific "in-design" mitigation measures were considered in evaluating the likely environmental effects:

- The once-through lakewater cooling design will incorporate water intake and discharge structures similar to DNGS, but sized to the necessary water volumes. The intake structure will be designed to limit the velocity of the water in the vicinity of the intake, minimizing the impingement of fish and effects of local currents. The discharge diffuser design of the DNGS limits the temperature increase to minimize effects on the aquatic environment. The design of a discharge for NND could be different than that for DNGS but would be designed to similarly mitigate potential environmental effects including those associated with a thermal plume; and

- The cooling tower option intake will be located at a minimum water depth of 10 m to decrease effects to aquatic habitat. Similarly, the cooling tower option will likely have a single port diffuser at a minimum water depth of 10 m.

No further mitigation measures for effects of the Project on Lake Water Temperatures are identified within the Surface Water Environment. Should mitigation measures be necessary to address likely effects on VECs in other environmental components, they will be described in the applicable sections of this EIS.

5.3.6.3 Residual Adverse Effects

No residual adverse effects on Lake Water Temperature are predicted in the Surface Water Environment as a result of the Project. Residual effects in other environmental components as they may result from lake water temperature as a pathway will be described in the appropriate sections of this EIS.

Potential consequences of climate change in the Surface Water Environment are likely to be evidenced in changing temperatures and water levels (see Section 6.4). Lake water temperatures are not expected to increase due to climate change such that they would inhibit efficient performance of the condenser cooling system (i.e. for once-through lakewater cooling) nor to alter the relative difference between cooling water intake and discharge temperatures (which determines the relative thermal input of the Project to the Lake). As noted in Section 6.4.2, increased lake water temperatures could result in more frequent algal entrainment and zebra mussel incidents, however, the deep water intake structure design will minimize the effect of these conditions.

5.3.7 Assessment of Likely Effects on Site Drainage and Water Quality

Likely effects on Site Drainage and Water Quality will be as a result of specific aspects of the following works and activities.

<u>Marine and Shoreline Works</u>

In conjunction with the warmer water likely to result in the embayment formed as a result of the lake infill, a reduction in mixing potential may lead to increased nutrient concentrations within the embayment area during the initial *Cladophora* growing period, potentially resulting in an increase in algae growth. The presence of algae problems along the Lake Ontario frontage from Durham to Niagara Regions is generally acknowledged. However, it is not specifically documented whether the frontage along Darlington Creek has been the site of such algae problems.

With regards to eutrophication, in recent years Lake Ontario has been classified as oligiotrophic (low or poor in dissolved nutrients such as nitrogen and phosphorus, hence with relatively low organic productivity such as algae, and usually rich in dissolved oxygen). Reported spring phosphorous concentrations in Lake Ontario have generally been less than 8 mg/L which is typical of all the Great Lakes except Lake Erie (US EPA 2006, 2007). The average phosphorous concentrations for lake water samples collected in the throughout the study areas from Spring 2008 to Fall 2008 was 6 mg/L in each study area. The potential for eutrophication to increase due to the Project is considered low since any discharges to the environment will meet regulatory water quality requirements (i.e., the PWQO states for phosphorous that a high level of protection against aesthetic deterioration will be provided by a concentration less than 10 mg/L for the ice-free period).

Construction of the coffer dam that surrounds the infilled area is expected to cause some localized re-suspension of fine lake sediments and may result in a visible turbidity plume during construction. Any turbidity plume is expected to be short in duration and contain suspended sediment concentrations that are less than those typically observed during storm events.

Construction of Intake and Discharge Structures

Construction of the structures in the lake is likely to cause some localized re-suspension of fine lake sediments and may result in a visible turbidity plume during construction. As noted above, however, any associated turbidity is expected to be short in duration and contain suspended sediment concentrations that are less than those typically observed during storm events.

Operation of Condenser, Condenser Circulating Water, Service Water, and Cooling Systems
Operation of Active Ventilation and Radioactive Liquid Waste Management Systems

Once-Through Lakewater Cooling Option

Since the once-through lakewater cooling system is non-contact, the water quality in the cooling water discharge flow will be generally consistent with the intake water quality. Changes to the water quality in the once-through cooling water discharge could, however, occur as a result of discharges into the cooling water flow from other plant systems. Actual discharge sources, flow rates and chemical concentrations are currently not known. However, all effluent discharges from the plant will comply with appropriate regulatory requirements for surface water discharges to Lake Ontario.

Construction of the new intake and diffuser for the once-through cooling option is expected to cause some localized re-suspension of fine lake sediments and may result in a visible turbidity plume. Any resulting turbidity plume is expected to be short in duration and contain suspended sediment concentrations that are less than those typically observed during storm events.

Cooling Tower Option

The effluent quality and flow rates for discharges associated with the cooling tower option are not known at this time since a specific technology and reactor vendor have not been selected. Similarly, the chemicals proposed to control water quality (biocides, anti-scaling agents and pH control) are vendor-specific. Nonetheless, any discharges to the environment from the cooling tower system will be appropriately treated to meet regulatory water quality requirements.

The expected dilution factor at the edge of the turbulent mixing zone is approximately 10 (see Section 5.3.6). Table 5.3-3 provides an example of the effect of the concentrating effect of recirculation within the cooling tower system water on quality at the edge of the turbulent mixing zone based on the known characteristics of Lake Ontario water quality. This example does not account for chemicals added to the cooling tower system for pH control, anti-scaling, etc., and does not account for bleed-off water treatment (although as noted above, effluent will be treated to meet regulatory water quality requirements). Based on the modelling carried out, all dilution factors for municipal drinking water intakes and surface water quality monitoring locations in the LSA and RSA are greater than 300. Water quality at these locations due to concentration in the cooling tower system will not differ meaningfully from the background conditions.

Construction of the new intake and outfall for the cooling tower option (including trenching for pipelines) is expected to cause some localised re-suspension of fine lake sediments and may result in a visible turbidity plume. Any resulting turbidity plume is expected to be short in duration and contain suspended sediment concentrations that are less than those typically observed during storm events

Replacement/Maintenance of Major Components and Systems

If refurbishment or maintenance activities result in the shutdown of one or more reactors and the total loading to the ALWMS and Inactive Drainage Systems remains consistent between normal operating conditions and refurbishment and maintenance activities, the liquid effluents from these systems will be treated and sufficient flow will be maintained through the discharge system to achieve a dilution capacity sufficient to ensure that C of A requirements are met prior to release to the environment.

TABLE 5.3-3
Estimated Water Quality at Edge of Turbulent Mixing Zone for Cooling Tower Option

Parameter[5]	Units	PWQO	Interim PWQO	Lake Mean[2]	New Intake Mean[3]	Effluent[4]	Edge of Turbulent Mixing Zone at Surface
Conductivity	mS/m			30	30	120	39
pH	units	6.5 to 8.5		8.2	8.1		
Alkalinity	ppm($CaCO_3$)	not >25% decrease		93	93	371	119
Total Hardness	ppm $CaCO_3$			129	129	516	165
Calcium	ppm			36	36	143	46
Magnesium	ppm			9.6	9.7	38.8	12.3
Total Dissolved Solids	ppm			176	177	710	227
Total Suspended Solids	ppm			1.9	2.2	8.9	2.6
Turbidity	NTU	no increase>10%		0.87	0.93	3.70	1.14
Ammonia	ppm			0.018	0.021	0.086	0.025
Ammonia (un-ionized)[1]	ppm	0.020		0.001	0.001		
Nitrate	ppm			2.2	1.7	6.8	2.6
Phosphorus	ppm		0.01	0.008	0.014	0.056	0.013
Potassium	ppm			1.8	1.7	7.0	2.2
Sodium	ppm			15	15	61	19
Aluminum	ppm			0.085	0.036	0.146	0.091
Aluminum (filtered)	ppm		0.075	0.006	0.006	0.024	0.008
Barium	ppm			0.037	0.023	0.092	0.042
Boron	ppm		0.2	0.11	0.03	0.14	0.11
Chromium	ppm	0.0089		0.0008	0.0005	0.0019	0.0009
Cobalt	ppm	0.0009		0.0004	0.0005	0.0021	0.0005
Copper	ppm	0.005	0.005	0.0013	0.0010	0.004	0.0015
Iron	ppm	0.30		0.026	0.032	0.129	0.036
Lead	ppm	0.025	0.005	0.0002	0.0001	0.0003	0.0002
Lithium	ppm			0.0029	0.0030	0.0120	0.0037
Manganese	ppm			0.0013	0.0015	0.0059	0.0018
Molybdenum	ppm		0.04	0.0013	0.0014	0.0054	0.0017
Nickel	ppm	0.025		0.0007	0.0007	0.0027	0.0009
Strontium	ppm			0.19	0.19	0.77	0.25
Titanium	ppm			0.0020	0.0024	0.0095	0.0027
Uranium	ppm		0.005	0.0004	0.0004	0.0015	0.0005
Zinc	ppm	0.030	0.02	0.0027	0.0022	0.0086	0.0033

Notes:
1. pH and Unionized Ammonia cannot be estimated due to dependencies on temperature.
2. Mean value for all samples collected at all Lake Ontario locations during field program (2007-2008) and are used to represent ambient water quality.
3. Samples collected at new intake location (SW10 bottom) were used to represent intake water quality.
4. Effluent concentrations are based on four times the intake concentration.
5. Parameter list does not include any system additives such as biocides, anti-scaling agents and pH control chemicals.
6. Values at the surface at the edge of the turbulent mixing zone (with the exception of pH and Unionized Ammonia) were estimated using the following equation: $C_X = C_E/D + [(D-1)C_B]/D$ where C_X is the concentration at any point (g/m^3), C_E is the effluent concentration (g/m^3), C_B is the background concentration (g/m^3), and D is the Dilution Factor.
7. The calculations assume that: a) constituents in the lake water were concentrated by a factor of 4 due to the cooling tower system and b) effluents were not treated prior to discharge to the lake.

5.3.7.1 Likely Effects on VECs

The VECs for the Surface Water Environment are pathways to human health, non-human biota and VECs in other environmental components. Accordingly, predicted changes in Site Drainage and Water Quality are: i) compared to the applicable assessment criteria (see Section 5.3.4) to determine effects in the Surface Water Environment: and ii) considered within other applicable environmental components to determine the consequential effects on VECs in those components.

Likely environmental effects as a result of predicted changes in Site Drainage and Water Quality are described as follows.

The operation of the cooling tower option will result in the concentration of constituents in the water withdrawn from the lake and chemicals will be added to the tower process water to ensure performance objectives are met. These flows will be returned to the Lake. Stormwater, active liquid effluent systems and inactive liquid effluent systems will contain contaminants. However, considering the in-design mitigation measures noted below, changes in Lake Water Quality associated with these processes are not likely to be meaningful (i.e., concentrations will meet regulatory requirements).

The embayment created at the mouth of Darlington Creek between the NND infilling area and St. Marys Cement wharf may experience increased algae growth and entrapment due to less mixing of the nutrients from Darlington Creek, warmer temperatures and the protected nature of the embayment.

Construction of the infill area coffer dam, as well as the cooling water intake and discharge for either cooling option is likely to result in turbidity in the lake water. Any turbidity created will be temporary in nature, and the extent of the turbidity plume will be limited because of the high energy environment of the nearshore.

The above-noted changes in Site Drainage and Water Quality are not considered to represent an adverse environmental effect in the Surface Water Environment. Accordingly, no further evaluation of associated effects in the Surface Water Environment is warranted.

However, changes in Site Drainage and Water Quality are considered further in terms of pathways to VECs in Human Health (Section 5.13) and Non-Human Biota (Section 5.14).

5.3.7.2 Mitigation Measures

In considering likely effects on Site Drainage and Water Quality, it was assumed that appropriate design features to pre-empt possible environmental effects will be incorporated into the Project based on industry practice and direct OPG experience. Accordingly, the following specific "in-design" mitigation measures were considered in evaluating the likely environmental effects:

- Good Industry Management Practices during all phases of the NND Project will be implemented with respect to stormwater management. Examples of Good Industry Management Practices include, among other actions: sediment control, appropriate treatment of dewatering discharges, stormwater conveyance systems and conventional stormwater treatment methods such as stormwater management ponds and oil-grit separators;

- Collection and appropriate management and disposal of all water having come into contact with blasting agents (e.g., ammonium nitrate/fuel oil - ANFO) and other contaminants;

- Dust and sediment control measures will be employed to minimize suspended sediment concentrations;

- Secondary containment of storage tanks (e.g., for fuel oil) will be provided to contain any releases from spillage or tank rupture;

- All cooling tower bleed-off will be directed to appropriate treatment and will not discharge to the groundwater system. Discharge is likely to ultimately be to Lake Ontario via management measures designed to accommodate sufficient volume for the system;

- All water impacted by radioactive or conventional contaminants, discharged from any liquid effluent stream (e.g., Inactive drainage System, Demineralized Water Treatment Sumps) to the environment (via the yard drainage system or directly to Lake Ontario or Darlington Creek) will be treated as necessary to meet regulatory requirements;

- Intermittent releases of Steam Generator blowdown will tested and treated, if necessary, to comply with the appropriate criteria for surface water discharge to Lake Ontario;

- All domestic sewage will be directed to the municipal wastewater treatment plant;

- All effluents associated with the Service Water System and the pumphouse trash racks of the once-through cooling water system will be tested and treated, if necessary, to comply with appropriate criteria for surface water discharge to Lake Ontario;

- Good Industry Management Practices will be employed during any activities associated with lake dredging, lake infilling (including coffer dam construction) and blasting in the lake (for intake and discharge structure construction) to minimize suspended sediment to meet appropriate regulatory requirements for discharge to Lake Ontario;

- Openings for ports of the cooling water discharge diffuser will be excavated into the lake floor using a method that will minimize deleterious effects to the environment; and

- During refurbishment or maintenance activities, all liquid effluents from the Radioactive Liquid Waste Management System (RLWMS) and inactive drainage systems will be treated, and adequate flow will be maintained through the discharge system, to ensure that regulatory requirements are met for release to the environment.

Should mitigation measures be necessary to address likely effects on VECs in other environmental components, they will be described in the applicable sections of this EIS.

5.3.7.3 Residual Adverse Effects

No residual adverse effects on Site Drainage and Water Quality are predicted in the Surface Water Environment as a result of the Project. Residual effects in other environmental components as they may result from lake water quality as a pathway will be described in the appropriate sections of this EIS.

Potential consequences of climate change in the Surface Water Environment are likely to be evidenced in changing temperatures and water levels (see Section 6.4). Modelling of the NND cooling water discharge plume to assess temperature and water quality implications (as pathways to Human Health and Non Human Biota; see Sections 5.13 and 5.14, respectively) considered the effects of changes in water levels and temperatures on the dilution factors used to establish contaminant concentrations, thereby effectively considering the sensitivity of the dilution factors due to effects of climate change.

5.3.8 Assessment of Likely Effects on Shoreline Processes

Likely effects on Shoreline Processes will be as a result of specific aspects of the following works and activities.

Marine and Shoreline Works

Creation of the LNDA in the embayment that will be formed east of the DN site will encourage the deposition of sediments from Darlington Creek, as well as offshore and up-drift sources. It is not likely that contributions from Darlington Creek alone will be sufficient to lead to re-development of the wetland habitat that currently fronts Darlington Creek and it is not expected that natural infilling of the embayment will progress at a measurable rate. This is not, however, considered to represent a meaningful adverse effect in terms of Shoreline Processes.

A local littoral sub-cell, the downdrift end of which is located immediately adjacent to Darlington Creek at St. Marys Cement wharf, is believed to intercept a large percentage of the alongshore sediment transport at this point. However, substantial sediment transport occurs offshore of St. Marys Cement property as the wharf appears to deflect sediment offshore into deeper water. It is unlikely that a considerable proportion of these sediments remain in suspension long enough to be transported back to shore east of the wharf. This conclusion is supported by the Lake Ontario Shoreline Management Plan (LOSMP) (Sandwell Swan Wooster, 1990) findings which suggested that shoreline protection at this location would not be detrimental to adjacent shoreline. Thus, bluff removal and shoreline protection is not considered to represent a meaningful adverse effect in terms of Shoreline Processes.

Infilling of the lake for the construction of the NND facility will eliminate approximately 40 ha of lake bottom.

Operation of Condenser, Condenser Circulating Water, Service Water, and Cooling Systems

Once-Through Lakewater Cooling Option

Previous studies have established that there is a deflection of the alongshore currents as a result of the operation of the existing DNGS intake and diffuser. It is expected that a similar deflection will likely result from the operation of the NND intake and diffuser.

The extent of lake bottom disturbance as a result of construction of the intake and discharge structures for the once-through lakewater cooling option is estimated at less than 2 ha.

Cooling Tower Option

There are no effects on local current patterns or sediment loading expected as the result of the operation of cooling towers at NND.

The extent of lake bottom disturbance as a result of construction of the intake and discharge structures for the cooling tower option is estimated at approximately 1 ha in total.

5.3.8.1 Likely Effects on VECs

The VECs for the Surface Water Environment are pathways to human health, non-human biota and VECs in other environmental components. Accordingly, predicted changes in Shoreline Processes are: i) compared to the applicable assessment criteria (see Section 5.3.4) to determine effects in the Surface Water Environment and ii) considered within other applicable environmental components to determine the consequential effects on VECs in those components. Likely environmental effects as a result of predicted changes in shoreline processes are described as follows.

Placement of the lake infill and construction of the cooling water intake and discharge structures will result in disturbance and loss of lake substrates. These changes in and of themselves are not considered to represent an adverse environmental effect in the Surface Water Environment. Accordingly, no further evaluation of these changes in the Surface Water Environment is warranted.

Loss of lake substrates is, however, considered further in terms of pathways to VECs in the Aquatic Environment (Section 5.4).

The above-noted changes in Shoreline Processes are not considered to represent an adverse environmental effect in the Surface Water Environment. Accordingly, no further evaluation of associated effects in the Surface Water Environment is warranted.

However, changes in lake substrates are considered further in terms of pathways to VECs in the Aquatic Environment (Section 5.4), the Terrestrial Environment (Section 5.5) and on Non-Human Biota (Section 5.14).

5.3.8.2 Mitigation Measures

Because there are no adverse effects on Shoreline Processes predicted as a result of the Project, no mitigation measures are identified within the Surface Water Environment. Should mitigation measures be necessary to address likely effects on VECs in other environmental components, they will be described in the applicable sections of this EIS.

5.3.8.3 Residual Adverse Effects

No residual adverse effects on Shoreline Processes are predicted in the Surface Water Environment as a result of the Project. Residual effects in other environmental components as they may result from lake substrates as a pathway will be described in the appropriate sections of this EIS.

Potential consequences of climate change in the Surface Water Environment are likely to be evidenced in changing temperatures and water levels. Neither the extent nor the uncertainty of environmental effects of the Project on Shoreline Processes is likely to be exacerbated by climate change.

5.4 Aquatic Environment

This Section provides an overview description of the potential effects of the Project on the Aquatic Environment. The detailed assessment of environmental effects in the Aquatic Environment is presented in the *Aquatic Environment – Assessment of Environmental Effects Technical Support Document, New Nuclear - Darlington Environmental Assessment*.

The Aquatic Environment comprises two environmental sub-components. These are: Aquatic Habitat and Aquatic Biota. The assessment addressed two primary effects pathways; specifically, physical changes to aquatic habitat, and organism-level effects involving intake losses and thermal discharge. Potential effects on non-human biota, including in the Aquatic Environment, as a result of exposures to radiological and conventional constituents from NND are evaluated in the *Ecological Risk Assessment and Assessment of Effects on Non-Human Biota TSD*.

5.4.1 Potential Project-Environment Interactions

Each Project work and activity was considered to determine if there was a plausible mechanism for it to interact with the individual sub-components of the Aquatic Environment. The potential interactions are illustrated as dots in the matrix on Table 5.1-1.

Each potential interaction was evaluated to determine if it was likely to result in a measurable change to the current (i.e., baseline) conditions in the applicable sub-components. The works and activities that were considered likely to result in a measurable change are summarized in Table 5.4-1.

TABLE 5.4-1
Project Works and Activities Likely to Measurably Change the Aquatic Environment

Project Works and Activities	Rationale
SITE PREPARATION AND CONSTRUCTION PHASE	
Mobilization and Preparatory Works	Preparatory works will involve the removal and/or alteration on-site ponds, a portion of two intermittent tributaries to Darlington Creek and intermittent portions of a tributary to Lake Ontario; road crossing of Darlington Creek and other physical works in proximity to the creek.
Marine and Shoreline Works	Changes in Aquatic Environment may result from eroded sediment in surface water discharges to Lake Ontario (surface water quality as a pathway to Aquatic Environment is considered in Surface Water Environment). Placement of lake infill and related structures will alter conditions in the Aquatic Environment.
Construction of Intake and Discharge Structures	Construction of intake and discharge structures will affect existing lake bottom conditions within a construction footprint and with the installation of permanent structures.
OPERATION AND MAINTENANCE PHASE	
Operation of Active Ventilation and Radioactive Liquid Waste Management Systems	Aquatic habitat and biota may be subject to effects of liquid effluents. Changes to surface water quality are considered in Surface Water Environment.
Operation of Condenser, Condenser Circulating Water, Service Water and Cooling Systems	Habitat and population effects due to cooling water circulation may be related to alteration of existing flow dynamics, thermal regime and water quality characteristics in the immediate areas surrounding the intake and diffuser. The physical and chemical changes are considered in Surface Water Environment. Aquatic biota will be impinged and entrained as a result of cooling and service water intake.
Replacement/Maintenance of Major Components	The periodic chemical cleaning of systems and components (e.g., steam generators) is likely to include discharge of effluent to Lake Ontario that may alter water quality and periodic shutdown of systems (e.g., condenser circulating water and service water) will change the flow dynamics and thermal regime in the Lake (surface water quality and circulation as pathways to the Aquatic Environment are considered in the Surface Water Environment).

Where a measurable change was considered likely, the interaction between the work or activity and the Aquatic Environment was further evaluated to determine whether the change from baseline conditions would represent an environmental effect.

5.4.2 Effects Assessment Scenario

The assessment of likely effects in the Aquatic Environment considered the bounding site layout in terms of overall physical disturbance in the NND development area. Development of the site will require removal of Treefrog Pond, Polliwog Pond and Dragonfly Pond (all of which have been created on the site) and uppermost portions of two intermittent tributaries of Darlington Creek. Depending on its final alignment, the new access road (relocated Maple Grove Road) may cross Darlington Creek in the northeast corner of the DN site, and such a crossing is assumed for EA purposes. Coot's Pond will remain. Although this pond was initially developed as a settling pond associated with the Northwest Landfill, it is the intention of the Project that the ecological attributes that have been successfully encouraged by OPG at the Coot's Pond location will be maintained through in-design mitigation measures incorporated for that purpose (see Section 5.5.4.2). While placement of excavated soil into the Northwest Landfill Area is not intended to extend east into the area of upper portions of an intermittent Lake Ontario tributary near Coot's Pond, related activities may have a consequence on the tributary. Lake infill will extend throughout an area of approximately 40 ha of near-shore Lake Ontario and construction of the cooling water intake and discharge structures will involve a further 2 ha (approximately) of lake bottom.

Because likely changes and associated environmental effects in the Aquatic Environment will be evidenced in Lake Ontario and, in large part, associated with cooling and service water intake and discharge flows between NND and Lake Ontario, the evaluation has considered both the once-through lakewater cooling option and the cooling tower option. The once-through lakewater cooling option is bounding in terms of environmental effects. However, where it is meaningful, assessment information is provided for both options.

It is to be noted that any effects of the NND Project on the Aquatic Environment are not expected to be measurable within the RSA. Therefore the assessment is focused within the SSA and LSAs as they have been established for the Aquatic Environment.

5.4.3 Assessment Criteria

Predicted changes in conditions in the Aquatic Environment as a result of the Project were evaluated against applicable criteria as described in Table 5.4-2. The criteria were applied for evaluation of changes in conditions as well as the effects that would result from the change.

TABLE 5.4-2
Evaluation Criteria used for the Aquatic Environment

Aquatic Environment Sub-component	Evaluation Criteria or Parameters
Aquatic Habitat	Quantity (i.e., area) and quality (i.e., function and relative productivity with respect to aquatic community).
Aquatic Biota	Population conservation (e.g., impingement losses in the context of known or likely population size of VEC Indicator species and comparisons with other facilities on the Great Lakes).

5.4.4 Assessment of Likely Effects on Aquatic Habitat

Likely effects on Aquatic Habitat will be primarily as a result of direct losses of habitat associated with physical development of the site and operation of the cooling/service water intake and discharge facilities. The effects on each of the on-site and Lake Ontario nearshore habitats as a result of the collective works and activities that included in site development and the intake and discharge facilities are summarised below.

<u>On-site Ponds (Treefrog, Dragonfly and Polliwog Ponds)</u>

These constructed ponds do not support fish and appear not to contribute directly or indirectly to downstream fisheries in any measurable way. Removal of the ponds is not expected to require a *Fisheries Act* authorization or fish habitat compensation, however opportunity will be available during Project design to create similar habitat elsewhere to offset the loss on-site habitat and biodiversity. These opportunities include the potential for creation of shallow wetland in other areas of the site including in the new lake infill area after the construction phase.

Removal of the ponds will result in loss of relatively uncomplicated aquatic habitat of low sensitivity that could be re-created elsewhere on the site. The ponds are also small in area and comprise a small fraction of similar habitat within the local and regional areas. Loss of the ponds will not measurably affect local or regional conservation of similar aquatic habitat and associated species, however, their loss is acknowledged as an effect of the Project, particularly in that opportunities to mitigate the loss are readily available as noted above.

<u>Darlington Creek Road Crossing</u>

As it is likely to be relocated to serve as a new access route into the DN site, Maple Grove Road may include a crossing of Darlington Creek at the northeast corner of the DN site. As an EA bounding assumption, the crossing will be a box culvert similar to existing crossings of the creek at the South Service Road and Highway 401.

Construction of the box culvert could result in the local loss of a short reach of stream habitat, as well as potential sedimentation in the creek from construction activities, and may constitute harmful alteration, disruption or destruction (HADD) under the *Fisheries Act.* This is considered further as an effect of the Project.

Upper Reaches of Intermittent Tributaries to Darlington Creek

The Project will affect portions of two intermittent swales that are upper reaches of tributaries to Darlington Creek. One is located in the proposed Northeast Landfill Area and the other lies south of the CN rail line within the NND station footprint. Approximately 400 m of each will be removed; however, realignment and incorporation of site drainage features and appropriately designed stormwater management facilities associated with the Northeast Landfill Area will maintain the contribution of flow into the lower reaches of the northern tributary and to Darlington Creek (see Section 5.6.7).

These upper reach portions of the intermittent tributaries do not directly support fish or aquatic invertebrates. However, their flow contributes to aquatic habitats downstream and they would, therefore, be considered “indirect” or “contributing” fish habitat. The loss/alteration of these reaches is considered further as an effect of the Project.

Coot’s Pond

Coot’s Pond was designed with its primary role to be a settling pond associated with the Northwest Landfill Area. It was intended to be fishless to promote amphibian biodiversity on the DN site. The pond’s connection to the nearby intermittent tributary is limited to its outflow structure which provides a barrier to upstream fish migration. Despite this strategy, a population of northern redbelly dace has become established in the pond. However, since the pond is a settling pond and is very poorly connected to nearby fish habitat, it is unlikely that it would be considered fish habitat subject to *Fisheries Act* provisions. Nonetheless, the function of Coot’s Pond will be maintained and will not be affected by the Project. In fact, modifications to the pond are proposed as in-design mitigation measures for the preservation of features in the Terrestrial Environment in the vicinity of the pond (see Section 5.5.4.2). Implementation of these measures may involve temporary disruption or alteration of Coot’s Pond, followed by habitat restoration. As such, these measures have the potential to improve conditions in the Aquatic Environment.

Upper Reaches of an Intermittent Lake Ontario Tributary

The portion of this intermittent Lake Ontario tributary that may be affected by the NND Project is located north of the CN tracks between the toe of the Northwest Landfill Area and Park Road. Although this area is not within the proposed footprint for soil placement into the Northwest Landfill Area, it is considered possible that the watercourse may be affected by the soil placement activities although, because the focus of the Project is on the eastern portion of the DN site, effects on this tributary are less likely.

Although upstream migration of fish from Lake Ontario is not possible, and the likelihood of pre-existing populations of resident fish species is low due to the intermittent nature of the watercourse, portions of the tributary are expected to support northern redbelly dace from Coot's Pond. A recently constructed series of beaver ponds within the tributary now provides localised areas of permanent aquatic habitat. Changes to the tributary could, therefore, directly affect fish habitat and are considered further as an effect of the Project.

Nearshore Lake Ontario

Lake infilling and shoreline protection associated with the NND Project will extend from the eastern limit of the DN site to approximately the DNGS intake channel, and about 100 m into the lake on its western limit and approximately 450 m on its most eastern dimension. This will result in the loss of approximately 40 ha of nearshore habitat. Filling along the portion in front of DNGS will advance the previously filled and armoured shoreline in a narrow band slightly further and deeper into Lake Ontario, resulting in some loss of nearshore habitat in approximately the 4-m to 5-m depth range. Filling at the NND portion of the site will be more extensive and extend out to approximately the 5-m depth.

Lake infilling will result in the permanent loss of some aquatic habitat within the infill footprint. The lakefill area represents a substantial portion of the Lake Ontario nearshore habitat in the Site Study Area (SSA), and to a lesser degree in the LSA, however, it is a very small proportion of the nearshore habitat that exists within the RSA. While population conservation and production on a regional or lakewide scale is unlikely to be measurably affected by lake infilling, it remains that a measurable area of habitat will be lost that is currently productive to varying degrees for various species. As such, a *Fisheries Act* Section 35(2) authorization will be required, along with fish habitat compensation measures to offset the loss of habitat and associated productivity. The loss of near-shore habitat as a result of lake infilling is considered further as an effect of the Project.

The consequence of this loss of habitat on Aquatic Biota is considered in Section 5.4.5.

Lake Infill Structure

As described in Section 5.3.5, lake infilling will create an artificial embayment between the infill area and the St. Marys Cement property. Due to the increased protection from the west resulting from the infilled area, the embayment which is already relatively sheltered as a result of the St. Marys Cement wharf will become even more sheltered from long-fetch waves from the west and southwest. The embayment created may experience increased algae growth and entrapment due to less mixing of the nutrients from Darlington Creek, warmer temperatures and the protected nature of the embayment.

The conditions and effects associated with the lake infill area and any embayment that may be created will largely depend on the final configuration of the lake infill. Accordingly, an adaptive management approach will be taken to address concerns that may arise in this area. This may involve the construction of a wetland to promote warm water fisheries and waterfowl habitat as a potential fish habitat compensation plan. Monitoring of the wetland could be incorporated with the ongoing site biodiversity monitoring plan. If monitoring indicates that algae growth in the area is expected be a problem, physical modifications to the shoreline in the area could be undertaken. These could include minor changes to the infill design geometry and/or further means such as additional lake infill to enhance water circulation to flush nutrients that could contribute to algal growth, or alternatively, measures to reduce water circulation, favouring the creation of a coastal wetland or marsh, dominated by vascular plants that would compete with algae for nutrients. Since development along the north shore of Lake Ontario has systematically reduced the quality and area of these coastal wetland habitats, the creation of productive new coastal wetland habitat would be an enhancement to the aquatic environment and the Lake Ontario fish community.

The potential effects on Aquatic Habitat associated with the embayment are considered an adverse effect of the Project.

Intake and Discharge Structures

The intake structure for the once-through lakewater cooling option will be situated at approximately the 10-m water depth to minimise interaction with aquatic species. Studies conducted for the placement of the DNGS intake found the area around the 10-m depth to be offshore of the highest concentrations of fish and inshore of the highest concentrations of freshwater shrimp (*Mysis*). The discharge diffuser will be situated along an alignment of approximately 1100 m, similar to DNGS, but in deeper water than DNGS, ranging from approximately 10 m to 20 m. Construction of the porous veneer intake structure and the diffuser ports will result in a loss of aquatic habitat estimated at <2 ha).

Siting of the intake and discharge diffuser structures will minimise the interaction with the aquatic habitat by avoiding shallow warmer water and nearshore spawning areas. The area of habitat affected will be negligible when considered against total habitat availability for these species. Nevertheless, a *Fisheries Act* Section 35(2) authorization will be required for this and other Project works and activities, and a fish habitat compensation plan developed to offset the loss of habitat and associated productivity. The loss of near-shore habitat as a result of construction of the intake and discharge structures is considered further as an effect of the Project.

The much smaller intake and discharge structures and associated effects of the cooling tower option are effectively bounded by the once-through lakewater cooling option described above.

Thermal Discharge

For purposes of the EA, the once-through cooling water discharge is assumed to be similar to that which is currently in use at DNGS. That system, which employs a series of diffuser ports, has met performance expectations by preventing the dispersion of heated water at temperatures more than 2°C above ambient beyond a narrow mixing zone along the diffuser alignment. The design of the diffuser is such that mixing and dilution occurs rapidly and there is minimal contact of heated water with lake bed substrates and no propagation of an extensive thermal plume as occurs with stations that employ surface discharge channels. The NND diffuser will extend into deeper water than the DNGS discharge due to bathymetric differences between the sites, and can reasonably be expected to be similar to or better than the DNGS diffuser in terms of mixing performance. The greater average depth of overlying water will enhance mixing. As with the DNGS diffuser, no measurable increase of water temperature is expected beyond the turbulent mixing zone of 50 m east or west of the discharge line under average annual conditions. In the case of a cooling tower diffuser, the turbulent mixing zone is expected to extend only approximately 15 m beyond the outlet under average annual conditions, therefore, that scenario is bounded by the analysis of the once-through lakewater cooling option.

Therefore, the effects of the thermal discharge on habitat are limited to very moderate water temperature increases in the immediate area surrounding the diffuser. In and of itself, this is not considered to represent an effect on aquatic habitat, however, the temperature change is considered further in Section 5.4.5 for its possible effects on aquatic biota.

5.4.4.1 Likely Effects on VECs

The VECs for the Aquatic Habitat sub-component are Darlington Creek and Darlington Creek Tributaries and Lake Ontario Nearshore Habitat. Likely effects on these VECs as a result of the Project are described as follows.

The Project will result in removal of the on-site ponds (Treefrog, Dragonfly and Polliwog Ponds) representing a net loss of on-site aquatic habitat. This is considered an adverse effect of the Project and is further considered in terms of mitigation measures and residual effects.

Construction of the new Maple Grove Road box culvert crossing of Darlington Creek could result in a HADD under the Fisheries Act. This is considered an adverse effect of the Project and is further evaluated in terms of mitigation measures and residual effects.

Approximately 400 m of the upper reaches of each of two intermittent tributaries of Darlington Creek will be lost and/or altered as a result of the Project. This is considered an adverse effect of the Project and is further evaluated in terms of mitigation measures and residual effects.

The Project may result in the degradation of fish habitat in the upper reaches of an intermittent tributary to Lake Ontario (west of Park Road) as a result of its re-alignment. This is considered an adverse effect of the Project and is further evaluated in terms of mitigation measures and residual effects.

The Project will result in the loss of approximately 40 ha of nearshore aquatic habitat as a result of lake infilling and construction of intake and discharge structures. This is considered an adverse effect of the Project and is further considered in terms of mitigation measures and residual effects.

The embayment created at the mouth of Darlington Creek between the NND infilling area and St. Marys Cement wharf may experience increased algae growth and entrapment due to less mixing of the nutrients from Darlington Creek, warmer temperatures and the protected nature of the embayment. This is considered an adverse effect of the Project and is further evaluated in terms of mitigation measures and residual effects.

5.4.4.2 Mitigation Measures

In considering likely effects on Aquatic Habitat, it was assumed that appropriate planning and design features would be incorporated into the Project based on industry practice and OPG experience. Accordingly, the following "in-design" mitigation measures were considered in evaluating likely environmental effects:

- Development of an appropriate Fish Habitat Compensation Plan[6] by OPG to satisfy the requirements of a federal *Fisheries Act* Section 35(2) authorization; and

- Location of the cooling and/or service water intakes and discharge structures in less sensitive habitats removed from more productive nearshore habitats and spawning areas.

In addition to the in-design mitigation measures noted above, the EA studies also identified additional measures to further ameliorate the likely environmental effects on Aquatic Habitat. These further mitigation measures are described as:

- Incorporation of wetland areas into the new lake infill area after the construction phase (it is noted that this is also identified as a mitigation measure for effects in the Terrestrial Environment and it will be necessary to coordinate this effort to ensure mutual benefit);

- Construction of a clear-span bridge in lieu of the box culvert crossing of Darlington Creek to avoid in-water works and the loss of creek habitat. Through the use of appropriate setbacks and sediment and erosion controls during construction, the crossing would avoid HADD. Alternatively, the stream crossing can be avoided entirely by relocating the access route during detailed design;

- Salvage and relocation of aquatic plants and biota, where practicable, to a suitable existing or created habitat in advance of site preparation activities; and

- As part of the detailed design of the lake infill, the potential effects on the Aquatic Habitat associated with shoreline processes will be considered and a plan developed to monitor these effects.

[6] OPG accepts the obligation under the federal *Fisheries Act* to provide acceptable and adequate mitigation/compensation measures for potential impacts to fish and fish habitat related to the Project. OPG has initiated the process by submitting an Application for Authorization for Works or Undertakings Affecting Fish Habitats to the DFO (September 30, 2009). At present, the measures identified are preliminary in nature and a list of potential options that may be used to form the compensation plan has been developed in consultation with DFO, MNR and CLOCA. The final mitigation/compensation plan provided will fulfill the requirements for an authorization under section 35(2) of the *Fisheries Act* (for the harmful alteration, disruption or destruction (HADD) of fish habitat). The final plan will also contain elements to address the requirements under Section 32 of the *Fisheries Act* for the destruction of fish by any means other than fishing.

5.4.4.3 Residual Environmental Effects

Considering the above-noted mitigation measures, no residual environmental effects on Aquatic Habitat are identified. It is reiterated that most important among the mitigation measures will be the development by OPG of an appropriate Fish Habitat Compensation Plan to satisfy the requirements of a federal *Fisheries Act* Section 35(2) authorization.

The assessment has concluded that the Project will not result in a residual adverse environmental effect on Aquatic Habitat because of the mitigation measures that will be implemented (notably, the Fish Habitat Compensation Plan). However, there may be a perception that the loss of aquatic habitat as a result of lake infilling and the construction of the intake and discharge structures will result in a residual adverse effect, notwithstanding that mitigation measures will be implemented to ensure there is no net loss of nearshore aquatic habitat. For this reason, therefore, the following is advanced for consideration of significance as if it was, in fact, considered a residual adverse effect:

- Loss of approximately 40 ha of Lake Ontario nearshore aquatic habitat as a result of lake infilling and construction of cooling water intake and discharge structures.

Neither the extent nor the uncertainty of environmental effects of the Project on Aquatic Habitat are likely to be exacerbated by climate change (see Section 6.4). Potential consequences of climate change include attached algae growth (e.g., *Cladophora*); expected to increase especially during the early spring periods at the eastern end of the proposed infill in the vicinity of the St. Marys Cement plant with increased water temperature and decreased water circulation. This could result in a change in the amount (e.g., larger) biomass of algae becoming detached. As noted above, the intended mitigation for this effect is an Adaptive Management Strategy to address potential nuisance algae growth for this location. This strategy will provide for the potential consequence of changes in the amount of algae detachment that may also result from warmer water associated with warmer temperatures.

5.4.5 Likely Environmental Effects on Aquatic Biota

Likely effects on Aquatic Biota are associated with localised mortality that may result from: i) some physical works associated with site preparation and construction (e.g., lake infilling, intake and discharge structures); ii) impingement and entrainment losses during the Operation and Maintenance phase; and, iii) thermal discharges from once-through lakewater cooling. Each is addressed below.

Effects of Physical Works

As noted above, an area of approximately 40 ha of nearshore habitat will be lost through lake infilling. A further 2 ha (approximately) will be lost as a result of the installation of the once-through lakewater cooling intake and discharge ports (this bounds the smaller area of habitat disturbance associated with the cooling tower option). Construction of the intake and discharge structures may involve some limited underwater blasting, and as such, will require a Section 32 authorization under the *Fisheries Act* for destruction of fish by means other than fishing. (As noted throughout Section 5.4.4, related authorizations under the *Fisheries Act* will also be required and all appropriate submissions will be combined and presumably, all authorizations received under the *Fisheries Act* will also be combined.)

Fish within the footprints of these physical works will, to the extent practicable, be salvaged and released elsewhere in the lake as the work advances. Benthic invertebrates and benthic fishes such as round goby cannot feasibly be salvaged from the fill and other physical works areas. Although there is no overall conservation concern associated with loss of these widespread species in such a limited area, the loss is considered an adverse effect of the Project.

Effects of Fish Impingement and Entrainment

Impingement

DNGS was the first OPG station where fish protection issues were considered in the decision-making process for both design and shoreline location of the cooling water intake. This design is completely different from a conventional submerged intake such as that used at Nanticoke GS (coal fired) or from a surface intake which exists at PNGS B. The porous intake concept used at DNGS was developed to circumvent the problems of the velocity cap intake. It incorporates features in its design to prevent entrapment of large schools of fish. For instance, flow near the intake was made heterogeneous and designed so that velocities did not exceed the swimming capacities of large schooling species such as alewife and rainbow smelt. The velocity design criterion for the intake was an average velocity of 0.15 m/s or less to minimize potential capture of the offshore migrating species. Other design features involved slot openings of 14-cm which acted as a behavioural barrier. Studies have shown that schooling fish such as alewife (the principal species impinged) avoid smaller sized openings due to space perception cues.

Fish protection principles were also considered in the location of the intake structure. Several studies were conducted to determine a “preferred” location for the intake taking into account distribution and abundance of entrainable biota including macrozooplankton, fish eggs and larvae, larval and adult fish. The intake was therefore located at approximately a 10-m depth.

The once-through lakewater cooling option bounds the cooling tower option for purposes of evaluating effects of impingement and entrainment. For purposes of the EA, the NND intake design is assumed to be the same as the existing DNGS intake with proportional increases to consider the higher flow requirement while maintaining the same intake velocity. The DNGS intake design has been very successful in reducing impingement. Underwater video studies showed that by maintaining low intake velocities, even small fish could swim over it without being drawn in (Patrick 1991).

DNGS condenser cooling water intake performance is summarized in Wismer (1997a) and includes impingement monitoring at DNGS from 1993 to 1996. These data were subsequently highlighted in the Darlington Ecological Effects Review (DEER) (ESG 2001) to assess impingement losses. Impingement for each year ranged from 164 kg in 1996 to 555 kg in 1994. Still, these estimates are not annualized and may be under-estimates due to errors in counting and fish identification (Wismer 1997b). In addition, in 1994, there were fish which bypassed the screens, and were estimated to weigh 1300 kg in sump samples which also likely contained debris (e.g. algae and zebra mussels).

Recent impingement sampling at DNGS was conducted from December 2006 to January 2008. Annual impingement was estimated to range from approximately 440 kg (approximately 15,000 fish) to 890 kg (26,020 fish), a total of only 8 species was collected of which alewife and round goby contributed approximately 85.9% and 8.5% of the total, respectively.

Based on DNGS recent impingement monitoring experience in 2007/2008, NND annual impingement loss for the relevant VEC Indicator species is estimated to range from approximately 23,500 fish to 43,500 fish for the once through cooling option (and approximately 3,900 fish for the cooling tower option). These are very small quantities relative to their populations in Lake Ontario; however, impingement of fish is considered an adverse effect of the Project. In addition, lake wide populations of alewife, the principal species impinged at DNGS, are on the decline (LOC 2009). No species listed under the SARA or the *Endangered Species Act* (*ESA*) are expected to be impinged.

Impingement losses at DNGS have been compared to those found at other power plants located on the Great Lakes which have either velocity cap or surface intakes. Results have clearly shown that losses at DNGS are considerably lower than these other facilities.

Entrainment

The DEER (ESG 2001) summarised entrainment effects at DNGS as involving mainly alewife, rainbow smelt and slimy sculpin. Although estimated numbers of larvae lost to entrainment were high during the 1993 and 1995 studies cited, the numbers of equivalent adults were considered insignificant to lakewide populations of alewife and smelt at that time. Invertebrate entrainment was also addressed in the ESG (2001) study and other studies by Kinectrics (Ager, D. D., *et al* 2005, 2006). Although estimates of chironomid, amphipod and *Mysis* losses involved large numbers, the respective studies cited high nearshore densities and huge lake populations of these organisms and concluded that they are unlikely to be affected.

Entrainment at NND is expected to also be dominated by alewife and smelt, the two most numerous fish species that spawn and occur as larvae in the nearshore. Although likely to be greater than at DNGS because of the larger flows, the losses are expected to remain on the level of thousands of adult equivalents against lake-wide populations which have been estimated at 1.03 billion (LOMU 2007). Entrainment of other fish species is expected to be low, related only to the incidental capture of some species and a lack of an entrainment pathway for those species that do not spawn or pass early life stages in proximity to the intake. Invertebrate entrainment is expected to be limited to the extremely abundant chironomids and amphipods, the populations of which are unlikely to be affected. Entrainment related to a cooling tower option at the NND is expected to be extremely low due to the small rate of intake relative to DNGS flow. Nonetheless, entrainment of aquatic biota is considered an adverse effect of the Project.

<u>Effects of Thermal Discharge</u>

As noted earlier, the once-through cooling water discharge is assumed to be similar to that currently in use at DNGS. The design of the diffuser is such that mixing and dilution occurs rapidly, there is minimal contact of heated water with lake bed substrates and the thermal plume occurs only within a narrow band along the diffuser line. The NND diffuser will extend into deeper water than the DNGS discharge due to bathymetric differences between the sites. Therefore, the potential effects of the thermal discharge on aquatic biota are limited to the immediate area surrounding the diffuser.

However, since the discharge diffuser mitigates contact of thermal effluent with the lake bottom there is little expectation of effect on benthic organisms and these are not considered further as an adverse effect of the Project. Based on temperature plume dynamics (see Section 5.3.6) lake bottom contact can occur with 4°C water during the winter, but this temperature is similar to ambient and is not deleterious to any of the benthic or demersal organisms.

For those VEC Indicator species that are not benthic or demersal, but occupy the water column, analysis of the DNGS discharge performance indicated that temperatures near the diffuser were within the preferred ranges for these species. Summer temperatures around the diffuser may not be suitable for whitefish, lake trout and other salmonid sportfish, but these are coldwater species that tend to occur in the colder, deeper areas of the lake during the summer months. During the other seasons, temperatures near the diffuser would be suitable when coldwater fish are inshore.

Water temperatures in the vicinity of the discharge diffuser are unlikely to affect benthic or demersal fish and invertebrates since the mixing is upwards and avoids the lakebottom, and are generally within the range of preferred temperatures of pelagic fish species (typical measured increases of 1-2^{o}C). Egg incubation studies on whitefish have shown that continuous elevations above ambient of 1^{o}C to 2^{o}C or periodic elevations of 3^{o}C to 4^{o}C will have little adverse effect. As such, there is no likely effect of thermal discharge on Aquatic Biota.

5.4.5.1 Likely Effects on VECs

The VECs for the Aquatic Biota sub-component are forage species, benthivorous fish, and predatory fish. VEC Indicator species include benthic invertebrates and the following fish: round goby, emerald shiner, alewife, white sucker, round whitefish, lake sturgeon, American eel, lake trout and salmonid sportfish. Likely effects on these VEC Indicator species as a result of the Project are described as follows.

The Project will result in localized loss of some VEC Indicator species (i.e., benthic invertebrates, round goby) within the construction area footprints of the lake infill and the cooling water intake and discharge structures. This is considered an adverse effect of the Project and is further evaluated in terms of mitigation measures and residual effects.

The Project will result in impingement and entrainment losses as a result of the once-through lakewater cooling option, and to a lesser degree, with the cooling tower option. No SARA species are expected to be impinged. This is considered an adverse effect of the Project and is further evaluated in terms of mitigation measures and residual effects.

5.4.5.2 Mitigation Measures

In considering likely effects on Aquatic Biota, it was assumed that appropriate planning and design features would be incorporated into the Project based on industry practice and OPG experience. Accordingly, the following "in-design" mitigation measures were considered in evaluating likely environmental effects:

- Capture and release fish from in-water work areas as work advances;
- Conduct underwater blasting program in compliance with applicable guidance to minimise incidental mortality to satisfy a *Fisheries Act* Section 32 authorization;

- Incorporation of intake and discharge structures for the once-through cooling option, of a design similar to DNGS but sized to the necessary water volumes. The intake structure will be designed to limit the velocity of the water in the vicinity of the intake, minimizing the impingement of fish and effects of local currents;

- Location of the cooling and/or service water intakes and discharge structures in less sensitive habitat removed from more productive nearshore habitats and spawning areas;

- Effects associated with impingement and entrainment will be considered in the Fish Habitat Compensation Plan noted above; and

- Implementation of an Adaptive Management Strategy to address changes to the environment associated with aquatic ecosystems over time.

No further mitigation measures for effects of the Project on Aquatic Biota are identified.

5.4.5.3 Residual Adverse Effects

Although the above-noted mitigation measures will be effective in addressing likely effects of the Project on Aquatic Biota, the following residual adverse effects may remain in spite of mitigation and are advanced for consideration of significance:

- Loss of some aquatic biota (i.e., benthic invertebrates, fish) during the construction of the lake infill and the cooling water intake and discharge structures; and

- Impingement and entrainment losses associated with the operation of the once-through lakewater cooling option, and to a lesser degree, the cooling tower option.

Neither the extent nor the uncertainty of environmental effects of the Project on Aquatic Biota are likely to be exacerbated by climate change (see Section 6.4). Reduced flow from the general watershed may lower water levels in Darlington Creek resulting in decreased fisheries productivity, however, the Creek is currently not deemed a productive fishery. Similarly, fish year class strength and fish community structure in Lake Ontario are expected to change with increased temperature with a decreasing recruitment of cold and coolwater species (e.g., lake trout, alewife), and increasing relative recruitment of warmwater species (e.g., smallmouth bass). These species are not predicted to be significantly affected by the Project.

5.5 Terrestrial Environment

This Section provides an overview description of the potential effects of the Project on the Terrestrial Environment. The detailed assessment of environmental effects in the Terrestrial Environment is presented in the *Terrestrial Environment – Assessment of Environmental Effects Technical Support Document, New Nuclear – Darlington Environmental Assessment*.

The Terrestrial Environment comprises six environmental subcomponents. These are: Vegetation Communities and Species, Insects, Bird Communities and Species, Amphibians and Reptiles, Mammal Communities and Species, and Landscape Connectivity. The assessment focused on physical change to terrestrial conditions (e.g., habitat removal) and its consequence on VECs. Potential effects on non-human biota in the Terrestrial Environment as a result of exposures to radiological and conventional constituents from NND are evaluated in the Ecological Risk Assessment and Assessment of Effects on Non-Human Biota TSD.

5.5.1 Potential Project-Environment Interactions

Each Project work and activity was considered to determine if there was a plausible mechanism for it to interact with the individual sub-components of the Terrestrial Environment. The potential interactions are illustrated as dots in the matrix on Table 5.1-1. As shown, almost all works and activities associated with site preparation and construction have the potential to interact with the Terrestrial Environment through emissions to air and/or the generation of noise. However, several of them are bounded by others with greater emissions to air and/or noise. There are also some interactions, although fewer of them, during the Operation and Maintenance phase.

Each potential interaction was evaluated to determine if it was likely to result in a measurable change to the current (i.e., baseline) conditions in the applicable sub-components. The works and activities that were considered likely to result in a measurable change are summarized in Table 5.5-1.

TABLE 5.5-1
Project Works and Activities Likely to Measurably Change the Terrestrial Environment

Project Works and Activities	Rationale
SITE PREPARATION AND CONSTRUCTION PHASE	
Mobilization and Preparatory Works	Will result in removal of vegetation and disruption of wildlife communities (including Bank swallow burrows); through dust and noise; and disrupt landscape connectivity and traffic likely to cause road mortality
Excavation and Grading	Dust and noise will disrupt habitat and waterfowl use of inshore lake area and traffic likely to cause road mortalities Construction activities will physically disrupt landscape connectivity Wetland areas beyond the excavation footprint may be affected by groundwater drawdown
Marine and Shoreline Works	Will disrupt waterfowl use of area and connectivity, and result in a loss of inshore habitat
Development of Administration and Physical Support Facilities	Migrant bird strikes on tall structures
Construction of Power Block	Dust may affect vegetation and dust and noise may disturb wildlife
Construction of Intake and Discharge Channels and Structures	Dust and noise likely to disturb near-shore birds
Construction of Ancillary Facilities	Migrant bird strikes on tall structures
Supply of Construction Equipment Material and Operating Plant Components	Dust may affect vegetation and dust and noise may disturb wildlife Traffic likely to cause road mortalities and disrupt landscape connectivity
Workforce, Payroll and Purchasing	Commuting traffic may affect vegetation and disturb wildlife (as a result of dust and noise) and cause road mortalities
OPERATION AND MAINTENANCE PHASE	
Operation of Condenser and Condenser Circulating Water, Service Water and Cooling Systems	Waterfowl likely to be attracted to facilities and warmer water Fogging, icing effects and salt deposition on vegetation communities and species Migrant bird strikes on tall structures
Operation of Electrical Power Systems	Particulate emissions and noise may affect vegetation and disturb wildlife
Operation of Site Services and Utilities	Station lighting likely to increase bird strikes Security measures may cause wildlife hazards (e.g., razor wire fencing) and disrupt connectivity
Physical Presence of the Station	Migrant bird strikes on station building
Administration, Payroll and Purchasing	Commuting traffic may affect vegetation and disturb wildlife (as a result of dust and noise) and cause road kills

Where a measurable change was considered likely, the interaction between the work and activity and the Terrestrial Environment was further evaluated to determine if the change in baseline conditions would represent an environmental effect.

5.5.2 Effects Assessment Scenario

The assessment of likely effects in the Terrestrial Environment was based on the bounding site development layout which represents the greatest overall physical disturbance in the NND development area.

Although it is acknowledged that Coot's Pond was initially developed as a settling pond, it is the intention of the Project that the ecological attributes that have been successfully encouraged at that location by OPG will be maintained essentially through in-design mitigation measures incorporated for that purpose (see Section 5.5.4.2).

Emissions to air (e.g., dust, particulate) and noise that may have consequence on flora and fauna were derived through the dispersion and noise modeling conducted for the bounding case emissions scenario applied for the assessment of effects in the Atmospheric Environment (see Section 5.2.2) and considered for potential effects in the Terrestrial Environment.

With a minor exception, any effects of the NND Project on the Terrestrial Environment are not expected to be measurable at the RSA or LSA level and for this reason, the assessment was focused within the SSA as it was established for the Terrestrial Environment (including the Bank Swallow Evaluation Area). The exception is in the case of a small area (approximately 1 ha) of wetland on the St. Marys Cement property immediately east of the DN site which may be affected as a result of changes in groundwater conditions. Although technically within the LSA, because of its very small size, and immediate proximity and connectivity to the SSA, this area was addressed as a small extension of the SSA.

5.5.3 Assessment Criteria

Predicted changes in conditions in the Terrestrial Environment as a result of the Project were evaluated against applicable criteria as described in Table 5.5.2. The criteria were applied for evaluation of changes in conditions as well as the effects that would result from the change.

TABLE 5.5-2
Evaluation Criteria Used for the Terrestrial Environment

Terrestrial Environment Sub-component	Evaluation Criteria or Parameter
Vegetation Communities and Species	• Ecological Land Classification (ELC) mapping • Provincially community ranks • Dust literature and benchmarks • Professional judgement • Provincially Significant Wetlands (PSW) or local functions (professional judgement) • Areas of Concern Habitat Guidelines
Insects	• Identified as S3 (provincially vulnerable by NHIC) • Species of Special Concern
Bird Communities and Species	• Federal law (protects most birds and their nests during the breeding season) • Noise literature • Professional judgement • Significant Wildlife Habitat guidelines
Amphibians and Reptiles	• Literature on habitat use • Professional judgement
Mammal Communities and Species	• Identified as S5 (provincially secure by NHIC) • Professional judgement
Landscape Connectivity	• Identified corridors • Professional judgement • Identified Life Science ANSIs • Identified ESAs

5.5.4 Assessment of Likely Effects on Vegetation Communities and Species

Likely effects on Vegetation Communities and Species will be bounded by the direct losses of vegetation communities and species as a result of works and activities performed during the Site Preparation and Construction phase including particularly, Mobilization and Site Preparation which will see extensive clearing and grubbing of the site to facilitate its development and Excavation and Grading which will generate dust. Dust emissions are also likely to result from some works and activities during the Operation and Maintenance phase with associated effects on vegetation. In terms of the more valued vegetation elements, the following is noted.

Cultural Meadow and Thicket Ecosystem

Approximately 140 ha or 58% of all natural or semi-natural upland communities at the DN site will be converted to alternate land uses. Over 93% of the loss (132 ha) consists of cultural communities and of these, 113 ha consists of the Cultural Meadow and Thicket Ecosystem.

While this is an entirely cultural ecosystem dominated by non-native plant species such as cool-season grasses, Black Locust, Dog-strangling Vine and Common Buckthorn, it still provides some habitat for native flora and fauna. These include a relatively diverse small mammal community, which in turn supports winter foraging by raptors. It also supports a variety of breeding birds although many true grassland species are absent or present only sporadically or in low numbers. An interesting feature of this ecosystem at the DN site is its use by Monarch butterflies; a species of Special Concern both federally and provincially. This loss will be evaluated as an effect of the Project.

Shrub Bluff Ecosystem

The Shrub Bluff Ecosystem is one of the only truly natural terrestrial systems at the DN site. It is supported by seepage that emerges from silty sand lenses into the bluff face and also into an adjacent small valley. The plant communities in this area include wetlands, woodland and shrub bluff. Many locally or regionally rare species have been recorded here and additional species of flora or fauna may be present but have not been located as the steep slopes are difficult to survey in some areas.

This area is relatively undisturbed. Nevertheless, its wildlife attributes are not remarkable and the highest level of function is the plant community.

This area in the southwest of the DN site will remain generally unaffected by the Project and because it will not subject to direct or measurable effects from noise or dust, will remain relatively undisturbed. Although its function is dependent upon groundwater movements, any change in conditions in this regard are not likely to be of a magnitude that would be of concern. Likely changes in the Shrub Bluff Ecosystem are not being further considered as an effect of the Project.

Wetland Ecosystem

Approximately 17 ha of wetlands will be removed which is 56% of those present on the site. In terms of ecosystem function, by far the highest levels of biodiversity and productivity are associated with Coot's Pond, Treefrog Pond, Polliwog Pond and Dragonfly Pond, all of which have been created on the site. All are surface water fed and although Coot's Pond was designed as a settling pond for the Northwest Landfill Area, as noted above, its ecological attributes have been successfully encouraged. The attributes and functions of the ponds range from habitat for migrant waterfowl, to breeding habitat for a wide variety and flora that are dependent on wetlands. Some other species, such as the Bank Swallows, use Coot's Pond for foraging purposes when inclement weather makes insects unavailable over Lake Ontario.

As a consequence of lowering the groundwater levels in areas beyond the excavation footprint through excavation dewatering and alteration of the topography, there is potential for conversion of approximately 5 ha of existing wetland (4 ha west of Holt Road; 1 ha on the St. Marys Cement property immediately east of the DN site) from wetland to upland vegetation communities.

The loss of some of these wetland ponds and the potential impairment of ecological function of Coot's Pond are considered further as an effect of the Project.

Woodland Ecosystem

Approximately 7 ha of the upland forest communities will be removed. This constitutes approximately half of the woodland present at the DN site. The Woodland Forest Ecosystem site is limited in area, isolated and fragmented. Even the largest patch is dominated by native species, vulnerable to edge effects and has no interior characteristics (i.e., characteristics that may develop when portions of a forest are at least 100 m from a well-developed edge). The soils of this unit harbour numerous earthworms from the adjacent fields which results in limited duff layer and summer soil desiccation. Also, the breeding bird community is impoverished with rarely any forest-based species present and very few breeding species are present at all. The woodland functions on the DN site are very minor and loss of half of this minor function is not considered further as an effect of the Project.

Rare Plant Species

Eleven plant species of conservation concern are located within the area of the site to be cleared. The potential loss on the site of four of these species, the Common Water-Flaxseed, Loesel's Twayblade, Cup Plant and Shag-bark Hickory are being considered further as an effect of the Project. A fifth, a Butternut tree located on the east side of the site south of the CN railway was determined by a qualified Butternut Health Assessor to be not retainable.

Of the others, one Buffaloberry shrub occurs in the development area, however many more are located elsewhere on the DN site. Similarly, many thousands of Grass-of-Parnassus are also located along the southwest bluff of the DN site. Greater Bladderwort and Green Fruit Bur-reed.

have colonized the constructed wetland and both are also present at Coot's Pond; neither of these is rare. The Fringed Gentian and the Small Yellow Ladies Slipper, known to occur at the base of the Northwest Landfill Area (Bobolink Hill) have not been recorded for five years.

Icing, Salt Deposition and Damage to Vegetation

Should the Project include cooling towers, there is a possibility that ice formation as a result of condensed vapour from the towers would cause damage to natural vegetation in the wetland area immediately east of the DN site on the St. Marys Cement property. However, since predictive atmospheric modelling (see Section 5.2.5) determined that icing resulting from either design cooling tower concept will not be measurably different from the annual average expected conditions, icing is not considered further as an effect of the Project. Based on the same atmospheric modelling, it was also concluded that potential salt deposition on vegetation associated with cooling towers was also of no further concern.

Dust and Particulate Disturbance to Vegetation

Dust and other particulate matter will be generated by the Project, particularly during the Site Preparation and Construction phase. During the growing season or year-round for evergreen species, dust can physically coat vegetation limiting photosynthesis and other growth processes. This in turn, can affect associated wildlife communities. Based on analyses of suspended particulate data relating to the Project (see Section 5.2.5 and the literature (e.g., Farmer 1991)), it was concluded that considering the very short periods of possible exposure and the concentrations of particulate likely to be deposited, a measurable effect of dust on vegetation was unlikely, other than possibly as very localized effects associated with haul routes.

Shoreline Disruption

The disruption of shoreline vegetation is considered inherently with loss of vegetation communities and species. Most of the shoreline areas that will be cleared are high energy environments with few plant species. The bluffs that characterise the undeveloped DN site shoreline are also near-vertical and support relatively few plants.

5.5.4.1 Likely Effects on VECs

The VECs for the Vegetation Communities and Species sub-component are Cultural Meadow and Thicket Ecosystem, Shrub Bluff Ecosystem, Wetland Ecosystem and Woodland Ecosystem. Likely effects on these VECs as a result of the Project are described as follows.

The Project will result in the loss of an estimated 113 ha of Cultural Meadow and Thicket Ecosystem. This is considered an adverse effect of the Project and is further considered in terms of mitigation measures and residual effects.

The Project will result in the loss of an estimated 17 ha of Wetland and Thicket Ecosystem. An additional 5 ha of Wetland Ecosystem may be converted to upland vegetation (as a result of changes in groundwater flow). This is considered an adverse effect of the Project and is further considered in terms of mitigation measures and residual effects.

Clearing and grubbing of the site may result in the loss of rare plant species: Shag-bark Hickory, Butternut, Common Water Flax-seed, Cup Plant and Loesel's Twayblade. This is considered an adverse effect of the Project and is further considered in terms of mitigation measures and residual effects.

5.5.4.2 Mitigation Measures

In considering likely effects on Vegetation Communities and Species, it was assumed that appropriate planning and design features would be incorporated into the Project based on industry practice and OPG experience. Accordingly, the following "in-design" mitigation measures were considered in evaluating likely environmental effects:

- Re-planting of approximately 40 to 50 ha of Cultural Meadow and approximately 15 to 20 ha of Cultural Thicket with native shrub plantings, and Woodland dominated by Sugar Maple;
- Include native forb seeds in seed mixture for Cultural Meadow re-planting; and
- The biodiversity of Coot's Pond will be maintained. Stormwater management techniques will be implemented to provide for adequate flow and water quality (e.g., TSS) management in Coot's Pond.

In addition to the in-design mitigation measures noted above, the EA studies also identified additional measures to further ameliorate the likely environmental effects. These further mitigation measures are described as:

- Creation of new fish-free wetland ponds with riparian plantings in appropriate locations on the DN site;

- Incorporation of wetland areas into the new lake infill area after the construction phase (it is noted that this is also identified as a mitigation measure for effects in the Aquatic Environment and it will be necessary to coordinate this effort to ensure mutual benefit); and

- Salvage and relocation or replanting of rare plant species (Shag-bark Hickory, Common Water Flax-seed, Cup Plant and Loesel's Twayblade) to a suitable existing or created habitat in advance of site preparation activities.

5.5.4.3 Residual Adverse Effects

Although the above-noted mitigation measures will be effective in addressing likely effects of the Project on Vegetation Communities and Species, the following residual adverse effect may remain in spite of mitigation and is advanced for consideration of significance:

- Loss within the DN site of approximately 40 to 50 ha of mostly Cultural Meadow Ecosystem.

Potential consequences of climate change in the Terrestrial Environment are likely to be associated with generally warmer temperatures, decreased precipitation and increased occurrence of extreme weather events (see Section 6.4). The effects of the Project on Vegetation Communities and Species are a result of the physical loss of portions of specific ecosystems because of DN site development. Neither the extent nor the uncertainty of such loss due to the Project is likely to be exacerbated by climate change.

5.5.5 Assessment of Likely Effects on Insects

Likely effects on Insects will be bounded by the direct loss of habitat as a result of works and activities performed during the Site Preparation and Construction phase, including particularly, Mobilization and Site Preparation which will see extensive clearing and grubbing of the site to facilitate its development, and Excavation and Grading which will generate dust and noise. In terms of the more valued insect species, the following is noted.

Dragonflies and Damselflies

Many species of dragonflies and damselflies have been attracted to the constructed and enhanced wetlands, including provincially rare species. The three recently constructed ponds (Treefrog Pond, Polliwog Pond and Dragonfly Pond) will be removed. Of the seven provincially Vulnerable species of dragonflies that have occurred at the DN site, only two have been associated with these ponds. One of these species, Williamson's Emerald, has occurred at Treefrog Pond as a visiting vagrant on only one occasion and is therefore not considered further. The other, Amber-winged Spreadwing has been recorded as breeding at Treefrog Pond, although it has not been seen elsewhere on the DN site and does not appear to be present every year. The on-site loss of this provincially Vulnerable dragonfly species is advanced for consideration as an effect of the Project.

Migrant Butterfly Stopover Areas

The DN site hosts thousands of migrant Monarch butterflies during the fall. The prime habitat at the DN site is Cultural Meadow, especially communities with good growth of forbs such as goldenrods and Common Milkweed. These are preferred nectaring plants for adults on migration during the late summer and fall. Prior to mitigation, approximately 74 ha of this habitat will be removed, or about 61% of that which is available at the DN site. Two regionally rare species, Buckeye and Little Sulphur have also been observed as migrants within the area that will be altered. The loss of this habitat as butterfly stopover area is considered further as an effect of the Project.

5.5.5.1 Likely Effects on VECs

The VECs for the Insect sub-component are dragonflies and damselflies and butterfly stopover areas. Likely effects on these VECs as a result of the Project are described as follows.

A rare species of dragonfly, Amber-winged Spreadwing, whose only known occurrence on the site is at Treefrog Pond will be lost to the DN site. This is considered an adverse effect of the Project and is further considered in terms of mitigation measures and residual effects.

Clearing of the DN site will result in the loss of an estimated 74 ha of Monarch (and other) butterfly habitat. This is considered an adverse effect of the Project and is further considered in terms of mitigation measures and residual effects.

5.5.5.2 Mitigation Measures

The mitigation measures described above in Section 5.5.4.2 for ameliorating effects in the Vegetation Community and Species sub-component will also be directly beneficial in addressing effects on the Insect sub-component since several of the effects are related directly to loss of habitat and the mitigation measures are intended to address this loss. No other mitigation measures are proposed specifically to address effects on Insects.

5.5.5.3 Residual Adverse Effects

Although the above-noted mitigation measures will be effective in addressing likely effects of the Project on Insects, the following residual adverse effect may remain in spite of mitigation and is advanced for consideration of significance:

- The net loss of approximately 24 to 34 ha of on-site habitat currently used as butterfly habitat during migration.

The effects of the Project on Insects is a result of the physical loss of portions of their habitat because of DN site development. Neither the extent nor the uncertainty of such loss due to the Project is likely to be exacerbated by climate change.

5.5.6 Assessment of Likely Effects on Bird Communities and Species

Likely effects on Bird Communities and Species will largely be as a result of the direct loss of habitat and construction-related disruption associated with works and activities performed during the Site Preparation and Construction phase. These will include, particularly, Mobilization and Site Preparation which will see extensive clearing and grubbing of the site to facilitate its development, and Excavation and Grading which will generate dust and noise, and the removal of lakeshore bluffs and associated Bank Swallow burrows. Effects may also occur as a result various works and activities during both the Site Preparation and Construction phase and the Operation and Maintenance phase in the form of bird strikes on structures and entanglement and entrapment in security fence; and during the Operation and Maintenance phase when waterfowl may be attracted to warmer water discharged from the condenser cooling system. In terms of the more valued bird communities and species, the following is noted.

<u>Noise Disturbance</u>

There is mounting scientific evidence that noise, including as it may be produced by vehicle traffic, is an important stressor, at least for breeding birds. Evidence concerning the specific levels of noise that cause effects to breeding birds and other wildlife is scant. A few studies have identified 24-hr Leq thresholds between 20 and 56 dBA (US DOT 2008). At these levels, declines in breeding bird density have been detected in some cases. However, other studies reviewed by the U.S. Department of Transportation (US DOT) reported waterfowl showed no effects at 24-hr Leq 63 dBA.

Several sources of constant and intermittent noise are associated with the existing conditions at the DN site, including DNGS, the CN railway, St. Marys Cement and Highway 401 traffic. The existing 24-hr Leq noise levels around Coot's Pond are approximately 56 dBA and these are expected to increase to the range of 65 dBA during site preparation activities when soil is being placed in the Northwest Landfill Area but will return generally to their current levels during the Operation and Maintenance phase. In other areas of breeding bird habitat, existing 24-hr Leq noise levels are in the 53 to 63 dBA range and are not likely to change, other than at St. Marys Cement's Raby Head Marsh, where it is likely to increase. However, given the existing relative high levels of noise throughout the DN site, it is likely that breeding birds and other wildlife communities are already adjusted to the elevated levels. As such, increased noise as a result of the Project is not considered a likely effect in the Terrestrial Environment.

Bird Strikes or Injuries

The killing or injury of birds may occur as a result of bird strikes on cooling towers and other structures and buildings and their possible entanglement in security fencing. There is considerable debate regarding the causal factors of bird strikes. In general, strikes appear to be weather related, seasonal (i.e., at times of migration in spring and fall) and more likely where migrants regularly occur. Bird strike studies conducted at OPG's Lennox and Nanticoke sites, both of which have double stacks in excess of 150 m, showed the highest number of bird strikes to occur during the fall migration when weather condition are less than favourable (i.e., low cloud, drizzle, fog). There are more strikes during fall which could possibly be attributed to birds that are less experienced and completing their first migration. As well, it is suspected that some lighting configurations may disrupt a bird's ability to navigate, leading to contact with structures. Studies have found the greatest numbers of strikes when incidental lighting that illuminated the actual obstacles was removed or ineffective such as during bad weather suggesting that illumination, if used properly, can reduce the number of strikes (Temme and Jackson 1979). Bird strikes due to the presence of cooling towers are considered a likely effect of the Project.

Fencing is not normally identified as a negative effect on the Terrestrial Environment since most wildlife species can readily negotiate the typical fencing systems. However, fencing around the Protected Area is substantial and some designs incorporate features that can entrap birds within the razor wire. This is a wildlife injury hazard that has been recorded at the existing DN site and can be expected to be reproduced at the NND Project. Entanglement or trapping of birds within security fencing is considered to be a likely effect of the Project.

Breeding Birds

Site clearing can be expected to reduce the habitat and consequently, the breeding population of the two indicator species of this VEC (i.e., Yellow Warbler and Red-eyed Vireo) by 54% and 74% respectively. They currently occupy primarily cultural communities and will persist at the DN site. This is typical of the effect likely on many of the more common species at the DN site. The loss of breeding bird habitat on the DN site is considered further as an effect of the Project.

None of the species identified within the development area are Provincially Vulnerable or Rare. Five species are noted as Regionally Scarce: Green Heron, Northern Harrier, Blue-gray Gnatcatcher, Northern Mockingbird and Clay-coloured Sparrow. Three of these species breed elsewhere on the DN site outside of the bounding areas of direct effects. The Northern Harrier will likely be lost from the DN site as a breeding bird. The Green Heron has nested twice, 2003 and 2005, in the area west of Treefrog Pond but did not nest in the same area in 2006 or 2007. The Blue-gray Gnatcatcher nests around and near Coot's Pond so it will likely not be affected. While some of the nine pairs of Northern Mockingbirds will be lost, this expanding species is generally associated with anthropogenic environments and therefore is not likely to be adversely effected by the Project. The Clay-coloured Sparrow is a recent arrival at the DN site, preferring early successional habitats that include small conifers. They were absent in 2007, but present in 2006, 2008 and 2009.

A successfully-breeding pair of Peregrine Falcon, a provincially and nationally "Threatened" species was located in the St. Marys Cement quarry in 2008. It is likely that this pair has nested or attempted to nest in the area for the past five years or so. The falcons' nest location is well-beyond the direct footprint of the Project. In addition, it is highly improbable that any indirect effects (e.g., noise or dust) attributable to the Project would have a measurable effect on this species given that the nest location is in an active quarry.

The Least Bittern is "Threatened" both provincially and nationally as its numbers have declined in response to wetland habitat loss. The Least Bittern was recorded at Coot's Pond in 2006 and 2007. However, there is marginally suitable breeding habitat at the DN site, about enough to support one breeding pair. At present, it is only considered to be a possible breeding species on the property. It is unlikely that a breeding attempt has occurred at Coot's Pond and it is similarly unlikely that the Project would have a measurable effect on this species.

A 2007 shoreline habitat survey of Bank Swallows along the entire Durham Region shoreline yielded a total of 86 colonies with a sum of 12,759 nesting burrows. The Project will effectively alter the shoreline on most of the OPG-owned portions of the Bank Swallow Evaluation Area. The active Bank Swallow burrows within this area numbered approximately 1,300 in 2007, representing 36% of the colony considered to be within the Bank Swallow Evaluation Area. The actual number and percentage of burrows potentially affected will vary from year to year. However, this number is estimated at approximately 1,300 burrows annually. This loss of Bank Swallow burrows is further considered as an effect of the Project.

Waterfowl Staging Areas and Winter Habitat

This area of shoreline appears to support larger than typical numbers of waterfowl in part because of the loafing opportunities offered by the DNGS structures and St. Marys Cement wharf. Project-related activities in the lake itself may disrupt these birds since they use this area throughout the year. More waterfowl will likely be attracted to the area after the disruptions have subsided, but an effect may occur while the disruptions are in progress.

The design of the condenser cooling water discharge diffusers is such that it will reduce the extent of warm water plumes but there is still likely to be an increase of areas of warm water along the shoreline and these may attract waterfowl in winter. Waterfowl are likely to use these areas as feeding and loafing opportunities. However, this effect is largely a positive one as migrant, summering and winter waterfowl will have additional habitat opportunities created by these effects. Coot's Pond is unlikely to be directly affected by the Project and waterfowl use is anticipated to continue. Potential changes in terms of Waterfowl Staging Areas and Winter Habitat are not considered further as an effect of the Project.

Migrant Songbirds and their Habitat

As the DN site is located on the Lake Ontario shoreline, it represents a location that is potentially important habitat for migrant birds in the spring. Some migrants cross the lake and may make first landfall at the DN site. Migrant birds often feed on insects emerging from Lake Ontario in May. Similarly in the fall, migrants move along the north shore of the lake and can gather in large numbers. Habitats present at the DN site consisting of woody vegetation are attractive to migrant birds. As has been noted above, the Project will result in the loss of an estimated 74 ha of such habitat and this is considered further as an effect on migrant songbirds.

Winter Raptor Feeding and Roosting Areas

This wildlife function is related to historical owl roosts, which tend to be in the same areas in years when there is sufficient food such as Meadow Voles. This function is also related to winter foraging habitat for raptors, which is primarily Cultural Meadow.

The primary Long-eared Owl roosts which are a meaningful indicator for this VEC are located in the west of the DN site. One such roost will be lost near the CN railway at least during the movement of excavated soil to the Northwest landfill Area. The other will remain alongside the Waterfront Trail east of the Northwest Landfill Area. The loss of the one primary roost and approximately 50% of the suitable winter foraging habitat is considered further as an effect of the Project.

5.5.6.1 Likely Effects on VECs

The VECs for the Bird Communities and Species sub-component are breeding birds and communities, waterfowl staging areas and winter habitat, migrant songbirds and their habitat, and inter raptor feeding and roosting areas. Likely effects on these VECs as a result of the Project are described as follows.

As a consequence of the removal of existing breeding bird habitat within the DN site, the Project will result in a decrease in the population of breeding birds on the site. This is considered an adverse effect of the Project and is further evaluated in terms of mitigation measures and residual effects.

As a consequence of the removal of the shoreline bluffs in the development area of the DN site, the Project will result in a decrease in Bank Swallow nesting habitat that supports approximately 1,300 active burrows (based on 2007 data) and overall colony size. This is considered an adverse effect of the Project and is further evaluated in terms of mitigation measures and residual effects.

Clearing of the DN site will result in the loss of an estimated 74 ha of migrant bird habitat. This is considered an adverse effect of the Project and is further evaluated in terms of mitigation measures and residual effects.

The presence of large (i.e., high) structures and buildings on the DN site, including and notably, natural draft cooling towers, will result in bird strikes causing injury and death to birds. This is considered an adverse effect of the Project and is further evaluated in terms of mitigation measures and residual effects.

The presence of security fencing on the DN site, including and notably, around the Protected Area, will result in bird entrapment causing injury and death to birds. This is considered an adverse effect of the Project and is further evaluated in terms of mitigation measures and residual effects.

Clearing of the DN site will result in the loss of an estimated 113 ha of Cultural Meadow and Thicket Ecosystem which is feeding and winter foraging area for raptors. This is considered an adverse effect of the Project and is further evaluated in terms of mitigation measures and residual effects.

5.5.6.2 Mitigation Measures

The mitigation measures described above in Section 5.5.4.2 for ameliorating effects in the Vegetation Community and Species sub-component will also be directly beneficial in addressing effects on the Bird Communities and Species sub-component since several of the effects are related directly to loss of habitat and the mitigation measures are intended to address this loss. Furthermore, the following additional in-design mitigation measures are included specifically as they relate to injuries to birds:

- Implementation of Good Industry Management Practice in the design and development of lighting systems and structures, including strategies to reduce the incidence of bird strikes to the extent practicable while considering the needs of navigation safety and site security; and

- Implementation of Good Industry Management Practice in the initial design of security fencing systems to reduce the incidence of bird entanglement and entrapment to the extent practicable.

In addition to the in-design mitigation measures noted above, the EA studies also identified additional measures to further ameliorate the likely environmental effects. These further mitigation measures illustrate a range of options being considered that focus specifically on addressing the decrease in Bank Swallow nesting habitat and colony size and indirectly support the reduction of aerial forage species in the RSA:

- Acquisition of lands that contain existing large Bank Swallow colony for study and protection;

- Development of artificial Bank Swallow habitat in potentially suitable locations on the DN site and the monitoring of existing colonies;

- Development of artificial habitat for aerial forage species (e.g., Chimney Swift and Purple Martin) in potentially suitable locations on the DN site;

- Development of partnerships to undertake research into the general decline of aerial foragers in Ontario; and

- Integrate interpretive opportunities related to the effects of the Project on shoreline bluff habitat and Bank Swallows such as erecting interpretative signage and constructing observation decks.

5.5.6.3 Residual Adverse Effects

Although the above-noted mitigation measures will be effective in addressing likely effects of the Project on Bird Communities and Species, the following residual adverse effects may remain in spite of mitigation and are advanced for consideration of significance:

- Decrease in populations of breeding birds on the DN site;

- Loss of nesting habitat for up to 1,000 active Bank Swallow burrows, however, some mitigation not directly comparable to effect, will result in advances for the species elsewhere; and

- Bird strike mortalities associated with natural draft cooling towers (estimated at <110 in the spring and <300 in the fall, assuming four cooling towers).

One possible consequence of climate change is the increased occurrence of extreme weather events (see Section 6.4). It may be speculated that increased weather events could result in a higher incidence of bird strikes because of high winds and reduced visibility. However, even if the predicted bird strike rate were to increase substantially, it is not likely that it would increase by an order of magnitude. In the event of such an increase, even though the effect would be greater numerically, it would reasonably be expected to remain within the general range predicted.

5.5.7 Assessment of Likely Effects on Amphibians and Reptiles

Likely effects on Amphibians and reptiles will be bounded by the direct loss of habitat as a result of works and activities performed during the Site Preparation and Construction phase, specifically, Mobilization and Site Preparation, which will see extensive clearing and grubbing of the site to facilitate its development.

Amphibian breeding occurs on the DN site at all four of the constructed ponds (Coot's, Treefrog, Dragonfly and Polliwog ponds). Key summer habitat for the species that breed at Coot's Pond (Green Frog, American Toad, Northern Leopard Frog and Midland Painted Turtle) may be disrupted moderately for one or two seasons. However, these populations are relatively small and sufficient habitat will remain to support these species. Given proposed changes to amphibian breeding ponds and the relatively low diversity of amphibians (and reptiles) it is unlikely that the Project, including road mortality, will have a measurable ecological effect on key summer habitat for amphibians and reptiles. However, three of the breeding ponds will be removed (Treefrog Pond, Polliwog Pond and Dragonfly Pond) hence these breeding areas will no longer exist. Loss of amphibian breeding habitat is considered a likely effect of the Project.

5.5.7.1 Likely Effects on VECs

The VECs for the Amphibians and Reptiles sub-component are breeding and key summer habitat. Likely effects on these VECs as a result of the Project are described as follows.

The Project will result in the removal of three amphibian breeding areas (Treefrog Pond, Polliwog Pond and Dragonfly Pond). This is considered an adverse effect of the Project and is further evaluated in terms of mitigation measures and residual effects.

5.5.7.2 Mitigation Measures

The mitigation measures described above in Section 5.5.4.2 for ameliorating effects in the Vegetation Community and Species sub-component will also be directly beneficial in addressing effects on the Amphibian and Reptile sub-component since several of the effects are related directly to loss of habitat and the mitigation measures are intended to address this loss. No other mitigation measures are proposed specifically to address effects on Amphibians and Reptiles.

5.5.7.3 Residual Adverse Effects

No residual adverse effects are likely on Amphibians and Reptiles.

The potential consequences of the Project on Amphibians and Reptiles is a result of the physical loss of portions of their habitat because of DN site development. Neither the extent nor the uncertainty of such loss due to the Project is likely to be exacerbated by climate change.

5.5.8 Assessment of Likely Effects on Mammal Communities and Species

Likely effects on Mammal Communities and Species will largely be as a result of the direct loss of habitat and construction-related disruption associated with works and activities performed during the Site Preparation and Construction phase. These will include, particularly, Mobilization and Site Preparation, which will see extensive clearing and grubbing of the site to facilitate its development, and Excavation and Grading which will generate dust and noise. Effects may also occur as a result of various works and activities during both the Site Preparation and Construction phase and the Operation and Maintenance phase in the form of collisions with Project-related traffic.

Removal of vegetation communities will result in the reduction of most of the breeding mammals at the DN site. A range of common mammal species occur at the DN site. However, the community is adaptable and tolerant of human activity. Populations of Meadow Voles (an effects measurement indicator of the VEC) will decline in proportion to the area of habitat that is ultimately removed. On the other hand, Muskrat is anticipated to persist at Coot's Pond where the population is present, except in draw-down years. The loss of habitat for breeding mammal is considered further as an effect of the Project.

The mammals present at the DN site are unlikely to be affected by road mortality at a measurable level. As noted above for birds, although some mammal species are sensitive to noise, those at the DN site are already exposed to elevated noise levels and have become habituated to these conditions.

5.5.8.1 Likely Effects on VECs

The single VEC for the Mammal Communities and Species sub-component is breeding mammals. Likely effects on this VEC as a result of the Project are described as follows.

Clearing of the DN site will result in the loss of an estimated 113 ha of Cultural Meadow and Thicket Ecosystem which represents Meadow Vole habitat. This is considered an adverse effect of the Project and is further evaluated in terms of mitigation measures and residual effects.

The effects of the Project on Mammal Communities and Species is a result of the physical loss of portions of their habitat because of DN site development. Neither the extent nor the uncertainty of such loss due to the Project is likely to be exacerbated by climate change.

5.5.8.2 Mitigation Measures

The mitigation measures described above in Section 5.5.4.2 as in-design and additional measures for ameliorating effects in the Vegetation Community and Species sub-component will also be directly beneficial in addressing effects on the Mammal Communities and Species sub-component, since several of the effects are related directly to loss of habitat and the mitigation measures are intended to address this loss. No other mitigation measures are proposed specifically to address effects on Mammal Communities and Species.

5.5.8.3 Residual Adverse Effects

No residual adverse effects are likely on Mammal Communities and Species.

5.5.9 Assessment of Likely Effects on Landscape Connectivity

Likely effects on Landscape Connectivity will be as a result of physical disruption (e.g., physical presence, noise, temporary barriers) associated with various works and activities performed during the Site Preparation and Construction phase.

There are no regional connectivity pathways associated with the DN site and the local linkage shoreline corridor is not continuous due to the presence of the St. Marys Cement property wharf complex and the existing DNGS. However, a terrestrial corridor does extend east-west through the DN site with a local linkage from the on-site ponds to the Raby Head Marsh wetland on the St. Marys Cement property. Some disruption of the east to west corridor can be expected during the Site Preparation and Construction phase. During this period movement of wildlife along this route will be minimal. The disruption to the wildlife corridor is considered further as an effect of the Project.

5.5.9.1 Likely Effects on VECs

The single VEC for the Landscape Connectivity sub-component is wildlife corridors. Likely effects on this VEC as a result of the Project are described as follows.

Access for wildlife travel along the wildlife corridor extending east-west across the DN site is likely to be interrupted at points in time during the Site Preparation and Construction phase.

This is considered an adverse effect of the Project and is further evaluated in terms of mitigation measures and residual effects.

5.5.9.2 Mitigation Measures

In considering likely effects on Landscape Connectivity, it was assumed that appropriate planning and design features would be incorporated into the Project based on industry practice and OPG experience. Accordingly, the following "in-design" mitigation measures were considered in evaluating likely environmental effects:

- Incorporate to the extent practicable in the Project design, measures to maintain access for wildlife travel on the east-west wildlife corridor during construction activities; and to enhance the corridor function for the long-term.

No other mitigation measures are identified for effects on Landscape Connectivity.

5.5.9.3 Residual Adverse Effects

Although the above-noted mitigation measure will be effective in addressing likely effects of the Project on Landscape Connectivity, the following residual adverse effect may remain in spite of mitigation and is advanced for consideration of significance:

- Periodic and short-term disruption to wildlife travel along the east-west wildlife corridor during the Site Preparation and Construction phase of the Project.

Potential consequences of the Project on Landscape Connectivity is directly related to physical disturbance of the wildlife corridor during construction activities. Neither the extent nor the uncertainty of this disturbance are likely to be exacerbated by climate change.

5.6 Geological and Hydrogeological Environment

This Section provides an overview description of the potential effects of the Project on the Geological and Hydrogeological Environment. The detailed assessment of environmental effects in the Geological and Hydrogeological Environment is presented in the *Geological and Hydrogeological Environment – Assessment of Environmental Effects Technical Support Document, New Nuclear – Darlington Environmental Assessment*.

The Geological and Hydrogeological Environment comprises three environmental sub-components: Soil Quality, Groundwater Quality and Groundwater Flow. These sub-components represent features that could be affected by the Project and as such serve as pathways or mechanisms for transfer of effects to other environmental components.

5.6.1 Potential Project-Environment Interactions

Each Project work and activity was considered to determine if there was a plausible mechanism for it to interact with the individual sub-components of the Geological and Hydrogeological Environment. The potential interactions are illustrated as dots in the matrix on Table 5.1.1. As shown, a large number of works and activities associated with Site Preparation and Construction have the potential to interact with the Geological and Hydrogeological Environment through disruptions of groundwater flow and degradation of groundwater and soil quality. There are also some interactions, although fewer of them, during the Operation and Maintenance phase.

Each potential interaction was evaluated to determine if it was likely to result in a measurable change to the current (i.e., baseline) conditions in the applicable sub-components. The works and activities that were considered likely to result in a measurable change are summarised in Table 5.6-1.

TABLE 5.6-1
Project Works and Activities Likely to Measurably Change the Geological and Hydrogeological Environment

Project Works and Activities	Rationale
SITE PREPARATION AND CONSTRUCTION PHASE	
Mobilization and Preparatory Works	Preparatory works will remove vegetation and loosen surface soils thereby increasing infiltration and the creation of roads and other hard surfaces will reduce infiltration. As a result, groundwater flow will change.
Excavation and Grading	Excavation and grading activities (regardless of the surface compression or compaction associated with them) will change the recharge characteristics of the site and therefore will change the groundwater flow. Placement of fill materials will alter infiltration and recharge conditions and flow conditions (e.g., gradients). Excavation and associated dewatering will change groundwater flow.
Marine and Shoreline Works	Extension of the shoreline into the lake will increase groundwater travel times to the lake thereby changing groundwater flow and groundwater discharge to the lake. Lake infill within the coffer dam will change infiltration rates at the shoreline.
Management of Stormwater	Stormwater runoff from parking areas, laydown areas and roadways discharging into ditches, swales, retention ponds, etc. can affect groundwater flow and recharge and when containing road salts, oils and greases, metals, nutrients, pesticides and petroleum hydrocarbons, can affect soil and groundwater quality.
OPERATION AND MAINTENANCE PHASE	
Operation of Active Drainage and Active Ventilation Systems	Releases of contaminants in the ventilation system and subsequent washout from precipitation have the potential to interact with the hydrogeology environment. Washout and infiltration of precipitation will affect groundwater quality.
Operation of Condenser and Condenser Circulating Water, Service Water and Cooling Systems	Condenser Circulating Water System (for once through cooling water) will intercept groundwater (i.e., in the Forebay Channel) thereby affecting groundwater flow.
Operation of Site Services and Utilities	Stormwater management systems (e.g., ditches, trenches) intercepts precipitation and changes groundwater infiltration and groundwater flow.
Physical Presence of the Station	Deep foundations, utility trenches, hard surfaces, stormwater management facilities and other features will affect and potentially change groundwater flow. The Forebay Channel will change the shoreline thereby altering groundwater discharge locations.

Where a measurable change was considered likely, the interaction between the work and activity and the Geological and Hydrogeological Environment was further evaluated to determine if the change in baseline conditions would represent an environmental effect.

5.6.2 Assessment Scenarios

The Project will change groundwater flow on the DN site as a result of dewatering during construction, and alterations to the existing topography and recharge/discharge conditions. These changes were evaluated through a computer-based, three-dimensional groundwater flow model to determine the nature and extent of the changes.

The bounding site development layout was adopted as the basis to consider Project-related changes in groundwater conditions. To ensure the full extent of possible changes due to site development was assessed, model runs of each of the individual model plant layout scenarios (see Figures 2.4-1, 2.4-2 and 2.4-3) were performed to evaluate conditions in terms of:

- Construction of the NND – considering the changes in the groundwater flow system resulting from different locations and configurations of the NND;
- Depth of excavation –considering the changes to the groundwater flow system resulting from both deep and shallow excavations into the bedrock;
- Soil landfilling – considering the consequences of stockpiling soil in the Northeast Landfill Area, the Northwest Landfill Area and of lake infilling; and
- Recharge – considering the altered groundwater recharge rates resulting from the Project.

The potential changes to the groundwater conditions as a result of some Project works and activities will be bounded by (i.e., contained within) the envelope of changes associated with other activities. Accordingly, the modelling scenarios considered the total overall physical changes on the DN site regardless of which specific works and activities would have contributed to those changes. In this manner, the changes associated with all works and activities contributing to alterations in groundwater flow and topography were modelled collectively rather than individually.

5.6.3 Assessment Methods

A three-dimensional groundwater flow model was developed to consider several different scenarios during site preparation, construction, operation and maintenance. Scenarios were incorporated into the model and the model run to determine the steady state conditions. Model results were plotted in terms of water table and piezometric elevations, drawdown associated with dewatering and baseflow impacts on Darlington Creek. The results of the modelling scenarios were then compared to the baseline conditions to establish the extent of likely changes.

5.6.4 Assessment Criteria

Predicted changes in conditions in the Geological and Hydrogeological Environment as a result of the Project were evaluated against applicable criteria as described in Table 5.6-2. The criteria were applied for evaluation of changes in conditions as well as the effects that would result from the changes.

TABLE 5.6-2
Evaluation Criteria for Geological and Hydrogeological Environment

Geological and Hydrogeological Sub-component	Evaluation Criteria or Parameter
Soil Quality	• Ontario Environmental Protection Act, Part XV.1, Table 3 • Comparisons to background concentrations • Professional judgement
Groundwater Quality	• Ontario Environmental Protection Act, Part XV.1, Table 3 • Ontario Drinking Water Standards • Comparisons to background concentrations • Professional judgement
Groundwater Flow	• Past studies • Professional judgement

5.6.5 Assessment of Likely Effects on Soil Quality

Likely effects on Soil Quality will largely be as a result of changes to it associated with the Management of Stormwater during both the Site Preparation and Construction phase and the Operation and Maintenance phase. Runoff from work sites and parking areas; and roadways containing road salt, oils and greases and petroleum hydrocarbons will discharge into ditches, swales and retention ponds from where some of it will infiltrate the surface. Most parameters typically found in stormwater are filtered out or adsorbed in the shallow soils. The locations and degree of changes as a result of surface infiltration will largely be dependent upon the design of the stormwater management system. Ditches and swales encourage groundwater infiltration whereas piped systems generally reduce it.

5.6.5.1 Likely Effects on VECs

The VECs for the Geological and Hydrogeological Environment are pathways to human health, to non-human biota and to VECs in other environmental components. Accordingly, predicted conditions in Soil Quality are: i) compared to the applicable assessment criteria (see Section 5.6.4) to determine effects in the Geological and Hydrogeological Environment and

ii) considered within other applicable environmental components to determine the consequential effects of Soil Quality on VECs in those components.

Likely environmental effects as a result of predicted changes in Soil Quality are described as follows.

Based on comparisons to the current operations at DNGS, stormwater management facilities can potentially affect Soil Quality. However, industry standard practices are effective in addressing this potential (see mitigation measures described below). Changes in Soil Quality as a result of the Project are not considered to represent an adverse effect in the Geological and Hydrogeological Environment. Accordingly, no further evaluation of the effects of the Project on Soil Quality is warranted.

Although no measurable changes in Soil Quality are likely as a result of the Project, Soil Quality as a pathway to VECs in other environmental components is considered as it may be relevant to Non-human Biota in Section 5.14.

5.6.5.2 Mitigation Measures

In considering likely effects on Soil Quality, it was assumed that appropriate design features to pre-empt possible environmental effects will be incorporated into the Project based on industry practice and direct OPG experience. Accordingly, the following specific "in-design" mitigation measure was considered in evaluating likely environmental effects:

- Good Industry Management Practices during all phases of the NND Project will be routinely implemented for stormwater management. Good practice typically includes, among other actions: sediment control practices, stormwater conveyance systems and conventional stormwater treatment methods such as stormwater management ponds and oil-grit separators.

5.6.5.3 Residual Adverse Effects

No residual adverse effects on Soil Quality are predicted in the Geological and Hydrogeological Environment as a result of the Project. Residual effects in other environmental components as they may result from Soil Quality as a pathway will be described in the appropriate sections of this EIS.

Potential consequences of climate change in the Geological and Hydrogeological Environment are likely to be evidenced in a general lowering of the groundwater table as a result of reduced precipitation, and increased evapotranspiration and runoff rates. Neither the extent nor the uncertainty of environmental effects of the Project on Soil Quality is likely to be exacerbated by climate change.

5.6.6 Assessment of Likely Effects on Groundwater Quality

Likely effects on Groundwater Quality will largely be as a result of changes to it associated with the Management of Stormwater during both the Site Preparation and Construction phase and the Operation and Maintenance phase.

Stormwater ditches, swales and retention ponds receive stormwater which can contain components such as road salts, oil and grease and petroleum hydrocarbons. Through infiltration, these contaminants can be transferred to the groundwater. Groundwater quality is usually impacted by conservative contaminants such as sodium and chloride associated with road salts. Chloride is a mobile contaminant and can be found in shallow groundwater in the area of roadways and parking lots. In a water table well adjacent to a roadside ditch that receives stormwater from Park Road, the chloride concentration in shallow groundwater was 963 mg/L versus an Aesthetic Drinking Water Objective of 250 mg/L. Sodium in shallow groundwater was found at a concentration of 265 mg/L versus an Aesthetic Drinking Water Objective of 200 mg/L. (Note: For comparison, background chloride concentrations in the shallow groundwater are typically less than 100 mg/L and sodium less than 50 mg/L). Groundwater will flow to and discharge into the lake and the groundwater on the site is not used for drinking purposes (nor is groundwater on the DN site considered to represent a potable groundwater source). There are no Provincial Water Quality Objectives for chloride and sodium and therefore there will be no adverse impacts on surface water quality resulting from stormwater-impacted groundwater discharging into surface water.

Operation of the active ventilation system results in releases from vents and stacks that have the potential to impact groundwater. Emissions of tritium from the operation of DNGS have resulted in elevated tritium concentrations in localised groundwater which are attributed to atmospheric washout or wet deposition of emissions from vents and stacks and subsequent infiltration into the groundwater system. The maximum measured tritium concentration in groundwater outside the Protected Area was approximately 500 Bq/L which is well below the Ontario Drinking Water Standards (ODWS) of 7,000 Bq/L.

5.6.6.1 Likely Effects on VECs

The VECs for the Geological and Hydrogeological Environment are pathways to human health, to non-human biota and to VECs in other environmental components. Accordingly, predicted conditions in Groundwater Quality are: i) compared to the applicable assessment criteria (see

Section 5.6.4) to determine effects in the Geological and Hydrogeological Environment and ii) considered within other applicable environmental components to determine the consequential effects of Groundwater Quality on VECs in those components.

Likely environmental effects as a result of predicted changes in Groundwater Quality are described as follows.

Based on comparisons to the current operations at DNGS, stormwater management facilities can potentially affect Groundwater Quality. However, groundwater on-site is not used as a source of drinking water and Provincial Water Quality Objectives do not exist for parameters such as chloride and sodium (common contaminants derived from stormwater) and industry standard practices are effective in addressing this potential (see mitigation measures described below). Changes in Groundwater Quality as a result of stormwater management are not considered to represent an adverse effect in the Geological and Hydrogeological Environment. Accordingly, no further evaluation of the effects of stormwater management on groundwater is warranted for the Geological and Hydrogeological Environment.

Changes in Groundwater Quality as a result of the Project are further considered as a pathway to VECs in other environmental components as it may be relevant to Non-Human Biota in Section 5.14.

Tritium concentrations were found at a maximum concentration of about 500 Bq/L in shallow groundwater just beyond the DNGS Protected Area. It is inferred, therefore, that operation of the NND may increase the concentration of tritium in groundwater. Using the existing conditions associated with DNGS as representative of the potential effects of the NND, given that the tritium concentrations are significantly lower than the ODWS (i.e., less than 10% of the ODWS), tritium in groundwater as a result of the Project is not considered to represent an adverse effect in the Geological and Hydrogeological Environment. Accordingly, no further evaluation of the effects of tritium in groundwater is warranted for the Geological and Hydrogeological Environment.

Tritium concentrations in groundwater as a result of the Project are further considered as a pathway to VECs in other environmental components as it may be relevant to Non-Human Biota in Section 5.14.

5.6.6.2 Mitigation Measures

In considering likely effects on Groundwater Quality, it was assumed that appropriate design features to pre-empt possible environmental effects will be incorporated into the Project based on industry practice and direct OPG experience. Accordingly, the following specific "in-design" mitigation measure was considered in evaluating likely environmental effects:

Good Industry Management Practices during all phases of the NND Project will be routinely implemented for stormwater management. Good practice typically includes, among other actions: sediment control practices, stormwater conveyance systems and conventional stormwater treatment methods such as stormwater management ponds and oil-grit separators.

5.6.6.3 Residual Adverse Effects

No residual adverse effects on Groundwater Quality are predicted in the Geological and Hydrogeological Environment as a result of the Project. Residual effects in other environmental components as they may result from groundwater quality as a pathway will be described in the appropriate sections of this EIS.

Potential consequences of climate change in the Geological and Hydrogeological Environment are likely to be evidenced in a general lowering of the groundwater table as a result of reduced precipitation, and increased evapotranspiration and runoff rates. It is reasonably expected that changes in the amount and frequency of precipitation and increases in runoff will be addressed by the stormwater management facilities and that the planned Good Industry Management Practices will remain applicable and effective in addressing both surface and groundwater quality issues associated with runoff. Accordingly, neither the extent nor the uncertainty of environmental effects of the Project on Groundwater Quality is likely to be exacerbated by climate change.

5.6.7 Assessment of Likely Effects on Groundwater Flow

Changes and associated effects on Groundwater Flow are described as follows in a framework of how conditions are predicted to change as a result of the works and activities that are likely to contribute to the change. Each such work and activity is considered below. The collective likely changes to groundwater flow associated with these works and activities were incorporated into the assessment scenarios evaluated for likely effects, as described in Section 5.6.2.

Excavation and Grading (Dewatering)

The greatest change to Groundwater Flow conditions will be as a result of dewatering necessary to facilitate excavation and grading activities. It is expected that dewatering will lower the water table in the area of new construction by approximately 14 m to an elevation of approximately 76 masl and this will permanently change the groundwater flow on the DN site. The drawdown associated with dewatering is largely limited to the DN site. However, minor change will extend east onto the St. Marys Cement property. There will be less than 1 m of drawdown in the shallow groundwater on the St. Marys property between the DN site and Darlington Creek. Dewatering will reduce baseflow in Darlington Creek and eliminate the tributary through the DN site. However, the reduced baseflow to Darlington Creek will be offset by increased recharge in the area of the proposed Northeast Landfill (see below). As a result, the change on Darlington Creek as determined by the groundwater flow model will be a net decrease of 2-5% of baseflow in the creek. This change is less than the typical accuracy of streamflow measurements (+/-10-15%) and as such, is not considered to be meaningful change from existing conditions.

Excavation and Grading; Marine and Shoreline Works

Earthworks associated with grading and excavation activities will result in changes to the water table elevation of +/- 1 to 2 m. This change is likely to be overwhelmed by the far more dramatic changes resulting from dewatering and are not expected to have a meaningful associated effect on groundwater flow. The exceptions to this are the construction of the Northeast Landfill Area, lake infilling at the Lake Ontario shoreline and the placement of additional soil in the Northwest Landfill Area. Construction of the Northeast Landfill will increase groundwater recharge in the area. This is considered a beneficial change in that it will offset the loss of baseflow in Darlington Creek and reduce the northern extent of the drawdown associated with dewatering.

Lake infilling will change both the groundwater flow and discharge patterns to the lake. Excavation and grading will eliminate groundwater discharge through the bluffs at Raby Head and toe drains as part of stormwater management on-site will collect groundwater and discharge it to the lake. While the groundwater flux to the lake will likely remain generally the same, the points of discharge will change.

Additional soil placement in the Northwest Landfill Area will increase recharge in the area resulting in more groundwater discharge to the existing settling pond (Coot's Pond). This is turn will increase groundwater flow to down-gradient creeks and wetland areas. However, the additional groundwater flow is unlikely to exceed a 10% increase and as such, will not be measurable.

Management of Stormwater

Stormwater management has the potential to alter groundwater flow conditions. However, the effects of any such changes would be minor compared to the changes associated with dewatering. Conversely, stormwater management can also result in beneficial effect on groundwater flow by offsetting changes as a result of dewatering. It is expected that appropriately placed stormwater management facilities associated with the creation of the Northeast Landfill Area will contribute to baseflow in Darlington Creek thereby offsetting, at least in part, the effects of dewatering on baseflow in the Creek.

Operation of Condenser and Condenser Circulating Water, Service Water and Cooling System

The operation of the Condenser and Condenser Circulating Water, Service Water and Cooling System (for the once-through lake water cooling system) will alter groundwater flow in that area of the site since the Forebay Channel required for such a system will collect groundwater that is under existing conditions discharging directly to Lake Ontario. However, because the Forebay Channel which is not an enclosed structure, maintains a hydraulic connection to the lake with the result being that any intercepted water ultimately flows into the lake, this is not considered a measurable change.

Physical Presence of the Station

Groundwater flow patterns within the area of NND-related structures will be permanently changed as a result of the presence of building, foundations, utility and service trenches, stormwater management facilities, landfilling/lake infilling, dewatering systems and other features. However, although the flow patterns may change, the ultimate flow direction and discharge point will remain to be Lake Ontario, as is currently the case.

5.6.7.1 Likely Effects on VECs

The VECs for the Geological and Hydrogeological Environment are pathways to human health, non-human biota and VECs in other environmental components. Accordingly, predicted changes in Groundwater Flow are: i) compared to the applicable assessment criteria (see Section

5.6.4) to determine effects in the Geological and Hydrogeological Environment and ii) considered within other applicable environmental components to determine the consequential effects of Groundwater Flow on VECs in those components.

Likely environmental effects as a result of changes in Groundwater Flow are described as follows.

Groundwater Flow conditions will be changed permanently by the NND Project. The most significant change will result from permanent dewatering necessary to facilitate the excavation and grading activities. Changes will also result from alterations to the topography and from new drainage system associated with the facility. These changes will result in consequential changes to existing flow and recharge characteristics. Some consequential changes will be beneficial in that they will serve to offset changes brought about by dewatering (e.g., increased recharge associated with the newly created Northeast Landfill Area will add new baseflow to Darlington Creek, some of which will have been lost as a result of dewatering.

Although Groundwater Flow patterns will change, the ultimate flow direction and discharge point will remain to be Lake Ontario, as is currently the case. As such changes in Groundwater Flow as a result of the Project are not considered to represent an adverse effect in the Geological and Hydrogeological Environment. Accordingly, no further evaluation of the effects of Groundwater Flow is warranted for the Geological and Hydrogeological Environment.

If changes in Groundwater Flow as a result of the Project are relevant as a pathway for effects on VECs in other environmental components, those changes and effects will be considered and described in the appropriate sections of this EIS.

5.6.8 Mitigation Measures

In considering likely effects on Groundwater Flow, it was assumed that appropriate design features to pre-empt possible environmental effects will be incorporated into the Project based on industry practice and direct OPG experience. Accordingly, the following specific "in-design" mitigation measures were considered in evaluating likely environmental effects:

- Stormwater management features incorporated into the Northeast Landfill Area will be designed and implemented with objectives of: i) contributing additional baseflow into Darlington Creek and ii) reducing the extent of the groundwater drawdown area north of the DN site; and

- All stormwater management features such as swales, ditches and retention ponds will be designed and implemented so as to optimize opportunities to recharge the groundwater flow regime with surface water runoff.

No further mitigation measures for effects of the Project on Groundwater Flow are identified within the Geological and Hydrogeological Environment. Should mitigation measures be necessary to address likely effects on VECs in other environmental components, they will be described in the applicable sections of this EIS.

5.6.9 Residual Adverse Effects

No residual adverse effects on Groundwater Flow are predicted in the Geological and Hydrogeological Environment as a result of the Project. Residual effects in other environmental components, as they may result from Groundwater Flow as a pathway, will be described in the appropriate sections of this EIS.

Potential consequences of climate change in the Geological and Hydrogeological Environment are likely to be evidenced in a general lowering of the groundwater table as a result of reduced precipitation, and increased evapotranspiration and runoff rates. The lowering of the water table resulting from climate change is likely to be small and gradual compared to the much more abrupt lowering of the water table resulting from the site dewatering. As such, neither the extent nor the uncertainty of environmental effects of the Project on Groundwater Flow is likely to be exacerbated by climate change.

5.7 Radiation and Radioactivity Environment

This Section provides an overview description of the potential effects of the Project on the Radiation and Radioactivity Environment. The detailed assessment of environmental effects in this environmental component is presented in the *Radiation and Radioactivity Environment – Assessment of Environmental Effects Technical Support Document, New Nuclear- Darlington Environmental Assessment*.

The Radiation and Radioactivity Environment comprises five environmental subcomponents. These are: Radioactivity in the Atmospheric Environment, in the Surface Water and Aquatic Environments, in the Terrestrial Environment, in the Geological and Hydrogeological Environments and in Humans.

5.7.1 Potential Project-Environment Interactions

Each Project work and activity was considered to determine if there was a plausible mechanism for it to interact with the individual sub-components of the Radiation and Radioactivity Environment. The potential interactions are illustrated as dots in the matrix on Table 5.1-1.

Each potential interaction was evaluated to determine if it was likely to result in a measurable change to the current (i.e., baseline) conditions in the applicable sub-components. The works and activities that were considered likely to result in a measurable change in the Radiation and Radioactivity Environment are summarised in Table 5.7-1.

Where a measurable change was considered likely, the interaction between the work and activity and the applicable environmental sub-components were further evaluated to determine if the change in baseline conditions would represent an environmental effect.

TABLE 5.7-1
Project Works and Activities Likely to Measurably Change the Radiation and Radioactivity Environment

Project Works and Activities	Radiation and Radioactivity Environment					Rationale
	Atmospheric Environment	Surface Water and Aquatic Environment	Terrestrial Environment	Geological and Hydrogeological Environment	Humans	
SITE PREPARATION AND CONSTRUCTION PHASE						
Excavation and Grading				•		Excavation and grading may result in local changes to the groundwater flow, thus redistributing any existing radioactivity in groundwater and soil (from emissions of existing facility).
Construction of Power Block			•		•	Construction of power block is expected to interact with the terrestrial environment and workers due to the industrial radiography completed as part of this activity.
Management of Stormwater				•		Management of stormwater is expected to result in the redirection of surface runoff flows, thus redistributing sub-surface soil radioactivity (from existing facility operations).
OPERATION AND MAINTENANCE PHASE						
Operation of Reactor Core					•	Reactor core operations can be expected to increase the radiation doses to workers.
Operation of Primary Heat Transport System					•	Workers are likely to be exposed to external gamma radiation and airborne emissions from this activity.
Operation of Active Ventilation and Radioactive Liquid Waste Management Systems	•	•	•	•	•	These systems can be expected to interact with all components of the Radiation and Radioactivity Environment through air and water emissions.
Operation of Fuel and Fuel Handling Systems					•	Workers can be expected to be exposed to increased radiation fields.

TABLE 5.7-1 (Cont'd)
Project Works and Activities Likely to Measurably Change the Radiation and Radioactivity Environment

Project Works and Activities	Radiation and Radioactivity Environment					Rationale
	Atmospheric Environment	Surface Water and Aquatic Environment	Terrestrial Environment	Geological and Hydrogeological Environment	Humans	
Operation of Condenser and Condenser Circulating Water, Service Water and Cooling Systems		•			•	Operation of condenser and condenser circulating water, service water and cooling systems is expected to result in airborne emission to workers and water emissions to surface water and members of the public.
Management of Operational Low and Intermediate-Level Waste	•		•		•	Management of operational low and intermediate-level waste is expected to result in airborne tritium emissions from the L&ILW building, increase the gamma radiation (in the Terrestrial Environment) and radiation doses to workers and members of the public.
Transportation of Operational Low and Intermediate-Level Waste to a Licensed Off-site Facility			•		•	Transport of operational low and intermediate-level waste to a licensed off-site facility is expected to increase the gamma radiation (in the terrestrial environment) and increase the radiation doses to workers and members of the public.
Dry Storage of Used Fuel			•		•	Dry storage of used fuel is expected to increase the gamma radiation (in the Terrestrial Environment) and radiation doses to workers and members of the public.
Replacement/Maintenance of Major Components and Systems	•	•	•	•	•	Replacement/maintenance of major components and systems is expected to interact with all components of the Radiation and Radioactivity Environment.

5.7.2 Assessment Criteria

Predicted changes in conditions in the Radiation and Radioactivity Environment as a result of the Project were evaluated against applicable criteria as described in Table 5.7-2. The criteria were applied for evaluation of changes in conditions as well as the effects that would result from the change.

TABLE 5.7-2
Evaluation Criteria for the Radiation and Radioactivity Environment

Radiation and Radioactivity Sub-Component	Evaluation Criteria
Atmospheric Environment[1]	• Radiation doses to humans must be below regulatory limits (CNSC 2000)[1]
Hydrology, Surface Water and Aquatic Environment[1]	• Drinking Water Standard (MOE 2007) • OPG's commitment to maintain annual average tritium levels at all nearby WSPs below 100 Bq/L (OPG 2008) • Radiation doses to humans must be below regulatory limits (CNSC 2000)[1]
Terrestrial Environment[1]	• Radiation doses to humans must be below regulatory limits (CNSC 2000)[1]
Hydrogeology Environment[1]	• Radiation doses to humans must be below regulatory limits (CNSC 2000)[1]
Members of the Public	• Radiation Protection Regulations (CNSC 2000) • Natural background radiation dose in Canada[2]
Workers	• Radiation Protection Regulations (CNSC 2000)

1 The levels of radiation and radioactivity in this environmental sub-component are not directly limited by regulation, but are indirectly limited by this requirement.
2 Used for comparison and perspective, but they are not regulatory criteria.

5.7.3 Assessment Methods

Two VECs were selected for the Radiation and Radioactivity Environment: pathway to human health, and pathway to non-human biota. Few regulatory criteria relate directly to radionuclide concentrations in the environment (e.g., atmospheric, terrestrial, surface water and aquatic, and geological and hydrogeological components). Nonetheless, radionuclide concentrations in these environmental components are indirectly regulated through the management and control of their consequential effects on Humans, as represented by radiation dose limits and to a lesser degree, by consequential effects on Non-human Biota. Dose limits do not apply, however, in the context of Non-human Biota.

Based on the above, the assessment of effects in the Radiation and Radioactivity Environment was conducted in the context of doses to humans that would result from the releases from the NND Project to various environmental media as represented by the environmental sub-components. Further, considering the "pathways" concept wherein radiation and radioactivity are simply the means for the transfer of an effect to a bio-physical receptor, the implications of the radiation dose in terms of Human Health are addressed in Section 5.13. The implications of radionuclides (and non-radioactive contaminants) on Non-human Biota are addressed in Section 5.14.

The following discussion of environmental effects is framed in terms of doses to humans, both the general public and workers. The calculations of doses were made using standard methodologies that considered exposures from all potential pathways from the NND Project to humans (e.g., inhalation of air, ingestion of garden vegetables, drinking of water, etc). The predicted concentrations of radionuclides in the various environmental media were primary inputs to the dose calculations.

5.7.4 Assessment Scenarios

The prediction of radionuclide concentrations in environmental media, and the calculation of doses to humans was carried out on the basis of a bounding release scenario that considered all of the radionuclides collectively associated with the three reactor types being considered (as described in Chapter 2) and their likely release rates to the environment. The maximum annual releases of the radionuclides to air and water from any of the reactor technologies, thus forming the bounding release scenario for assessment purposes, are presented in Tables 5.7-3 and 5.7-4, respectively.

TABLE 5.7-3
Radionuclide Releases to Air

Radionuclide	Bounding Value Release Rate (Bq/y)
Carbon/Tritium	
C-14	1.10E+12
HTO	4.80E+14
Gamma/Beta	
Ba-140	6.20E+07
Ce-141	6.20E+06
Co-57	1.21E+06
Co-58	3.40E+09
Co-60	1.29E+09
Cr-51	9.04E+07
Cs-134	3.40E+08
Cs-136	1.26E+07
Cs-137	5.32E+08
Fe-59	1.17E+07
Mn-54	6.36E+07
Nb-95	3.70E+08
Ru-103	1.18E+07
Ru-106	1.16E+07
Sb-125	9.04E+06
Sr-89	4.44E+08
Sr-90	1.78E+08
Zr-95	1.48E+08
Iodine	
I-131	1.78E+10
I-133	5.92E+10
Noble Gas	
Ar-41	5.04E+12
Kr-85	3.78E+15
Kr-85m	1.67E+13
Kr-87	5.88E+12
Kr-88	2.00E+13
Xe-131m	3.90E+14
Xe-133	9.54E+14
Xe-133m	2.00E+13
Xe-135	1.33E+14
Xe-135m	1.55E+12
Xe-138	1.33E+12

TABLE 5.7-4
Radionuclide Releases to Water

Radionuclide	Bounding Value Release Rate (Bq/y)
Carbon/Tritium	
C-14	1.0E+11[a]
HTO	1.40E+15
Gamma/Beta	
Ag-110	2.07E+07
Ag-110m	1.56E+08
All Others	2.96E+06
Ba-137m	1.84E+09
Ba-140	8.16E+08
Br-84	2.96E+06
Ce-141	1.33E+07
Ce-143	6.78E+07
Ce-144	4.68E+08
Co-58	4.96E+08
Co-60	6.52E+07
Cr-51	2.74E+08
Cs-134	1.47E+09
Cs-136	9.32E+07
Cs-137	1.97E+09
Fe-55	1.48E+08
Fe-59	2.96E+07
La-140	1.10E+09
Mn-54	1.92E+08
Mo-99	1.94E+08
Na-24	6.81E+08
Nb-95	3.11E+07
Np-239	6.45E+07

Radionuclide	Bounding Value Release Rate (Bq/y)
Gamma/Beta (con't.)	
Pr-143	1.92E+07
Pr-144	4.68E+08
Rb-88	4.00E+07
Rh-103m	7.28E+08
Rh-106	1.09E+10
Ru-103	7.28E+08
Ru-106	1.09E+10
Sr-89	1.48E+07
Sr-90	1.48E+06
Sr-91	8.88E+06
Tc-99m	1.89E+08
Te-129	2.22E+07
Te-129m	1.78E+07
Te-131	6.66E+06
Te-131m	3.45E+07
Te-132	5.34E+07
W-187	5.10E+07
Y-91m	1.48E+06
Y-93	3.99E+07
Zn-65	6.08E+07
Zr-95	3.40E+07
Iodine	
I-131	3.81E+09
I-132	2.43E+08
I-133	3.87E+09
I-134	1.20E+08
I-135	1.67E+09

a) OPG 2009c

5.7.4.1 Conditions in the Atmospheric Environment

Conditions in the Atmospheric Environment were derived based on maximum radionuclide releases to air for any of the reactor types. The maximum release from any of the three reactor types was applied as the bounding release value. In establishing the Table 5.7-3 values for releases to the Atmospheric Environment, the Project design and operations assumptions (i.e., for controlling or preventing release) as described in the *Scope of the Project for EA Purposes Technical Support Document* were considered. Based on the releases to air noted above in Table 5.7-3, radionuclide concentrations in the atmosphere are not considered in and of themselves, to represent an adverse environmental effect and accordingly, are not evaluated further in this regard.

However, radionuclide concentrations in air are pathways to potential effects on Human Health and on Non-human Biota. As such, radioactivity in the Atmospheric Environment is considered further in Section 5.7.5 in terms of effects on Humans and in Section 5.14 in terms of effects on Non-human Biota.

5.7.4.2 Conditions in the Surface Water and Aquatic Environments

Conditions in the Surface Water and Aquatic Environments were derived based on maximum radionuclide releases to water for each of the reactor types. The maximum release from any of the three reactor types was applied as the bounding release value. In establishing the Table 5.7-4 values for releases to the water, the Project design and operations assumptions (i.e., for controlling or preventing release) as described in *Scope of the Project for EA Purposes Technical Support Document* were considered. Based on the releases to water noted above in Table 5.7-4, radionuclide concentrations in water are not considered in and of themselves, to represent an adverse environmental effect and accordingly, are not evaluated further in this regard.

However, radionuclide concentrations in surface water are pathways to potential effects on Human Health and on Non-human Biota. As such, radioactivity in the Surface Water and Aquatic Environments are considered further in Section 5.7.5 in terms of effects on Humans and in Section 5.14 in terms of effects on Non-human Biota.

5.7.4.3 Conditions in the Terrestrial Environment

Conditions in the Terrestrial Environment will largely be related to releases to air and water and subsequent deposition and/or uptake. However, these conditions will also be affected by external gamma radiation levels including spent fuel and low and intermediate level (L&ILW) waste, both in transit and in storage.

Based on the releases to the environment indicated in Tables 5.7-3 and 5.7-4, the correspondingly very low levels of deposition and uptake, the Project design and operation assumptions (described in *Scope of the Project for EA Purposes Technical Support Document)* and the operational practices and procedures that will routinely be applied based on policy and good practice, radiation and radioactivity is not considered in and of itself, to represent an adverse environmental effect in conditions in the Terrestrial Environment and accordingly, is not evaluated further in this regard.

However, radionuclide concentrations in the Terrestrial Environment (e.g., in plants, vegetables and other farm-raised foods) are pathways to potential effects on Human Health and on Non-human Biota. As such, radioactivity in the Terrestrial Environment is considered further in Section 5.7.5 in terms of effects on Humans; and in Section 5.14 in terms of effects on Non-human Biota.

5.7.4.4 Conditions in the Geological and Hydrogeological Environment

Conditions in the Geological and Hydrogeological Environment will largely be related to releases to air and water and subsequent deposition on soil surfaces and/or transfer into groundwater.

Based on the releases to the environment indicated in Tables 5.7-3 and 5.7-4, the correspondingly very low levels of deposition and transfer to groundwater, the Project design and operation assumptions described in the *Scope of the Project for EA Purposes Technical Support Document*, and the operational practices and procedures that will routinely be applied based on policy and good practice, radiation and radioactivity is not considered in and of itself, to represent an adverse environmental effect in conditions in the Geological and Hydrogeological Environment and accordingly, is not evaluated further in this regard.

However, radionuclide concentrations in the Geological and Hydrogeological Environment (e.g., in groundwater) are pathways to potential effects on Human Health and on Non-human Biota. As such, radioactivity in the Geological and Hydrogeological Environment is considered further in Section 5.7.5 in terms of effects on Humans and in Section 5.14 in terms of effects on Non-human Biota.

5.7.5 Likely Effects of Radioactivity on Humans

5.7.5.1 Doses to the General Public

The receptors selected for evaluating doses to the public from NND included nearby residents, commercial/industrial workers, farms (including dairy farms), schools and users of recreational facilities (e.g., campers, soccer players, etc.). However, it should be noted that for ease of discussion, the individual receptor with the highest dose from each receptor type (e.g., dairy farm, farm, resident, recreational, etc.) was selected to represent the receptor type for discussion in the main text.

The total dose estimates considered all relevant exposure pathways using reasonably conservative assumptions (e.g., bounding release scenario, exposure times, etc.), and were calculated for both potential condenser cooling options (i.e., once-through cooling with lake water; and cooling towers). The calculated doses from NND to the various receptors are shown on Table 5.7-5. As indicated, the maximum dose is to the resident at the dairy farm is approximately 4 µSv/y (0.004 mSv/y). The dose to this maximum-exposed receptor is the same for either cooling option. The dose is well below (i.e., less than 0.5% of) the regulatory limit for members of the public of 1 mSv/y (CNSC 2000). Furthermore, this maximum dose is a small fraction of the annual dose from natural background radiation in Canada (about 1,840 µSv/y [see Section 4.7]).

TABLE 5.7-5
Doses for Maximum Receptor for Each Scenario Based on Bounding Releases

Receptor Scenario	Age	Total Dose µSv/y	
		Once-through Cooling Option	Cooling Tower Option
Bowmanville	1year	0.87	1.0
Campers Long Term	1year	1.3	1.4
Campers Short Term	Adult	0.031	0.032
Dairy Farm Residents	1year	4.4	4.4
Farm Residents	1year	3.0	3.0
Farm Worker	Adult	0.15	0.15
Fisher	Adult	0.061	0.17
Industrial Workers	Adult	0.70	0.70
Oshawa	1year	0.79	0.84
Recreational	1year	0.090	0.090
Rural Residents	1year	2.6	2.6
Teacher/Student	Adult	0.086	0.086
West-East Beach	1year	2.5	2.5

5.7.5.2 Doses to Workers

The reactors being considered for the NND Project are all Generation III+. As such, the plant equipment designs are simplified from previous design versions and configured to facilitate ease of maintenance and safe operation. In addition, the previous lessons learned have been used to develop design strategies to minimize occupational dose during execution of different phases of the plant life cycle like outages, fuelling operations and future plant rehabilitation. These design features include requirements for better plant equipment reliability performance resulting in less maintenance needs and shorter plant outages. The improved equipment reliability performance standards will contribute to shorter and efficient outage execution requiring plant workers to spend less time in radiological hazard locations, hence receiving less radiation dose. Thus, it is expected that the actual dose for the three reactor designs (AP1000, EPR and ACR-1000) will be lower than existing reactors of predecessor designs.

Predicted Worker Dose

The annual collective dose to NEWs averaged over the plant life for the three proposed reactors have been estimated by the respective vendors. The estimated bounding annual collective dose for NND is approximately 0.67 P-Sv per unit or 2.68 P-Sv in total, considering the maximum number of units for each reactor type (AECL 2008, U.S. NRC 2008a, U.S. NRC 2008b). This includes both normal operations and routine outage maintenance activities.

Collective doses associated with reactor refurbishment will vary among the design depending on:

- Extent and nature of the required work;
- Time between reactor shutdown and commencement of refurbishment; and
- Level of decontamination conducted.

Collective dose associated with refurbishment work was not provided by all reactor vendors, therefore, historical experience from operational reactors was also considered. The maximum estimated collective dose to workers for NND mid-life refurbishment is expected to be less than 4 P-Sv per unit (AECL 2008, NEA 2008, NEA 2007, NEA 2006, NEA 2005, NEA 2002).

The collective dose estimates to workers from normal operations and refurbishment activities, as noted above, represent the best preliminary estimates. Radiation protection programs at NND will be in place, including implementation of ALARA practices, throughout the operation and refurbishment of the plant, and will contribute to dose reduction through implementation of good practices such as work planning, utilization of shielding, contamination control, remote tooling, and teledosimetry.

During the Site Preparation and Construction phase, workers may be exposed to external gamma radiation from industrial radiography associated with construction activities (e.g., construction of power block). However, this activity would not alter the radiation and radioactivity environment and workers participating in these activities would be required to follow all regulations, standards and safe work practices.

During the Operation and Maintenance, and Decommissioning phases, the access and movement of non-NEWs involved on NND will be controlled by OPG. Radiation doses to these workers (non-NEWs) as a result of licensed activities on site will also be controlled by OPG, thus ensuring that they do not exceed 1 mSv/y, the regulatory limit for individuals who are not NEWs.

5.7.5.3 Likely Effects on VECs

The VECs for the Radiation and Radioactivity Environment are pathway to Human Health, and pathway to Non-human Biota. Likely effects on these VECs as a result of the Project are described as follows.

NND will contribute to radiation doses to the general public. The predicted radiation doses are well below the regulatory limit for members of the public of 1 mSv/y, and are a small fraction of the annual dose from natural background radiation. Accordingly, radiation doses to the general public are not considered to represent an adverse effect of the Project in the Radiation and Radioactivity Environment and no further evaluation is warranted in this environmental component.

However, doses to the general public are considered further in terms of pathways to VECs in the Human Health environmental component (Section 5.13).

NND will contribute to radiation doses to workers. The predicted radiation doses are well below the regulatory limit for workers (100 mSv per 5 years with a maximum of 50 mSv in any one year). Accordingly, radiation doses to workers are not considered to represent an adverse effect of the Project in the Radiation and Radioactivity Environment and no further evaluation is warranted in this environmental component.

Doses to workers are, however, considered further in terms of pathways to VECs in the Human Health environmental component (Section 5.13).

NND will result in emissions of radionuclides to the environment. Therefore, radionuclide emissions are considered further in terms of pathways to VECs in the Non-human Biota environmental component (Section 5.14).

5.7.5.4 Mitigation Measures

Because there are no adverse effects predicted in the Radiation and Radioactivity Environment as a result of the Project, no mitigation measures are identified within the Radiation and Radioactivity Environment. Should mitigation measures be necessary to address likely effects on VECs in the Human Health and Non-human Biota environmental components, they will be described in those sections of the EIS (Sections 5.13 and 5.14, respectively).

5.7.5.5 Residual Adverse Effects

No residual effects in terms of doses to the general public are predicted in the Radiation and Radioactivity Environment as a result of the Project. Residual effects in the Human Health and Non-human Biota environmental components as they may result from radiation doses or radionuclide emissions as pathways will be described in those sections of this EIS (Sections 5.13 and 5.14, respectively).

5.8 Land Use

This Section provides an overview description of the potential effects of the Project on the Land Use environmental component. The detailed assessment of environmental effects in this component is presented in the *Land Use Environment – Assessment of Environmental Effects Technical Support Document, New Nuclear – Darlington Environmental Assessment*.

The Land Use component includes two environmental sub-components: Land Use and Visual Setting. These represent fundamental constituent features that are potentially susceptible to effects of the Project.

5.8.1 Potential Project-Environment Interactions

Each Project work and activity was screened to determine if there was a plausible mechanism for it to interface with the individual sub-components of Land Use. These interactions are shown in Table 5.1.1.

Each potential interaction was evaluated to determine if it was likely to result in a measurable change to the current (i.e., baseline) conditions. The works and activities that were considered likely to result in a measurable change are summarised in Table 5.8-1.

TABLE 5.8-1
Project Works and Activities Likely to Measurably Change Land Use Conditions

Project Works and Activities	Rationale
SITE PREPARATION AND CONSTRUCTION PHASE	
Mobilization and Preparatory Works	Clearing and Grubbing will create a permanent and/or measurable change to the surrounding visual setting including vistas or views.
Excavation and Grading	Expansion of the Northwest Landfill Area and development of the Northeast Landfill Area for disposal of soil will result in a measurable change to the surrounding visual setting including views and vistas.
Marine and Shoreline Works	Lake infilling, cofferdam development, shoreline protection and dredging works will result in a measurable change to the visual setting from Lake Ontario vantage points.
Construction of Ancillary Facilities	Construction of cooling towers will result in a measurable change on the visual setting.
OPERATION AND MAINTENANCE PHASE	
Operation of Condenser and Condenser Circulating Water, Service Water and Cooling Systems	Vapour plumes from mechanical draft cooling towers; and the physical presence of the natural draft cooling towers and associated vapour plumes will result in a measurable change to land use and visual setting.
Operation of Site Services and Utilities	Lighting systems and fencing at the facility will result in a measurable change to the visual setting.
Physical Presence of the Station	The increased intensity of on-site activities; and the apparent visual presence of dominant features (e.g., cooling towers) are likely to contribute to the evolution of employment uses in proximity to the DN site.

The potential changes in the Land Use component as a result of some Project works and activities will be bounded by (i.e., contained within) the envelope of changes associated with other activities. Accordingly, the assessment of effects on both Land Use and Visual Setting considered the total overall physical changes on the DN site regardless of which specific works and activities would have contributed to those changes. In this manner, the changes associated with all works and activities that might measurably change conditions in the Land Use component were evaluated collectively rather than individually.

5.8.2 Assessment Scenarios

5.8.2.1 Land Use

To effectively consider changes and effects of the NND Project in terms of Land Use, it was necessary to anticipate evolving land use and municipal growth patterns over time frames relevant to the Project. The following four time-based scenarios were adopted as milestone points at which Project-related effects would be evaluated:

- **Existing Land Use Scenario -** essentially represents conditions as they currently exist (i.e., current baseline);

- **Growth Scenario (2006-2031)** - considers a long-term land use planning horizon established by the Province through the Growth Plan for the Greater Golden Horseshoe – Places to Grow (Growth Plan) (MEI 2006), issued under the *Places to Grow Act*. The municipal allocation of growth to the year 2031 was carried forward in the growth management work being undertaken by the Region of Durham through the Growing Durham Study (Durham 2008d).

- **Growth Scenario (2032-2056)** - reflects longer-term growth projections developed by the Region of Durham to the year 2056 to assist in their planning for major infrastructure; and

- **Long Term Growth Scenario (beyond 2056)** - conceptually illustrates how the South Durham Region may ultimately develop based on a review of future developable areas beyond the forecasted needs to 2056 and south of the established Protected Countryside designation identified in the Province's Greenbelt Plan (MMAH 2005).

5.8.2.2 Visual Setting

Because specific reactor and condenser cooling technologies have not yet been selected, two of the specific model plant layout scenarios (rather than the bounding site development layout) were adopted for evaluation of likely visual-related effects in order to effectively consider the visual range of the alternatives. Both scenarios involve cooling towers since towers will be the most physically prominent structures on the site and their operation will include a vapour plume which will add to their overall visibility. The scenarios chosen for visual analyses were:

- Model Plant Layout 2 (see Figure 2.4-2): which includes mechanical draft cooling towers in a circular configuration (four towers assumed for evaluation purposes); and

- Model Plant Layout 3 (see Figure 2.4-3): which includes natural draft cooling towers (four towers assumed for evaluation purposes).

The bounding conditions from a visual perspective are four natural draft cooling towers. However, because atmospheric modeling indicated that four mechanical draft cooling towers in a circular configuration would also have a pronounced vapour plume, this scenario was also included in the analysis.

5.8.3 Assessment Methods

To consider potential effects of the Project on Land Use, the forecast future uses of lands in relevant assessment zones were evaluated in the context of the NND Project, the applicable land use regulatory and policy regime and the existing (i.e., baseline) condition. The existing condition is an important basis for comparison of future conditions since the DN site already exists as an operating nuclear generating station and the planning and design of the site was based on the expectation that it would be expanded to add reactors in the future. The forecast uses were based on the growth scenarios noted above. Two land use assessment zones were adopted for the Land Use EA studies:

- **NND Exclusion Zone:** A specific exclusion zone has not been established for the NND reactors. For EA purposes, it is assumed that the NND exclusion zone will not extend beyond the DN site boundary. Accordingly, as noted in Section 4.8.1, because the DN site is under the ownership, care and control of OPG, potential land use effects within the DN site (and therefore, the NND exclusion zone) are not of further consideration in this EIS; and

- **10-km Land Use Assessment Zon**e: This zone is within the LSA (see Figure 3.1-2). It includes the major urban areas and residential communities in proximity to the DN site and is appropriate for evaluation of atmospheric emissions, traffic impacts and the interface between land uses and visual interactions. The 10-km distance is derived from and generally consistent with, the "Primary Zone" used for emergency evacuation purposes (see Chapter 7.3.2.2). The Primary Zone includes the land area bounded generally by Taunton Road to the north, Wilmot Creek to the east, and Park Road (Regional Road 54) to the west (the zone also extends out into Lake Ontario in a radius of approximately 10 km from the reactor buildings). Consistent with nuclear emergency plans, to ensure planning for the effective implementation of protective measures according to the possible risks and hazards, the Primary Zone is subdivided into three rings, the first of which is termed the "Contiguous Zone". The Contiguous Zone extends approximately 3 km from the reactor buildings. During the land use analysis, this Contiguous Zone was applied to consider the effects on adjacent land use as a result of the development of NND.

The Visual Setting was assessed primarily considering the likely effects associated with cooling towers since, if they are selected as the means for condenser cooling, they will be the most visually dominant features on the DN site. The visual effect of towers considers both their physical presence and the vapour plumes released from them. Views and vistas under baseline conditions were compared to the future views and vistas as developed through computer simulations. The visual assessment considered views and vistas from the LSA and RSA only (i.e., views internal to the DN site were not considered relevant).

5.8.4 Assessment Criteria

Predicted changes in parameters relevant to conditions in the Land Use environmental sub-components were evaluated against applicable criteria described in Table 5.8-2. The criteria were applied for evaluation of the changes in conditions as well as the likely effects that would result from the changes.

TABLE 5.8-2
Evaluation Criteria for Land Use Environmental Component

Sub-Component (Land Use)	Evaluation Criteria or Parameter
Land Use	• Regular disturbance/nuisances to off-site residences, businesses and institutions which may change the manner in which land is used (i.e., increased noise, dust, or traffic). • Compliance with legislation, regulations, policy and good planning practice. • Existing and future use and development of land (impact on present and planned land use). • Professional judgement.
Visual Setting	• Impact on views and vistas (based on sensitivity of vantage point; extent of obstruction, distance from DN site and duration of view). Evaluation parameters as follows: - Strong: visual feature would not be overlooked by the average observer, and is dominant in the landscape and viewshed. - Moderate: visual feature begins to attract attention and to dominate the landscape and viewshed. - Weak: visual feature is visible but does not attract attention or dominate the landscape or viewshed. • Likelihood of change brought about on existing and future uses of land as a result of the visual feature. • Professional judgement

5.8.5 Assessment of Likely Effects on Land Use

For assessment purposes, effects on Land Use were evaluated within a framework of the 10-km Land Use Assessment Zone.

The 10-km Land Use Assessment Zone encompasses a broad range of existing rural and urban uses, and includes the urban communities of Oshawa, Courtice, Bowmanville, Newcastle and Orono. The review of existing land uses and future growth scenarios focuses on areas in proximity to the DN site, particularly north of Highway 401. Effects of the Project on the existing, planned, future and long-term land uses at greater distance from the DN site are not expected since the DN site is already an established nuclear facility and the Project will be in keeping with the intended long-term use for the DN site as a nuclear generating facility and a planning regime that has considered this ongoing use.

Existing land uses in proximity to the DN site include a range of residential, employment and commercial and related uses. Sensitive land uses include residential uses, institutional uses (elementary and secondary schools, community facilities and emergency services) and open space uses (parks and major open space). Existing land use policy developed by the Region of Durham and the Municipality of Clarington acknowledges the DN site and its current and future use as a nuclear power plant under OPG's control.

For the 2006-2031 Growth Scenario, Planned Living and Employment Areas (i.e., currently designated for development) will result in residential development in the western portion of Bowmanville toward the DN site and employment development to the west of the DN site (Clarington Energy Business Park) in the case of Employment Areas. A number of developments are proposed in proximity to the DN site, including sensitive land uses (e.g., new residential subdivision development including schools). Future Living and Employment Areas (2006-2031) have also been identified based on the Region's growth scenario and include the eastern expansion of the Courtice urban area.

For the 2032-2056 Growth Scenario, Future Living and Employment Areas have been identified to include lands between Courtice and Bowmanville, immediately north of the DN site. Furthermore, it is anticipated that additional future development in this area beyond 2056 may occur through redevelopment, infill and intensification, particularly within the identified Bowmanville Regional Centre, Courtice and Bowmanville Planned Transit Station/Villages and along Regional and Growth Corridors. As the intensity of use increases on the DN site, the existing sensitive land uses surrounding the site will likely transition to employment and industrial uses.

The Long-term Growth Scenario does not provide for any future greenfield development in proximity to the DN site since it is anticipated that greenfield land in this area will have been depleted. However, it is recognised, that future development surrounding the DN site beyond 2056 may occur through redevelopment, infill and intensification, particularly within the identified Bowmanville Regional Centre, Courtice and Bowmanville Planned Transit Station/Villages and along Regional and Local Growth Corridors.

5.8.5.1 Likely Effects on VECs

The single VEC for the Land Use sub-component is the land use planning regime in the LSA. Likely environmental effects on this VEC as a result of the Project are described below.

The visual analysis (see Section 5.8.6) has established that cooling towers associated with NND will be a visually dominant feature in the landscape. The structures themselves will be highly visible in the case of natural draft towers, while mechanical draft cooling towers will be less so as a result of visual screening afforded by topographic features. However, in both cases the vapour plumes that will emanate from the towers will be highly visible. The visual dominance of the natural draft cooling towers is likely to affect both the municipal planning regime and land use development patterns and opportunities, in the vicinity of the DN site.

This likely environmental effect is further considered in terms of mitigation measures and residual effects.

As the NND is developed and operated, the increased intensity of activities on the DN site is likely to result in changes to land use and development patterns that would transpire otherwise. As the intensity of use increases on the DN site, the existing, as well as currently-proposed sensitive, land uses surrounding the site will likely transition to employment and industrial uses. For emergency planning purposes, it can be expected that new sensitive land uses will be directed away from the DN site, which will result in a change to the land use and development patterns from those that would otherwise exist.

This likely environmental effect is further considered in terms of mitigation measures and residual effects.

5.8.5.2 Mitigation Measures

In considering likely effects on Land Use, it was assumed that appropriate design features to pre-empt possible environmental effects will be incorporated into the Project based on industry practice and direct OPG experience. Accordingly, the following specific “in-design” mitigation measure was considered in evaluating likely environmental effects:

- Implementation of Good Industry Management Practices during the design and construction of the NND Project to visually screen cooling towers from selected key off-site vantage points.

In addition to the in-design mitigation measure noted above, the EA studies identified additional mitigation measures to further ameliorate the likely effects of the Project on Land Use. These further mitigation measures are:

- OPG to continue to monitor land use activity in proximity to the DN site and consult with the Municipality of Clarington and the Region of Durham on proposed land use changes and effects on implementation of emergency plans; and

- OPG to continue to engage the Region of Durham with respect to the Regional Official Plan Amendment application to implement the Growing Durham Study, Preferred Growth Scenario and Policy Directions and proposed Future Land Uses in the Primary and Contiguous Zones.

5.8.5.3 Residual Adverse Effects

The mitigation measures noted above are expected to ameliorate adverse environmental effects on the land use planning regime in the LSA. No residual effects have been identified for the environmental sub component Land Use.

5.8.6 Assessment of Likely Effects on Visual Setting

Based on the graphical simulations, the natural draft cooling tower structures will extend significantly above the surrounding buildings and structures associated with NND and the adjacent topography. As well, based on atmospheric modelling carried out, the vapour plume released from either the natural draft or mechanical draft cooling towers will rise to very high altitudes. Accordingly, cooling towers (natural draft and mechanical draft) and their associated plumes, were adopted as the bounding features of the NND for visual assessment purposes. Figures 5.8-1 and 5.8-2 present computer-generated simulations of views of the DN site with cooling towers.

Typical natural draft cooling towers extend to a height of approximately 150 m above finished grade. Mechanical draft cooling towers extend approximately 20 m above finished grade. Both towers will release a visible vapour plume to heights approaching 1,000 m 20% of the time. Based on atmospheric modeling, it is estimated that the plume height will extend to 800 m approximately 80% of the time. The plume may occasionally extend up to 10,000 m in horizontal distance. In winter conditions, the plume is likely to extend a distance of 3,500 m about 60% of the time (see Section 5.2.5).

The natural draft cooling tower structures will be visible from stationary vantage points as far away as 20 km. For vehicles travelling on Highways 401 and 115/35, the cooling towers will be visible at distances up to 15 km and for transit times up to approximately 10 minutes. Because of their greater overall dimensions, the natural draft cooling towers are bounding in terms of physical presence, although as noted above, both tower types will release plumes of generally similar geometry. Based on the significant plume heights noted above, the plumes themselves are likely to be visible for several tens of kilometres.

The visual character throughout the LSA and portions of the RSA will be altered to varying degrees as a result of either natural draft or mechanical draft cooling towers. The visual change associated with natural draft cooling towers will be greater because the towers themselves will be visually dominant whereas mechanical draft cooling towers will be generally screened from view by topographic features. The plume conditions associated with either tower will be generally similar.

Existing lighting associated with the DNGS and structures on the St. Marys Cement plant property is visible from waterfront locations to the east and west and from areas in the northern portion of the LSA. With this as a reference basis, it is likely that the natural draft cooling towers, especially when equipped with navigation safety lighting, will also be visible at night from a considerable distance. The vapour plumes released from both tower types are also expected to be visible especially during moonlight conditions and due to reflection of ground-source lighting.

Because of their greater height, the natural draft cooling towers bound the mechanical draft cooling towers in terms of shadow effects. Shadows cast by the natural draft towers will fall off-site only during the winter season and for only a brief period in the early morning. Under the worst-case shadow conditions, the shadow cast extends onto the St. Marys Cement plant property for a brief period, only and does not extend onto any sensitive land uses that would have a material effect on existing or planned land uses. As such, shadow conditions associated with the towers are not considered further in terms of visual aesthetics.

Figure 5.8-1

Highway 401 Traveling Westbound North of the DN Site, Facing South-West and Eastbound West of the DN Site, Facing South-East Worst Case Scenario

Natural Draft Cooling Towers
Highway 401 Eastbound, Facing South-East (No-Foliage)

Natural Draft Cooling Towers
Highway 401 Westbound, Facing South-West (No-Foliage)

Mechanical Draft Cooling Towers
Highway 401 Eastbound, Facing South-East (No-Foliage)

Mechanical Draft Cooling Towers
Highway 401 Westbound, Facing South-West (No-Foliage)

Date: September 2009

Project: 34500

SOURCE:
ADAPTED FROM MMM GROUP, LAND USE, ENVIRONMENTAL EFFECTS T.S.D., FIGURES 4.3-12 AND 4.3-14, 2009

Figure 5.8-2

Oblique Modelling Looking East
Worst Case Scenario

Natural Draft Cooling Towers

Mechanical Draft Cooling Towers

Date: September 2009

Project: 34500

SOURCE:
ADAPTED FROM MMM GROUP, LAND USE, ENVIRONMENTAL EFFECTS T.S.D., FIGURE 4.3-18, 2009

ONTARIO POWER GENERATION

5.8.6.1 Likely Effects on VECs

The single VEC for the Visual Setting sub-component is visual aesthetics. Likely environmental effects on this VEC as a result of the Project are described below.

The visual landscape on the DN site will be permanently altered as a result of the Project. Changes will result from several aspects of the Project, including the development of the Northeast Landfill Area, expansion of the existing Northwest Landfill Area and grading of the existing bluff formations on the lakefront. However, the greatest visual effect will be as a consequence of the existence and operation of cooling towers, either natural draft or mechanical draft since their vapour plumes are of similar geometry. The visual dominance of the cooling towers and associated vapour plume is likely to have a consequential effect on Land Use (as noted above) and is also considered for effects in VECs in the Socio-economic Environment.

This is considered an adverse effect of the Project and is evaluated further in terms of mitigation measures and residual effects. The likely effect is also considered further in terms of consequential effects on VECs in the Socio-economic Environment (Section 5.11).

5.8.6.2 Mitigation Measures

In considering likely effects on Visual Setting, it was assumed that appropriate design features to pre-empt possible environmental effects will be incorporated into the Project based on industry practice and direct OPG experience. Accordingly, the following specific "in-design" mitigation measures were considered in evaluating likely environmental effects:

- Good Industry Management Practices will be implemented during the design and construction of the NND Project to visually screen on-site features from selected off-site vantage points;

- Incorporation of landscape design principles (e.g., naturalization of the Northwest and Northeast Landfill Area surfaces and the lake infill area, planting plans and revegetation programs) in the design and construction of the Project to reduce the visibility of the operating facility; and

- Good Industry Management Practices will be implemented during the design and development of lighting systems that will, among other considerations (e.g., bird strikes, navigation safety) serve to reduce to the extent practicable, the night-time visibility of the overall site and its dominant features, including cooling towers.

No further mitigation measures for effects of the Project on Visual Setting are identified within the Land Use environmental component. Should further mitigation measures be necessary to address likely effects in VECs in the Socio-Economic Environment, they will be described in Section 5.11.

5.8.6.3 Residual Adverse Effects

Although the above noted mitigation measures will be of some benefit in reducing likely effects of the Project on Visual Setting, visual effects of the natural draft cooling tower structures and the associated vapour plume released from either natural draft or mechanical draft cooling towers from off-site vantage points, including those at considerable distance, cannot be effectively mitigated. The following residual adverse effect is advanced for consideration of significance:

- Changes in the quality of existing views of the DN site throughout the operating life of the Project from viewing locations in the LSA and the RSA as a result of the presence of natural draft cooling tower structures and the associated vapour plumes released from either natural draft or mechanical draft cooling towers.

5.9 Traffic and Transportation

This Section provides an overview description of the potential effects of the Project on the Traffic and Transportation environmental component. The detailed assessment of environmental effects on traffic and transportation is presented in the *Traffic and Transportation – Assessment of Environmental Effects Technical Support Document, New Nuclear – Darlington Environmental Assessment*.

The Traffic and Transportation component comprises two environmental sub-components; Transportation System Operations (road, rail, marine) and Transportation System Safety (road, rail, marine).

5.9.1 Potential Project-Environment Interactions

Each Project work and activity was considered to determine if there was a plausible mechanism for it to interact with the individual sub-components of Traffic and Transportation. The potential interactions are illustrated as dots in the matrix on Table 5.1-1.

Each potential interaction was evaluated to determine if it was likely to result in a measurable change to the current (i.e., baseline) conditions in the applicable sub-components. The works and activities that were considered likely to result in a measurable change are summarised in Table 5.9-1.

TABLE 5.9-1
Project Works and Activities Likely to Measurably Change Traffic and Transportation Conditions

Project Works and Activities	Rationale
SITE PREPARATION AND CONSTRUCTION PHASE	
Mobilization and Preparatory Works	Mobilization of equipment will introduce additional traffic to the roads network, including heavy vehicle and equipment movements.
Excavation and Grading	Off-site transport of excavated material will introduce additional traffic to the roads network.
Supply of Construction Equipment and Material and Plant Operating Components.	Delivery of material and equipment will introduce additional traffic to the roads network, including heavy vehicle and equipment movements. Material and components shipped to the DN site via rail and marine transport may alter existing conditions in these modes in the vicinity.
Workforce, Payroll and Purchasing	Workforce commuters to and from the site will add traffic to the existing roads network.
OPERATION AND MAINTENANCE PHASE	
Transportation of Low and Intermediate-Level Radioactive Waste to a Licensed Off-site Facility	Should L&ILW be shipped off-site, the activity would introduce additional traffic to the roads network. (Note that this work/activity is not expected to add measurable traffic volumes to the roadways, however, it is included herein because of public interest in transportation of radioactive waste).
Administration, Payroll and Purchasing	Workforce commuters to and from the site will add traffic to the existing roads network.

Where a measurable change was considered likely, the interaction between the work and activity and Traffic and Transportation conditions was further evaluated to determine if the change in baseline conditions would represent an environmental effect.

5.9.2 Assessment of Likely Effects on Transportation System Operations

5.9.2.1 Effects Assessment Scenarios (Roads Network)

To appropriately evaluate likely effects on traffic and transportation conditions on the roads network as a result of the Project, it was necessary to: i) consider the Project at specific points in time throughout its evolution, ii) predict what the future traffic conditions would be at those specific points in time and, iii) consider the operational and safety-related improvements that would have been made to the roads-related infrastructure as a matter of course by the agencies having responsibility for system function in order to address conditions associated with non-Project growth in traffic.

Considering the above, the following four time horizons that represent milestone development and operating conditions at the DN site were adopted for assessment purposes:

- **Horizon 2012 –** site preparation activities will be underway involving the maximum number of workers for this activity, and the normal DNGS work force will be on-site;
- **Horizon 2016** – a full complement of NND Project construction staff and the DNGS work force will be on-site, plus DNGS refurbishment staff;
- **Horizon 2021** – NND Project construction staff (for two units) and operations staff (for two units) will be on-site as will the normal DNGS work force plus DNGS refurbishment staff; and
- **Horizon 2031** – all construction activities will be complete; a full operating staff complement will be in place at NND and DNGS and a nominal DNGS refurbishment staff will remain.

In order to consider traffic conditions and routine system improvements that will have been made by the responsible agencies at each time horizon, predicted transportation network performance was analyzed on the basis of traffic forecasts, not including NND-related traffic. Based on modelling of the expected future conditions, system improvements were introduced into the model reflecting infrastructure upgrades that could reasonably be expected to be in place at the time as a result of on-going operational improvements carried out by the municipal and provincial agencies in response to development and growth in and through the area. This improved case at each time horizon was adopted as the "Future Baseline Condition" on which effects of the Project were then considered. In this manner, the effects of the Project were evaluated against a transportation network expected to be in place at each time horizon. The improvements expected to be in place were applied in the analyses as modelling assumptions.

An evaluation of traffic network performance was made at each of the noted time horizons. The evaluation, largely based on traffic modelling, considered the system as it would exist at the time (i.e., future baseline including assumed upgrades) and the added traffic associated with the NND Project. Where the analyses suggested Project-related traffic would result in unacceptable system performance, further upgrades were identified as mitigation measures.

5.9.2.2 Assessment Methods and Criteria

Changes in traffic and transportation conditions on the roads network were predicted on the basis of traffic modelling to establish the Level of Service (LOS) at key intersections in the roads network. The LOS is a qualitative measure of traffic flow at intersections based on vehicle delay and queue length at the approaches. It is calculated in terms of the ratio of traffic volumes and approach capacity (v/c ratio). The ratio is classified within a range of A to F with a LOS of E or F indicating unsatisfactory traffic conditions.

5.9.2.3 Road Traffic Modelling Results

Comprehensive evaluations of intersection performance were performed at key intersections in the LSA to consider conditions at each Horizon for the Future Baseline Condition (i.e., without the NND Project) and for the NND Project Condition. A summary of the evaluations is provided below.

Horizon 2012

Initial modelling indicated that without improvements, some intersections in the LSA would already be operating beyond their design capacity at this time horizon. However, under the Future Baseline Condition, intersection improvements, most notably at Highway 401 and Courtice Road and South Service Road at Holt Road will result in acceptable LOSs at all intersections.

Under the NND Project Condition, the transportation network generally operates acceptably, with the exception of the Highway 401 ramps at the Waverly Road intersection, which operate with LOSs ranging from E to F.

Horizon 2016

Under the Future Baseline Condition, it is assumed that a full interchange will have been constructed at Holt Road and Highway 401 and although the Highway 407 East extension will be complete, the Highway 407 East Durham Link will not yet be in place. Related intersection improvements will have restored operational capacity at the key intersections in the area.

Under the NND Project Condition, intersection movements operate within capacity. It is noted that OPG and the Ontario Ministry of Transportation (MTO) have initiated dialogue and will continue to with regard for capacity planning and design of the re-configured Highway 401 and Holt Road intersection. For assessment purposes, it is assumed that the re-constructed interchange at this location will fully consider transportation system efficiency, including as it is related to the Project. As such, no further improvements at or associated with this intersection, are identified as mitigation measures associated with the Project.

Horizon 2021

The Future Baseline Condition in 2021 is generally the same as in 2016, although further lane improvements have been made at the Highway 401 and Courtice Road intersection and traffic signals have been installed at South Service Road at Waverly Road. With these improvements, traffic operations are generally satisfactory, although the Highway 401 westbound ramps at Courtice road will continue to operate at near capacity during the P.M. peak hour.

Under the NND Project Condition, traffic will generally operate under acceptable conditions. The most significant operational issues will be associated with the access points from South Service Road into the DN site. Note that as indicated above, the re-constructed Holt Road interchange and associated improvements will have addressed access issues that would also exist otherwise.

Horizon 2031

Under the Future Baseline Condition, Project-related traffic levels will have decreased slightly from 2021 (i.e., DNGS refurbishment is now complete) and the associated roads network is projected to operate generally adequately assuming that the improvements made in 2021 remain in place, notwithstanding the slight decrease in traffic. However, some additional improvements are also assumed to address local development issues (e.g., Baseline Road West at Waverly Road).

Under the NND Project Condition, there will be a net reduction in Project-related traffic because, although all reactors are now in service, the construction activities are complete. The intersections will generally operate satisfactorily, although as noted above, the improvements made in 2021 are reaffirmed as necessary for 2031 conditions as well. No other improvements are identified as a result of the Project.

An alternative under consideration for the management of low and intermediate level radioactive waste (L&ILW) generated during the Operation and Maintenance phase is its shipment to a licensed off-site facility. As described in the *Nuclear Waste Management TSD*, for the bounding case (i.e., 3 EPRs) the lifetime volume of low-level radioactive waste is estimated at approximately 38,700 m^3 which would result in approximately 1,935 truck shipments of 20 m^3 each, or two to three truck shipments per month during the 60-year operating life of NND. For intermediate-level radioactive waste, for the bounding case (i.e., 4 AP1000 reactors) the lifetime volume generated would also result in two to three truck shipment per month during the operating period. Although peak shipping rates may be higher during outage campaigns, the average shipping rate will still be very low.

At an average of about five or six shipments per month, the traffic associated with L&ILW shipment off-site will not add measurable additional traffic to the roadways and does not warrant further consideration from a traffic perspective.

OPG has safely transported L&ILW and other radioactive materials for more than 35 years. All transportation of such materials associated with NND will comply with existing approved systems, including appropriate licenses and transport packages. As such, there are no safety-related transportation issues associated with the normal transport of such materials. Safety issues associated with accidents and malfunctions, including those relating to transportation of L&ILW are addressed in Section 7 of this EIS.

5.9.2.4 Transportation System - Rail

The CN Rail corridor extending east-west through the DN site will remain in service during all phases of the Project. Overall serviceability, capacity and operational efficiency of the rail service through the DN site is not expected to be affected by the Project under normal operations. Accordingly, no further consideration of the effects of the Project on rail system operations is warranted.

5.9.2.5 Transportation System - Marine

It is possible that some oversize operating components for the Project will be shipped to the DN site by marine transport, likely by barge from an appropriate Lake Ontario port (e.g., Port of Oshawa). The barge operations, if any, are reasonably expected to be limited in number and frequency. Barge operations can also be expected to be near shore and as such, will not conflict with Lake Ontario shipping lanes which are at considerable distance into the Lake. Accordingly, no further evaluation of the effects of the Project on marine system operations is warranted.

5.9.2.6 Likely Effects on VECs

The single VEC for the Transportation System Operations (road, rail, marine) sub-component is transportation system efficiency relative to demand. Likely environmental effects on this VEC as a result of the Project are described as follows.

Notwithstanding system improvements that will be made by the jurisdiction responsible for the roads network, some intersections will experience decreased Levels of Service (LOS) in the future as a result of Project-related traffic. These conditions will be experienced primarily at intersections and in the roads network south of Highway 401 between Courtice Road and Waverly Road.

This is considered an adverse effect of the Project and is further evaluated in terms of mitigation measures and residual effects.

5.9.2.7 Mitigation Measures

The transportation system modelling carried out to evaluate intersection capacities considered the incorporation of system improvements over time that will be carried out by the jurisdictions in authority (i.e., MTO, Region of Durham, Municipality of Clarington) in response to the needs continuing growth and development in the community that are unrelated to the NND Project. For purposes of this EA, these improvements are incorporated as modelling assumptions. They comprise a variety of elements that are routinely undertaken by municipal and provincial agencies as they progressively upgrade their transportation networks as well as some planned major infrastructure works. In the case of the LSA, these measures will include (among others):

- Widening of Highway 401;
- New interchange at Highway 401 and Holt Road;
- Widening of sections of Holt Road from two to four lanes;
- Installation of traffic signals at key intersections and Highway 401 ramps; and
- Addition of turning lanes at key intersections.

These improvements will serve to address system performance issues both related and unrelated to traffic associated with the NND Project.

Further to the above, in considering likely effects related to Transportation System Operations, it was assumed that appropriate planning and design features would be incorporated into the Project based on industry practice and OPG experience. Accordingly, the following “in-design” mitigation measure was considered in evaluating likely environmental effects:

- A Traffic Management Plan (also included as a mitigation of potential effects on the Socio-Economic Environment, see Section 5.11.6.1) will be implemented with the objective of reducing disruption and maintaining safe traffic conditions during the Site Preparation and Construction phase.

In spite of the above-noted routine system improvements, the assessment of effects on Transportation System Operations did determine that there is likely to be some decrease in system performance as a result of the Project. Accordingly, the following additional mitigation measures are identified to further ameliorate the likely environmental effects:

- As part of the Traffic Management Plan, collaborate with the responsible agencies to ensure that the NND Project-related traffic is fully considered in the design and implementation of off-site road improvements; and

- As part of the Traffic Management Plan, collaborate within a framework of specific undertakings between the appropriate parties to identify transportation system deficiencies and facilitate improvements with respect to traffic safety and roadway degradation related to the NND Project.

Because there are no likely adverse effects on rail and marine transportation system operations predicted as a result of the Project, no mitigation measures are identified.

5.9.2.8 Residual Adverse Effects

Considering implementation of the identified mitigation measures, no residual adverse effects on Transportation System Operations (road, rail, marine) are predicted.

5.9.3 Assessment of Likely Effects on Transportation System Safety

The traffic modelling carried out to evaluate Transportation System Operations on the roads network was also the basis for considering Transportation System Safety since system function is directly reflected in system safety. Where operational deficiencies were identified, as was the case for system operation, it was assumed that improvements would be made by the appropriate provincial and municipal agencies based on need and these improvements would have a corresponding benefit in terms of addressing safety concerns.

Consideration of safety concerns in a context of marine and rail modes is based on professional judgement which is considered appropriate given the very limited potential interactions between the Project and these modes of transportation. The NND Project is not expected to change conditions in terms of either marine or rail transport to the extent that transportation system safety would be affected. Accordingly, no further evaluation of the effects of the Project on marine and rail system safety is warranted.

5.9.3.1 Likely Effects on VECs

The single VEC for the Transportation System Safety (road, rail, marine) sub-component is transportation system safety. Likely environmental effects on this VEC as a result of the Project are described as follows.

As described in Section 4.9.5, locations of increased collision occurrence have been identified in the LSA. The road safety audit (see Section 4.9.5) conducted along major roadways within the LSA identified issues generally typical of those that can routinely be found in similar study areas. The most common concerns include pavement conditions, approach configurations, sightline issues and inadequate pedestrian facilities. Given that the Project will add traffic to the existing roadways and contribute to ongoing degradation of the roads system, there is an increased likelihood of collisions and/or other safety-related incidents. This is considered an adverse effect of the Project and is further evaluated in terms of mitigation measures and residual effects.

It is possible the some unknown quantity of surplus excavated soil may be exported from the DN site for disposal. Until a destination for such soil is known, specific haul routes for the transport vehicles are also unknown. However, the three north-bound arterial roads in the vicinity of the DN site, Holt Road, Waverly Road and Courtice Road, Holt Road was selected for the assessment of effects. Depending on the frequency of truck trips, the CP Rail level crossing on Holt Road north of Highway 401 could contribute to an increased frequency of train/truck collisions. This is considered an adverse effect of the Project and is further evaluated in terms of mitigation measures and residual effects.

5.9.3.2 Mitigation Measures

The mitigation measures described above in Section 5.9.2.7 to address likely effects on Transportation System Operations will also be directly beneficial in addressing likely effects on Transportation System Safety (road). No other mitigation measures are proposed.

5.9.3.3 Residual Adverse Effects

Considering implementation of the identified mitigation measures, no residual adverse effects on Transportation System Safety (road, rail, marine) are predicted.

5.10 Physical and Cultural Heritage Resources

This Section provides an overview description of the potential effects of the Project on Physical and Cultural Heritage Resources. The detailed assessment of environmental effects in this environmental component is presented in the *Physical and Cultural Heritage Resources – Assessment of Environmental Effects Technical Support Document, New Nuclear – Darlington Environmental Assessment*.

Physical and Cultural Heritage Resources comprise two environmental sub-components; Archaeology and Built Heritage, and Cultural Landscapes.

5.10.1 Potential Project-Environment Interactions

Each Project work and activity was considered to determine if there was a plausible mechanism for it to interact with the individual sub-components of Physical and Cultural Heritage Resources. The potential interactions are illustrated as dots in the matrix on Table 5.1-1. The only works and activities that interact with this environmental component are those associated with physical disturbance to the site of the works (i.e., Mobilization and Preparatory Works, Excavation and Grading, Marine and Shoreline Works, and Management of Stormwater) and these take place only during the Site Preparation and Construction phase of the Project. No interactions will occur during the Operation and Maintenance phase.

Each potential interaction was evaluated to determine if it was likely to result in a measurable change to the current (i.e., baseline) conditions in the applicable sub-components. The works and activities that were considered likely to result in a measurable change are summarised in Table 5.10-1.

TABLE 5.10-1
Project Works and Activities Likely to Measurably Change Physical and Cultural Heritage Resources

Project Works and Activities	Rationale
Mobilization and Preparatory Works	Creation of parking areas, mobilisation and positioning of heavy equipment, clearing and grubbing, installation of utilities and the development of roads and related infrastructure are likely to result in destruction or displacement of archaeological sites, built heritage features or cultural landscape units determined to have heritage value or interest.
Excavation and Grading	Earthmoving, rock excavation and related grading activities are likely to result in destruction or displacement of archaeological sites, built heritage features or cultural landscape units determined to have heritage value or interest.
Management of Stormwater	Construction of ditches, swales stormwater ponds and other related aspects of stormwater management are likely to result in destruction or displacement of archaeological sites, built heritage features or cultural landscape units determined to have heritage value or interest.

Where a measurable change was considered likely, the interaction between the work and activity and Physical and Cultural Heritage Resources was further evaluated to determine if the change in baseline conditions would represent an environmental effect.

5.10.1.1 Assessment Methods

To consider the likely effects associated with the Project, the bounding case from the perspective of physical disturbance throughout the SSA was determined by compositing the three model plant layouts described in Section 2.3.2 to establish the collective outer limit extent of disturbance considering all layouts. The locations of identified Physical and Cultural Heritage Resources were overlain on the composited layout template that represented the aggregated worst case physical disturbance and the extent of the loss or disturbance to these resources was evaluated.

5.10.1.2 Assessment Criteria

Predicted changes in conditions relating to Physical and Cultural Heritage Resources as a result of the Project were evaluated against criteria as described in Table 5.10-2.

TABLE 5.10-2
Evaluation Criteria Used in
Physical and Cultural Heritage Resources

Physical and Cultural Heritage Resources Sub-Component	Evaluation Criteria or Parameter
Archaeology	Loss or displacement of archaeological sites determined to have heritage value or interest.
Built Heritage and Cultural Landscapes	Loss, displacement or disruption of built heritage features (BHF) or cultural landscape units (CLU) determined to have heritage value or interest.

5.10.2 Assessment of Likely Effects on Archaeology

5.10.2.1 Likely Effects on VECs

The selected VECs for the Archaeology sub-component include both Aboriginal and Euro-Canadian archaeological resources (including sub-surface features and artifacts). Likely environmental effects on this VEC as a result of the Project are described as follows.

As a result of physical disturbance of the site during the Site Preparation and Construction Phases, two Euro-Canadian archaeological resources, identified as Site H1 (Brady, AlGq-83) and Site H7 (Crumb, AlGq-86), will experience total displacement. The locations of these resources are identified on Figure 4.10-1.

This is considered an adverse effect of the Project and is further evaluated in terms of mitigation measures and residual effects.

5.10.2.2 Mitigation Measures

In some circumstance, avoidance and/or protection of the archaeological resource are viable mitigation measures. However, neither are suitable options in the context of this Project. As such and consistent with procedures detailed in the revised draft *Standards and Guidelines for Consultant Archaeologists* (MCL 2009: Section 4) excavation of the two affected archaeological sites will be performed as a mitigation measure.

The mitigation will be performed in advance of the construction-related activities in the area of the subject sites and conform to the above-noted MCL revised draft *Standards and Guidelines*. Qualified specialists will undertake a controlled removal and recording of archaeological site context, cultural features and artifacts to document the cultural heritage value or interest of the site and to preserve its information for future study.

5.10.2.3 Residual Adverse Effects

Considering implementation of the identified mitigation measures, no residual adverse effects on Aboriginal and Euro-Canadian archaeological resources are predicted.

5.10.3 Assessment of Likely Effects on Built Heritage and Cultural Landscapes

5.10.3.1 Likely Effects on VECs

The VECs for the Built Heritage and Cultural Landscapes sub-component are Euro-Canadian built heritage resources and Euro-Canadian cultural landscape resources. Likely environmental effects on these VECs as a result of the Project are described collectively as follows.

The Project may include the placement of surplus excavated soil at the existing Northwest Landfill Area. Should this occur and should the soil placement encroach into the area thought to be occupied by the Burk Cemetery, and Burk Pioneer Cemetery Monument and Plaque (BHF-1) (see Figure 4.10-2) the cemetery, and the monument and plaque will be deemed to be totally displaced.

This is considered an adverse effect of the Project and is further evaluated in terms of mitigation measures and residual effects.

5.10.3.2 Mitigation Measures

In some circumstances, avoidance and/or protection of built heritage resource are viable mitigation measures and these will be the objectives in the case of the Burk Cemetery, Monument and Plaque. Nonetheless, and consistent with procedures detailed in the *Guideline for Preparing the Cultural Heritage Component of Environmental Assessments* (MCC 1992), if Project impacts are unavoidable, then documentation and re-location are appropriate mitigation measures and will be implemented in this situation.

Should it be necessary to do so, and in advance of construction-related activities in the area, the Burk Cemetery will be closed in accordance with the *Cemeteries Act* (Revised 1992) and all burial remains re-interred in a local cemetery. The Burk Pioneer Cemetery Monument and Plaque will be relocated to a suitable off-site location.

5.10.3.3 Residual Adverse Effects

Considering implementation of the identified mitigation measures, no residual adverse effects on Euro-Canadian built heritage resources and Euro-Canadian cultural landscape resources are anticipated.

5.11 Socio-economic Environment

This Section provides an overview description of potential effects of the Project on the Socio-economic Environment. The detailed assessment of environmental effects in this environmental component is presented in the *Socio-economic Environment – Assessment of Environmental Effects Technical Support Document, New Nuclear – Darlington Environmental Assessment*.

The Socio-economic Environment is comprised of five environmental sub-components (and their respective key attributes) that represent those community assets that must be created, maintained or enhanced in order to achieve "community well-being", namely: Human Assets, Financial Assets, Physical Assets, Social Assets and Natural Assets. As such, the Socio-economic Assessment uses the concept of "community well-being" as its overall analytical framework. The use of this concept facilitates the focus of the assessment on understanding the interaction of the Project with, and its contribution to, community well-being.

5.11.1 The DN Site and its Socio-economic Context

5.11.1.1 Historical Context

Development of the DN site as an operating nuclear generating station and the evolution of its relationship with the local and regional communities are important bases for understanding how this relationship may be changed and affected into the future by the NND Project. The following paragraphs provide a synopsis of this evolution.

The DN site was originally identified by Ontario Hydro (OH) in the late 1960s as an appropriate site for an electricity generation centre. The site had the necessary physical attributes, including space for at least two multi-unit generating stations, a location on the shore of Lake Ontario (an advantage for reactor cooling purposes), suitable foundation conditions, good transportation access, and proximity to the Ontario electricity load centre and the upcoming east-west transmission corridor.

When construction began in the late 1970s, development of the DNGS was one of the largest construction projects in Canada at the time. Construction peaked in 1986 with about 7,060 workers on-site. At that time, the Town of Newcastle was the host community and had a population of approximately 32,000 persons. Its economy was based largely on the agricultural industry. Durham Region itself was also a largely rural area, with its major population centres being the City of Oshawa (115,000 persons) and the Town of Pickering (35,000 persons). In the late 1970s and early 1980s, Oshawa was the primary employment centre for all of the lakeshore municipalities with its strong manufacturing base. A large proportion of the DNGS workforce commuted to the DN site from outside the local area. A majority of the workforce/families moving in during construction resided in Durham Region, Northumberland County, then Town of Peterborough and Peterborough County, and Victoria County. In 1986, the population moving into these communities associated with Ontario Hydro represented approximately over 9% of their total population growth.

To assist the host community (i.e., the Town of Newcastle) in managing socio-economic effects of station construction, Ontario Hydro and the Town entered into a formal impact management agreement (i.e., community agreement) in 1977. Several supplementary agreements followed in the late 1970s and early 1980s, including a separate tripartite agreement between the Region of Durham, Town of Newcastle and Ontario Hydro. Key elements of these community agreements included provisions for financial compensation, including funding for independent studies to assess impacts and their compensation, and monitoring of ongoing social, economic and financial impacts of the construction. Funding was also provided for costs associated with improving and maintaining roads and bridges where required to address the anticipated increased traffic resulting from the project. Funding was also extended for advancing community services, growth management and impact assessments (e.g., funds were provided to the Town of Newcastle for new recreational facilities and improvements to existing community facilities such as the local library and museum). The agreement was terminated at the end of the construction phase.

Mobilisation of the operations workforce began in 1985, seven years before construction was completed. Currently there are approximately 2,800 workers on the DN site. Some 84% of these workers reside within the RSA and Durham Region (63%) in particular. The largest number of workers reside in Clarington (32%) and Oshawa (14%).

5.11.1.2 OPG and Clarington NND Host Municipality Agreement

The Municipality of Clarington and OPG entered into a Host Municipality Agreement, dated August 31, 2009. The Agreement provides compensation to the Municipality to mitigate effects resulting from the NND Project, as identified in the EIS. A number of matters were discussed during a series of meetings including municipal finance (development charges, building permits, property taxation), municipal services (fire protection, recreational services), municipal infrastructure (local roads, municipal facilities), and the socio-economic benefits of the NND Project.

OPG shared Project-related information with municipal staff, and OPG technical experts presented preliminary results concerning potential effects related to traffic and transportation and the socio-economic environment. The Municipality provided OPG with an understanding of the municipal development processes, the current levels of municipal services and socio-economic context of the community. From this, the parties agreed that the Host Municipality Agreement will be finalized as the means to resolve subject NND Project effects as they might relate to the Municipality. The Host Municipality Agreement acknowledges the benefits of the Project to the host municipality and confirms that payments made by OPG to Clarington will constitute the mitigation and full and final compensation for any effects on the Municipality of Clarington that may arise from the construction and operation of the NND Project, with the exception of certain specified construction-related effects.

5.11.2 Potential Project-Environment Interactions

Each Project work and activity was considered to determine if there was a plausible mechanism for it to interact with the individual sub-components of the Socio-economic Environment. The potential interactions are illustrated as dots in the matrix on Table 5.1.1.

Each potential interaction was evaluated to determine if it was likely to result in a measurable change to the current (i.e., baseline) conditions in the applicable sub-components. The works and activities that were considered likely to result in a measurable change are summarised in Table 5.11-1.

TABLE 5.11-1
Project Works and Activities Likely to Measurably Change the Socio-Economic Environment

Project Works and Activities	Rationale
SITE PREPARATION AND CONSTRUCTION PHASE	
Mobilization and Preparatory Works Excavation and Grading Marine and Shoreline Works Development of Administration and Physical Support Facilities Construction of the Power Block Construction of Intake and Discharge Structures Construction of Ancillary Facilities Construction of Radioactive Waste Storage Facilities Supply of Construction Equipment and Material and Plant Operating Components. Management of Construction Waste, Hazardous Materials, Fuels and Lubricants Workforce, Payroll and Purchasing	Measurable change is likely to result from a wide range of interactions, including, but not limited to those described below. The changes will be in the form of "Direct" changes where the cause-and-effect relationship is apparent; as well as "Indirect" change, where the change in the Socio-economic Environment is a consequence of change elsewhere (e.g., an increase in noise levels in the Atmospheric Environment). - Connection of Project utilities to municipal services; - Requirements for security, health and safety services from the Municipality; - Marine-related works and recreational boating; - Permits and development fees to the Municipality; - Employment opportunities afforded by the Project plus associated demands on municipal infrastructure and services; and - Indirect changes in Socio-economic conditions as a result of physical change (e.g., dust, noise, traffic) in other environmental components.
OPERATION AND MAINTENANCE PHASE	
Operation of Active Ventilation and Radioactive Liquid Waste Management Systems Operation of Secondary Heat Transport System and Turbine Generator Operation of Condenser and Condenser Circulating Water, Service Water and Cooling Systems Operation of Electrical Power Systems Operation of Site Services and Utilities Management of Conventional Waste Transportation of Operational Low and Intermediate-Level Waste to a Licensed Off-site Facility Replacement / Maintenance of Major Components and Systems Dry Storage of Used Fuel Physical Presence of the Station Administration, Purchasing, and Payroll	Measurable change is likely to result from a wide range of interactions typically as described above. However, the following two interactions are particularly relevant: - The ongoing presence and operation of new reactor units at the DN site for a long period of time may have special meaning to some residents, potentially affecting their feelings of personal health, sense of safety and overall satisfaction with the community. - The presence of cooling towers and their associated vapour plumes will be new and unique in the community/region and may directly alter community character.

Where a measurable change was considered likely, the interaction between the work and activity and the Socio-economic Environment was further evaluated to determine if the change in baseline conditions would represent an environmental effect.

The assessment of effects in the Socio-economic Environment was carried out considering the likely overall change to baseline conditions as a result of the collective works and activities associated with the Project rather than in a context of individual works and activities. Where appropriate, the likely changes and effects were evaluated and are described separately for the Site Preparation and Construction phase and the Operations and Maintenance phase.

5.11.3 Evaluation Indicators, Parameters and Criteria

Effects measurement indicators (i.e., evaluation indicators) appropriate for evaluating conditions in the Socio-economic Environment were formulated as the basis for determining the degree of change attributable to the Project in each environmental sub-component. Where possible, the change was assessed based on quantifiable parameters. However, professional judgement remained an important parameter since many of the attributes in the Socio-economic Environment are not measurable in a numeric framework. The evaluation indicators relevant to each environmental sub-component are described in Table 5.11-2.

TABLE 5.11-2
Evaluation Indicators for the Socio-Economic Environment

Environmental Sub-Component	Evaluation Indicators[1]
Human Assets	• Presence or absence of socio-economic features (e.g., schools, health and safety facilities) in the study areas likely to be affected • Magnitude of Project-related changes in population relative to baseline and/or projected conditions • Magnitude of Project-related service demand (direct and indirect) relative to baseline and/or projected conditions • Self-assessment by RSA and/or LSA stakeholders likely to be affected • Magnitude of behavioural intentions in context of changes in baseline conditions • Likelihood and/or magnitude of changes in natural assets relative to baseline • Likelihood and/or magnitude of changes in off-site traffic levels • Changes in the geographic extent of the viewshed and quality of views relative to baseline • Likelihood and/or magnitude of changes in other community assets relative to baseline • Professional judgement
Financial Assets	• Presence or absence of socio-economic features (e.g., sensitive businesses, tourist attractions, tourist accommodations, commercial fishers, agricultural lands) in the study areas likely to be affected • Magnitude of Project-related changes in employment, business activity, income, municipal costs and revenues relative to baseline and/or projected conditions • Magnitude of Project-related service demand (direct and indirect) relative to baseline and/or projected conditions • Self-assessment by RSA and/or LSA stakeholders likely to be affected • Magnitude of behavioural intentions in context of changes in baseline conditions • Likelihood and/or magnitude of changes in natural assets relative to baseline • Likelihood and/or magnitude of changes in off-site traffic levels • Changes in the geographic extent of the viewshed and quality of views relative to baseline • Likelihood and/or magnitude of changes in other community assets relative to baseline • Professional judgement

TABLE 5.11-2 (Cont'd)
Evaluation Indicators for the Socio-Economic Environment

Environmental Sub-Component	Evaluation Indicators
Physical Assets	• Magnitude of Project-related changes in housing stock relative to baseline and/or projected conditions • Magnitude of direct and indirect Project-related demands on municipal infrastructure and services relative to baseline and/or projected conditions • Self-assessment by RSA and/or LSA stakeholders likely to be affected • Likelihood and/or magnitude of changes in natural assets relative to baseline • Likelihood and/or magnitude of changes in off-site traffic levels • Changes in the geographic extent of the viewshed and quality of views relative to baseline • Project-related changes in off-site land uses relative to baseline • Likelihood and/or magnitude of changes in other community assets relative to baseline • Professional judgement
Social Assets	• Presence or absence of socio-economic features (e.g., community and recreational facilities, residential properties) in the study areas likely to be affected • Magnitude of Project-related demand on community and recreational facilities relative to baseline and/or projected conditions • Self-assessment by RSA and/or LSA stakeholders likely to be affected • Magnitude of behavioural intentions in context of changes in baseline conditions • Likelihood and/or magnitude of changes in natural assets relative to baseline • Likelihood and/or magnitude of changes in off-site traffic levels • Likelihood and/or magnitude of changes in other community assets relative to baseline • Professional judgement
Natural Assets	• Likelihood and/or magnitude of Project-related changes in dust and noise levels relative to baseline at selected receptor locations • Likelihood and/or magnitude of Project-related changes in surface water quality relative to baseline at selected receptor locations • Likelihood and/or magnitude of Project-related changes in fish and fish habitat in Lake Ontario relative to baseline • Likelihood and/or magnitude of Project-related changes in terrestrial features at the DN site relative to baseline

NOTE:
[1] The evaluation indicators were applied as they may be appropriate for the various key attributes of each sub-environmental component

5.11.4 Assessment of Likely Effects on Human Assets

The assessment of effects on Human Assets is presented as follows in a framework of the individual attributes of Human Assets that were considered appropriate for this EA.

Population and Demographics

Population levels and density are determinants of a community's character, cohesion and the ability of people to use and enjoy their property, ultimately affecting the well-being of that community.

Each of the municipalities across the RSA and LSA is expected to experience continuing population growth into the future and projections reflect a trend towards increased population densities, intensification and general urbanisation in many of these municipalities. The population in Durham Region is anticipated to grow the most with an annual average growth rate of approximately 1.9% over the timeframe of the Project. The populations in the Municipality of Clarington and the City of Oshawa are projected to grow at annual average growth rates of approximately 2.1% and 1.3%, respectively during the same period.

Table 5.11-3 summarises the population growth estimates and incremental effects of current operations at DNGS (i.e., in 2006), the Site Preparation and Construction phase and the Operations and Maintenance phase for NND for the municipalities in the RSA and the LSA. The population associated with the NND Project represents the number of people who reside within the municipality and are associated with the Project through its direct and indirect employment. As shown in the table, the DNGS is associated with about 1.2% of the RSA's population and 5.6% of the LSA's population. During the Site Preparation and Construction phase, the total DN site-related population will increase to about 1.8% in the RSA and 6.9% in the LSA. Although additional population will be associated with the NND Project during the Operations and Maintenance Phase, the total DN site-related population will be essentially the same as current levels due to ongoing population growth unrelated to the NND Project.

Public attitude research conducted for this study (IntelliPulse 2008b) indicates that individuals who experience a change in their feelings of personal health, their sense of personal safety or their satisfaction with community may choose to voluntarily leave their communities. Should such voluntary out-migration be of sufficient magnitude, overall population levels could be affected. However, only 4% of LSA residents and 3% of RSA residents indicated that they were more likely to move because of the Project. Only 2% across both study areas indicated that they were "much more" likely to move. Sociological research also indicates that people do not always act on their intentions, therefore should some people decide to move because of the Project, adverse effects on population levels are not likely to be noticeable. Moreover, between 13% of LSA residents and 15% of RSA residents indicated the opposite, namely that they were "not at all" or "not very" likely to move because of the Project.

Overall, the NND Project will result in an increase in the population associated with, or directly dependent on Project-related employment. The Project will be a positive contributor to the anticipated growth in population across the study areas; with Durham Region in the RSA and the Municipality of Clarington in the LSA experiencing the most Project-related growth.

Skills and Labour Supply

The skills and amount of labour available in a community reflect the proportion of its labour needs that can be met locally and hence the potential for individuals and households to realize employment and income benefits. These in turn determine the potential for in-migration and the amount of commuting that occurs, thereby affecting housing, transportation infrastructure in a community; and influence the quality of education, health and safety, social services in a community.

It is estimated that the NND Site Preparation and Construction phase will require an on-site workforce of up to 3,500 skilled and unskilled construction workers, engineers, architects and technicians for up to 8 years for two units and up to 16 years for four reactor units. Based on the analysis, the Ontario labour force in the Industrial/Engineering Trades and other trades likely to be involved in the NND Project is sufficient to supply peak labour demands of the Project. It is also anticipated that most of the individuals, gaining construction related employment at the DN site are likely to be current residents of Ontario and more likely residents in the GTA or Central Ontario.

The NND Project will likely place a sustained demand on the regional and provincial construction labour force. In addition, interviews conducted as part of this Socio-economic Assessment indicate that the NND Project is likely to be very attractive to construction workers due to the long term employment prospects, its proximity to the GTA and major population centres. Stakeholder interviews also indicated that major construction companies would likely modify their resourcing plans for existing and upcoming projects to make their best workers and construction management staff available to work on the NND Project. Such a sustained demand for construction workers has in the past, created competition for experienced construction workers.

Nonetheless, given the relatively recent downturn in Ontario's (and the global) economy, and sustained initiatives by government, employers, labour groups and educational institutions aimed at establishing a stable, qualified construction workforce, measureable adverse effects of the NND Project on the regional and provincial construction labour force are not considered likely. On the contrary, ongoing restructuring of the automotive manufacturing industry in Durham Region and across the GTA is likely to allow the NND Project to draw on former auto sector workers. Some auto sector workers skilled in trades that are in demand (e.g., boilermakers, construction millwrights, crane operators, heavy duty equipment mechanics, ironworkers) are likely to have immediate opportunity for employment on the NND Project during the Site Preparation and Construction Phase. Others may need to retrain and upgrade skills to take advantage of the employment opportunities presented by the NND Project.

Conversely, given the size of the construction workforce and the duration of the Site Preparation and Construction phase, it is likely that the NND Project will create new apprenticeship opportunities that will positively contribute to the ongoing initiatives of government, labour groups and others involved in the construction industry. For example, the City of Oshawa and Durham Region's *"Community Adjustment and Sustainability Strategy for Oshawa and Durham Region"* have recognized the forces shaping Ontario's economy and labour market, including restructuring in the manufacturing industry, particularly the automotive sector, and proposed to undertake a number of initiatives to support affected workers.

OPG has estimated that the Operation and Maintenance phase will require an on-site workforce of up to 1,400 skilled and unskilled workers, including management, tradespeople, nuclear operators and maintainers, engineering and technical support staff, security staff and others for two units and up to 2,800 workers for four reactor units.

Based on the initiatives being undertaken by governments and organisations involved in the electricity sector, the NND Project will likely be able to attract the operation workforce it requires, however in doing so, the Project is also likely to place an increased and sustained demand on provincial electricity sector labour force and increase competition for skilled electricity sector workers. However, given sustained initiatives by government, employers, labour groups and educational institutions aimed at establishing a stable, qualified electricity sector workforce, measureable adverse effects of the NND Project on this sector are not considered likely.

Finally, the Project will help maintain existing jobs at the DN site during the Operation and Maintenance phase and will serve to maintain the skilled employment base of the RSA's and LSA's energy sector in the short term and contribute to the expansion of the skills base over the long term. This beneficial effect will likely be experienced by those municipalities with economic development initiatives focused on the energy sector (i.e., Durham Region, Municipality of Clarington and City of Oshawa).

Education

The educational system in a community determines its ability to provide opportunities for growth and learning, and access to skills and knowledge. It also provides a local source of employment and serves to attract new residents and business opportunities, thereby affecting its population and economic development. Educational facilities often act as a focus of local community life and activities, thereby influencing community cohesion.

As the population in the RSA and LSA grows, it may be expected that the number of students would also grow proportionally. However, since 2002 most of the school boards serving the RSA have experienced declining enrolments and the actual number of students in elementary and secondary schools is projected to continue to decline, largely due to declining fertility rates resulting in smaller household sizes.

Increased school enrolment will occur across the RSA as a result of the NND Project, with the greatest increase during the Operation and Maintenance phase, and in those municipalities where the increase in associated population is greatest. The largest increase will be in the Municipality of Clarington where it is estimated that approximately 1,425 students would be associated with the NND Project or 4.4% of total enrolment during this time period.

School boards and individual schools that have a declining student base will benefit from increased enrolment. Depending on the number of new students enrolled, some schools under accommodation review could remain open, while would benefit from increased funding because much of the school funding is based on the numbers of students. Those schools that are anticipating increased enrolment will also benefit from increased enrolment-related funding and will be in a position to implement plans for new facilities and programs with more confidence.

Nevertheless, without proper planning and depending upon the distribution of population within the LSA and the timing of NND Project related in-migration, some individual schools that are at or nearing capacity may have difficulty in accommodating new students quickly. However, School Board official interviewed indicated that regular reviews are undertaken to determine school closures, consolidations, additional capacity requirements at existing schools and the need for new schools. As such, they did not anticipated that the NND Project would place additional indirect demands on School Boards that could not be met through normal planning. It is also not expected that the NND Project will disrupt activities at individual schools (e.g., indoor classes or outdoor activities, use of school facilities by other community members or staff). Existing fiscal mechanisms are available to assist with capital and operating costs of School Boards (i.e., Provincial funding mechanisms, educational development charges and municipal tax revenues).

TABLE 5.11-3
Indirect Effects of NND Project (4 Units) on Population – Regional and Local Study Areas (2010 – 2084) By Phase

Study Area	Municipalities	Current Effect of DNGS Year 2006			Site Preparation and Construction At Peak Employment Around 2018				Operation and Maintenance At full NND Employment Around 2050			
		Municipal Population	DNGS	DNGS as a % of Municipality	Municipal Population	NND Project	NND Project as a % of Municipality	DN Site as a % of Municipality	Municipal Population	NND Project	NND Project as a % of Municipality	DN Site as a % of Municipality
Regional Study Area	Durham Region	602,010	17,163	2.9	798,635	11,491	1.4	0.4	1,219,109	13,999	1.2	2.6
	City of Toronto (partial)	639,272	290	<0.1	739,583	3,166	0.4	0.5	878,066	917	0.1	0.1
	York Region (Partial)	307,693	92	<0.1	410,650	1,245	0.3	0.3	567,554	292	0.1	0.1
	City of Kawartha Lakes	78,800	1,434	1.8	93,545	1,861	1.99	3.5	124,868	1,642	1.3	2.5
	City of Peterborough / County of Peterborough (Partial)	112,975	830	0.7	124,714	1,497	1.20	1.9	133,347	1,034	0.8	1.9
	County of Northumberland (Partial)	54,662	968	1.8	62,436	1,007	1.61	3.2	67,582	1,086	1.6	3.0
	Total RSA	1,795,412	20,776	1.2	2,229,562	20,267	0.9	1.8	2,990,526	18,970	0.6	1.3
Local Study Area	Clarington	83,368	10,243	12.3	109,050	4,217	3.9	13.3	176,755	7,729	4.4	10.2
	Oshawa	148,826	2,637	1.8	170,833	2,170	1.3	2.5	224,614	2,203	1.0	2.2
	Total Local Study Area	232,194	12,880	5.6	279,882	6,387	2.3	6.9	401,369	9,932	2.5	5.7

Notes:

1. The "Current Effect of DNGS" column represents the effect of the existing DNGS. It provides context for the predicted effects of the NND Project.
2. Effects of the NND Project are based on the construction and operation of four reactor units
3. Values for "Durham Region" and "Total Regional Study Area" include the values for the "Municipality of Clarington", "City of Oshawa" and "Total Local Study Area".
4. "Municipal Population" values represent the average number of people resident in the municipality in a given year during the time period indicate
5. "NND Project" values represent the average number of people resident in the municipality that are associated with the NND Project.
6. "NND Project as a % of Municipality" values are the proportion (%) that the "NND Project Average" represents of the "Municipal Average". These data provide for the NND Project effect to be considered in the context of the anticipated municipal population during the time period indicated.

The NND Project will not place any measurable direct demands on elementary or secondary schools. As well, direct effects of the Project are not likely to disrupt activities at individual schools (e.g., indoor classes or outdoor activities, use of school facilities by the community). However, it is noted that students of many of the schools in the vicinity of the DN site travel to and from their schools by bus and most area roads, particularly those north of Highway 401, are used regularly by school buses. These same roads will be subject to Project-related traffic and it is to be expected that there may be disruption to normal school bus operation as a result of this traffic. The greatest disruption is likely to be experienced during the Site Preparation and Construction phase and, specifically, along the transport route used for shipment of surplus soil from the DN site. This potential for disruption is considered further as an effect of the Project.

Apart from increased enrolment in elementary and secondary schools, the NND Project will likely be a driver for increased enrolment in post secondary educational programs that provide energy or nuclear related degrees or certificates and other training programs that support certification in a skilled trade. Those post-secondary institutions that have an established relationship with OPG, other nuclear and construction industry partners are likely to have the best opportunity to benefit from the NND Project. Within the LSA, it can be expected that programs at Durham College and the University of Ontario Institute of Technology (UOIT) will likely expand to better meet the anticipated increase in demand.

<u>Fire, Police and Emergency Services and Health Care</u>

The availability and quality of fire services, policing and emergency preparedness, and health care services play a crucial role in maintaining people's feelings of health and a sense of safety on a daily basis and during crisis situations, thus affecting people's satisfaction with community.

During the Site Preparation and Construction phase, under the terms of its agreement with OPG and its responsibilities as the "Constructor" under provincial occupational health and safety legislation, the Vendor (i.e., the entity retained by OPG to implement the site preparation and construction activities) will be required to develop a health and safety plan that will include provisions, among others, for fire and emergency protection, that is acceptable to OPG and applicable regulatory agencies.

A Memorandum of Understanding (MOU) currently exists between the Municipality of Clarington and OPG with regard to provision of fire protection services, including coordinated emergency response. This MOU recognizes an existing cooperative relationship between the parties with respect to fire protection, emergency response, and community emergency management. In the event of a major off-site incident, OPG is to provide assistance to Clarington if requested while respecting the limitations of regulatory requirements. This assistance may include personnel, equipment and supplies to support Clarington in their efforts to control and mitigate an emergency. In the event of an on-site incident, Clarington's Emergency and Fire Services is to be called to all fire events at the DN site. This MOU will remain in place and continue to be reviewed and updated as appropriate.

A recent study completed for the Municipality of Clarington recommended that the fire department should hire four new firefighters a year from 2009 to 2018, expand full-time firefighting into Newcastle, and, eventually, add on to the current department's headquarters and build a new station between Bowmanville and Newcastle. This would allow Clarington's fire department to move closer to the 10-in-10 rule for level of service, a guideline of the Ontario Fire Marshal's Office, which calls for 10 firefighters to be on-scene at an incident within 10 minutes. Given the desire for Clarington's fire department to move closer to the Fire Marshal's guideline, the number of fire services staff likely required per capita in the future will be greater that it is today. However, the proposed increase in the number of fire fighters in Clarington over the next several years, along with associated support staff is considered sufficient to meet the indirect NND Project related demands on fire services.

It may be that municipal fire services will experience some ad hoc or short-term increases in service requirements resulting from the workforce at the DN site and the presence of additional reactor units. The Municipality of Clarington's Fire Department will likely be called upon for routine non-emergency management services (e.g., advice/guidance and site inspections) during both the Site Preparation and Construction phase and Operation and Maintenance phase. There may be requirements for additional orientation and training of fire-fighting staff with respect to the presence of the new facility. Similarly service requirements on Durham Region's police service are also likely.

Increased population associated with the NND Project will place additional demand on fire and police services off the DN site. However, the increase in the number of fire-fighters in Clarington and police officers in Durham Region and associated support staff already being planned for and likely to occur over the coming years, is considered sufficient to meet the indirect NND Project related demands. In all other municipalities, the increased indirect demand is measurable, but considered marginal (i.e., less than five fire services and police staff) in the context of population growth on continued expansion of fire services across the RSA.

Overall, measureable changes on the availability and quality of fire and police services in the RSA and LSA, either directly or indirectly attributable to the Project, are not anticipated. The costs for the modest level of any additional services likely to be required to meet increased demands of the NND Project will be satisfied through increased household property taxes associated with the NND Project.

Given the advanced state of emergency preparedness among all municipalities in the RSA and LSA, it is not likely that the NND Project will require any change to these emergency planning organisations. This conclusion is supported by the results of stakeholder interviews with all RSA and LSA municipal emergency management co-ordinators. Nevertheless, it is likely that existing nuclear emergency plans may need to be reviewed and updated to reflect the presence of additional reactor units and the increased number of construction workers on the DN site. Similar to the direct effects on fire and policing services, additional demands will likely be placed on emergency preparedness staff with respect to planning and participation in additional emergency exercises and drills. Funding for the provision of the required services to meet the direct demands of the NND Project will be made available through the payment of property taxes by OPG and other existing mechanisms (e.g., MOU). As such, noticeable effects on the adverse effects on emergency preparedness services in the RSA or LSA are not anticipated.

In any major construction project, conventional workplace accidents are likely to occur and will require some form of medical attention. During the Site Preparation and Construction, and Operation and Maintenance phases, first aid capabilities will be provided, however it is anticipated that any injuries would require further treatment at the nearest hospital to the DN site (i.e., Lakeridge Health Bowmanville). As such, the Project will likely directly increase the demand for emergency medical services. Funding for the provision of some emergency medical services (e.g., ambulance services) to meet the direct demands of the NND Project will be made available through the payment of property taxes by OPG.

It is also noted that direct environmental effects of the NND Project are not likely to disrupt activities conducted at health and safety facilities because noticeable noise and dust effects will be largely limited to the DN site and its immediate vicinity.

An increased indirect demand on hospital beds will also occur during both the Site Preparation and Construction phase and Operation and Maintenance phase of the NND Project. In the LSA, it is estimated that the increased population associated with the NND Project would increase demands for up to 16 hospital beds (i.e., for four reactors). The total projected number of beds available at Lakeridge Health (Oshawa) and Bowmanville by 2011 is 722. As such, the indirect increase in demand for hospital beds is only approximately 2.5% of their projected capacity. Therefore, a noticeable effect on the provision of health care services in the LSA is not anticipated as a result of increased population.

Social Services

Social services directly affect community well-being by assisting members of the community to achieve a better quality of life through the alleviation of needs and problems. Overall, the NND Project is likely to result in several positive effects which may contribute to reducing the demand for various social services offered throughout the RSA and LSA. For example, increased employment and business opportunities along with increased household incomes may contribute to reduced demands on income support services. Increased housing and diversification of the housing stock may ease demands on housing services. Increased tax and other revenues that result in an improved financial status of RSA and LSA municipalities may also serve to enhance the finances of social service agencies. Positive influence of the Project on community cohesion also works towards positive outcomes on other social services. Overall, the NND Project may have positive implications for the demands on a delivery of social services, although measureable positive effects attributable to the NND Project are not considered likely.

Nevertheless, some types of social services, day-care, for example, may be adversely affected. Based on the current number of available day care spots, especially for infants and toddlers, and the anticipated population growth within the LSA and RSA, there will likely be an increase in enrolment that exceeds the existing supply during the Site Preparation and Construction phase. However, in the context of overall population growth and the likely continued expansion of such services across the RSA and Durham Region in particular, it is anticipated that the indirect demand placed on these services will be met through ongoing service expansion initiatives.

Economic Development Services

Economic development services are those provided by municipalities and affiliated organizations aimed at generating wealth through increased employment and business activity, and attracting investment and tourists.

The Project will contribute to increased local and regional economic development throughout all of its phases. The local and regional economies will be stimulated by the increased population and skills base (Human Assets), more employment opportunities and greater income (Financial Assets) and the increased business activity (Financial Assets) generated by the Project. Each of these positive effects of the Project is anticipated to improve the attractiveness of the RSA to potential investors, particularly those in the nuclear service industry. It is also expected that the NND Project will serve to attract new investment in the tourism sector (Financial Assets) in the LSA, thereby supporting the economic development objectives of Durham Region, the City of Oshawa and the Municipality of Clarington.

5.11.4.1 Likely Effects on VECs

The VECs for the Human Assets sub-component are local and regional population, education, and health and safety facilities and services. Likely environmental effects on these VECs as a result of the Project are described as follows.

NND Project-related traffic may disrupt normal school bus operation in the vicinity of the DN site. The greatest disruption is likely to be experienced during the Site Preparation and Construction phase and, specifically, along the transport route used for shipment of surplus soil from the DN site

This is considered an adverse effect of the Project and is further evaluated in terms of mitigation measures and residual effects.

The NND Project may result in increased requirements for some municipal and social services, including fire, policing, emergency preparedness, health care and day-care. The increased requirements are small relative to the existing municipal and social services base and can reasonably be expected to be addressed through ongoing service expansions required as a result of routine development and supported by increased tax revenues associated with the NND Project

These changes are not considered adverse effects of the Project and are not evaluated further in terms of mitigation measures and residual effects.

The following are considered to be beneficial effects of the NND Project:

- *Increased population associated with, or directly dependent on, NND Project-related employment resulting in the maintenance of the social structure and stability of LSA communities and selected municipalities across the RSA. The NND Project will be a positive contributor to the anticipated population growth in all RSA and LSA municipalities.*
- *The NND Project is likely to create new apprenticeship opportunities that would generate a substantial number of new certified tradespeople available for the Project itself and/or Ontario's construction labour market subsequently;*
- *The NND Project will serve to maintain the skilled employment base of the RSA's and LSA's energy sector in the short term and contribute to the expansion of the skills base over the long term;*
- *The NND Project will likely be a driver for increased enrolment in post secondary educational programs that provide energy or nuclear related degrees or certificates and other training programs that support certification in a skilled trade; and*
- *The NND Project will likely be a driver for increased local and regional economic development during each phase of the Project, as well as a driver for the further development of the Durham Energy Industry Cluster and the Clarington Energy Business Park through the likely establishment of new business operations in the RSA that are involved in the nuclear service industry.*

Beneficial effects are not considered further in terms of mitigation measures and residual effects.

5.11.4.2 Mitigation Measures

In considering likely effects on Human Assets, it was assumed that planning and design features will be incorporated into the Project based on industry practice and OPG experience, including this experience as it relates to its current relationship with the local and regional municipalities. The following actions and programs were considered as "in-design" mitigation measures in evaluating likely environmental effects, and for EA purposes, it is assumed that these actions and programs will be relevant for the NND Project:

- OPG and the Municipality of Clarington entered into a Host Municipality Agreement, dated August 31, 2009. The Agreement provides compensation to the Municipality to mitigate effects resulting from the NND Project, as identified in the EIS;

- OPG will share information with local and regional land use planners, economic development staff, and social service providers with respect to the timing and magnitude of its on-site labour force during the Site Preparation and Construction phase;

- OPG will work with government, other electricity sector employers, labour groups and educational institutions through existing liaison mechanisms and programs during the Site Preparation and Construction and Operation and Maintenance phases; and

- A Traffic Management Plan (also included as a mitigation of potential effects on Traffic and Transportation, see Section 5.9.2.7) will be implemented with the objective of reducing disruption and maintaining safe traffic conditions during the Site Preparation and Construction phase.

5.11.4.3 Residual Adverse Effects

No residual adverse effects are likely on Human Assets.

5.11.5 Assessment of Likely Effects on Financial Assets

The assessment of effects on Financial Assets is presented as follows in framework of the individual attributes of Financial Assets that were considered appropriate for this EA.

<u>Employment</u>

Employment provides a sense of personal security and contributes to a person's own self-image and status within a community. The availability of employment opportunities ultimately affects population levels, housing, community infrastructure and services which are major determinants of community character and cohesion. Further, public attitude research undertaken as part of the EA studies indicated that up to 53% of RSA residents and 67% of LSA residents anticipate that their household will benefit from NND Project related employment. Moreover, the majority of RSA and LSA residents (up to 58%) also anticipate that the new jobs and employment opportunities created will contribute positively to their community's well-being.

The NND Project is anticipated to involve a peak construction workforce of up to 3,500 management, tradespeople and labourers, plus a Project team of approximately 300 supervisory and oversight staff. During construction-related activities, the Project will generate approximately 7,500 direct, other direct and indirect jobs across the RSA, which would be associated with approximately 0.8% of total jobs in the RSA. During this period, the NND Project will create over 2,100 new direct and indirect jobs in the LSA and be associated with 4% of Clarington's total employment and approximately 1.3% of Oshawa's total employment.

During the Operation and Maintenance phase, the NND Project will have a work force of up to 2,800 and create approximately 7,300 direct, other direct and indirect jobs across the RSA. In the LSA, the NND Project is predicted to create approximately 2,500 new jobs in the Municipality of Clarington and approximately 1,200 new jobs within the City of Oshawa. During its Operation and Maintenance phase, the Project will be associated with 4.3% of Clarington's total employment and approximately 1% of Oshawa's total employment.

In addition to these direct and indirect employment opportunities, the NND Project will induce the creation of further employment opportunities as a result of wage spending by OPG staff, construction workers employed at the DN site and others gaining indirect employment because of the Project. During the Site Preparation and Construction phase, induced employment is estimated to be over 2,500 jobs in Durham Region and approximately 800 jobs in the Municipality of Clarington. During the Operation and Maintenance phase, induced employment is estimated to be over 3,600 jobs in Durham Region and 1,700 jobs in the Municipality of Clarington.

Overall, the Project will create new direct, indirect and induced employment opportunities for existing and potential in-movers to the RSA and LSA. It will be a positive contributor to anticipated employment growth in these municipalities, and will serve as a catalyst for further local and regional economic development.

Business Activity

Business activity generates the employment opportunities and income that people use to achieve their personal financial objectives, which define their style and quality of life. The level of business activity also influences the way a municipality, community or region is perceived and its attractiveness as a place to live or conduct business.

A relevant measure of business activity is local Gross Domestic Product (GDP). The GDP will increase as a result of the NND Project. In 2025, at completion of the Site Preparation and Construction phase, the added annual GDP in the RSA attributable to the project is forecast to be more than $1.2 billion, more than half of which occurs in Clarington. During the Operation and Maintenance phase, the annual GDP contribution in the RSA attributable to the NND Project ranges from $1.4 billion in 2018 to $709 million in 2084. About one-third of this total will be associated with the LSA.

Household spending will also increase as a result of the Project. Across the RSA, household spending by persons gaining employment associated with the NND is estimated to be approximately $82 million per year during the Site Preparation and Construction phase and about $359 million per year during the Operation and Maintenance phase. Within the LSA, NND-related household spending is estimated to be approximately $375 million per year during the Site Preparation and Construction phase and about $143 million per year during the Operation and Maintenance phase.

A further gauge of economic activity is operating floor space associated with business activities in the industrial, commercial and institution (ICI) sector. During the Site Preparation and Construction phase, the amount of ICI floor space in the RSA associated with the Project will total approximately 4 million ft^2 or 0.8% of the average ICI municipal floor space across the RSA. Similarly, the amount of ICI floor space in the LSA associated with the Project will increase by approximately 1.2 million ft^2 or 2% of the average ICI municipal floor space across the LSA. During the Operations and Maintenance phase, the amount of ICI floor space in the RSA associated with the Project will be approximately 4 million ft^2 or 0.5% of the average ICI municipal floor space across the RSA. Similarly, the amount of ICI floor space in the LSA associated with the Project will be approximately 1.9 million ft^2 or 2% of the average ICI municipal floor space across the LSA.

In the specific context of agri-business, the NND Project will require the removal of the 46.3-ha plot of Class 1 agricultural land currently farmed on the DN site and the termination of the lease or licensing arrangement of one farm operator with OPG. This loss represents about 5% of this operator's total farm revenues. During interview, the farmer indicated that all revenues are important to his operation, but this loss of revenue would not likely affect the overall viability of the overall farm operation.

It is also noted that most LSA farmers utilise public roads for the movement of their farm vehicles and their products to market. NND Project-related traffic can be expected to affect the movement of slow moving farm vehicles such as tractors and combines. This issue was also identified by respondents to the surveys undertaken during the EA studies.

Finally, no adverse effects on any commercial fishery are anticipated as no commercial fishing activities are undertaken in or around the DN site (see Section 4.11.3.2). No adverse effects on farm or agri-business operations are anticipated as a result of direct environmental effects of the NND Project or adverse changes in community character.

Tourism

During the Site Preparation and Construction phase, some construction workers, particularly weekend commuters and those that are on short-term assignments, may compete with tourists for temporary accommodation in the vicinity of the DN site (i.e., the LSA). This competition may result in some tourists opting for alternative accommodations elsewhere in the LSA and RSA. Should this be the case, some tourist businesses, including souvenir and gift shops, pick-your-own farm operations, tourist vineyards, wineries, bed and breakfast providers (B&Bs) and other temporary accommodation providers, whose operations are largely dependent on visiting tourists would be the most vulnerable. With respect to effects on tourists, those preferring to stay at the Darlington Provincial Park (DPP), hotels and motels, and nearby campgrounds would be the most inconvenienced by competition for temporary accommodation.

Any such competition is not expected to be of sufficient magnitude to affect the tourism industry in the LSA over the long term largely because current occupancy rates are generally low and are expected to remain so until the NND Project commences. As well, the number of tourist accommodation establishments across the LSA and RSA is increasing and such growth is likely to continue into the foreseeable future (e.g., a new Holiday Inn is now operating in Bowmanville and some tourist accommodation operators interviewed indicated that they have plans for expansion). In fact, increased population and workforce activity in the LSA are anticipated to be a source of increased business activity at all hotel/motel operations and other tourist accommodation businesses in the LSA. Improved economic viability and increased investment in tourist accommodation businesses would result in improved stock of tourist accommodations in the LSA during the Site Preparation and Construction phase.

Notwithstanding the positive effects on temporary accommodation providers, should tourist visits to the DPP, and hotels, motels and campgrounds in the LSA lessen, it is not likely that the overall revenue stream for these businesses would suffer because NND Project workers will become an alternate source of revenue to a large extent. Nonetheless, it is recognized that certain businesses are largely dependent on visiting tourists (rather than workers), however, the majority of these businesses, such as pick-your-own farms, wineries, and bed and breakfast providers are located at a distance from the DN site such that the nuisance effects of the Project (e.g., noise, dust and traffic) would not dissuade tourists from visiting these business operations or attractions.

The proximity of DPP to the DN site makes the park particularly susceptible to effects on its tourist-based business. However, assessment of effects in other bio-physical environmental components, including the assessment of the visual effects of potential cooling towers has established that the DPP will not experience substantial direct adverse effects and, as such, its continuing appeal to users is not expected to be diminished. In the context of growing local and regional populations, it is not expected that NND Project would result in a measureable decrease in the use of the DPP by tourists or day users.

Further, the interviews conducted as part of the EA studies across the LSA and RSA (i.e., DPP users, tourism business operators, accommodation providers and agricultural, fishing and boat service and product providers) support the conclusion that the RSA and LSA have not been stigmatised by the ongoing presence of the DN site and there are no strong indications that the NND Project would stigmatize the community. As such, no adverse effects on tourism are anticipated.

Income

To individuals and families, income provides the means to achieve their personal financial objectives and status within a community. Income provides the financial means for residents to undertake a variety of educational, social and community activities that strengthen a community's Human and Social Assets.

The GDP increases associated with the NND Project correspond to an approximate $500 million increase in total household income in the RSA during both phases. Increased total household income in the LSA ranges from about $150 million during site preparation and construction to $250 million during operations. The contribution of the NND Project to increased total household income is considered a beneficial effect.

Residential Property Values

Property value refers to the market value of land and buildings. The value of residential property has a substantial effect on a person's spending power and as such is often the most important determinant of an individual's use and enjoyment of property and their satisfaction with community. To the municipalities and communities, property values determine in part municipal tax revenues and therefore, a municipality's financial health.

Because population growth across the LSA is projected during the Site Preparation and Construction phase, increased demand for residential properties will likely occur as a result of the NND Project. Consequently, it is likely that the NND Project will be a positive influence on property values in the LSA. As such, the real estate market could experience increased sales volumes. It is also expected that the increased demand for housing and growth in property values and increased sales volumes across the LSA could extend into the Operation and Maintenance phase. In fact, case study research suggests that some employees may place a premium on living in proximity to their place of work.

It may be speculated that the presence of visible cooling towers and their associated vapour plumes or storage of additional nuclear waste associated with the NND Project would be detrimental to residential property values. However, recent reviews of case studies regarding property values near nuclear facilities in the U.S indicate that negative imagery surrounding nuclear plants or stored nuclear waste does not necessarily result in a detrimental influence on residential home prices in the immediate vicinity of these facilities.

Within the LSA, any potential for decreased values of individual properties as a result the Project (e.g., residential properties along the truck haul route to the DN site) would likely be offset by the positive influences on property values as a result of Project-related demand for housing, changes in accessibility due to planned improvements in the transportation infrastructure, or masked by other changes in land use, servicing and infrastructure unrelated to the NND Project.

Municipal Finance

To an individual, family or household, the manner in which the lower and upper tier municipalities manage their financial and administrative affairs can directly affect their tax burden and consequently their spending power. To the municipalities and communities in the RSA, the ability of governments to gain funding from appropriate sources and manage their financial and administrative affairs directly affects the availability and quality of services they can provide.

The key component of municipal finance considered is the contribution of taxes to municipal revenues both directly and indirectly as a result of the NND Project. During the Site Preparation and Construction phase tax revenues contributed from households associated with the NND Project will total about $20.3 million per year, representing about 0.9% of the total residential tax base in the RSA. Within the LSA, property tax payments from households associated with the NND Project will be about $7.1 million per year, representing 2.0% of the total tax base in the LSA. During the Operation and Maintenance phase, these amounts will be $20.0 million and $10.7 million, respectively within the RSA and LSA, representing 0.6% and 2.1% of the total tax bases in the RSA and LSA, also respectively.

In addition to property taxes derived from residential households, OPG estimates that it will contribute about $2.7 million in annual taxes for two reactor units and $5.4 million for four units. In 2006, the total industrial tax base in the Municipality of Clarington was about $8.9 million. The addition of $2.7 million per year resulting from the operation of NND Project will add about 30% to the industrial base of the Municipality which will serve to positively affect the ratio between residential and industrial taxes.

The Official Plan for the Municipality of Clarington provides for a fiscal impact analysis to be undertaken for large scale developments. However, at this time it is not possible to identify and quantify all of the potential costs to the Municipality of Clarington as a result of the NND Project. As the Project continues through its planning and design stages, OPG and the Municipality of Clarington will collaborate to refine their understanding of the potential effects of the Project from a municipal finance perspective, and work to together to address any such adverse effects through the Host Community Agreement.

5.11.5.1 Likely Effects on VECs

The VECs for the Financial Assets sub-component are local and regional economic development, tourism, agriculture, residential property values and municipal revenues and financial status. Likely environmental effects on these VECs as a result of the Project are described as follows.

The NND Project is not expected to result in adverse environmental effects on economic development, tourism, agriculture, property values, or municipal revenues and finance.

Accordingly, no further evaluation of effects on Financial Assets is warranted.

The following are considered to be beneficial effects of the NND Project:

- *Creation of new direct, indirect and induced employment opportunities for existing and potential in-movers to the RSA and LSA and will positively influence employment growth in these municipalities;*
- *Creation of new business activity and opportunities due to increased spending associated with households, directly or indirectly associated with the NND Project employment, and increased Project expenditures of goods and services during the Site Preparation and Construction phase and the Operation and Maintenance phase;*
- *Improved economic viability and increased investment in tourist accommodation businesses (i.e., hotels and motels) resulting in improved stock of tourist accommodations in the LSA during the Site Preparation and Construction phase;*
- *Increased total household income during both the Site Preparation and Construction, and Operation and Maintenance phases of the Project;*
- *Increased rate of growth in property values and increased sales volumes in the LSA municipalities; and*
- *Increased municipal tax and other revenues during the Site Preparation and Construction phase and the Operations and Maintenance phase.*

Beneficial effects are not considered further in terms of mitigation measures and residual effects.

5.11.5.2 Mitigation Measures

As noted above, no adverse environmental effects are expected on Financial Assets as a result of the Project. It reaching this conclusion, however, it was assumed that planning and design features will be incorporated into the Project based on industry practice and OPG experience, including this experience as it relates to its current relationship with the local and regional municipalities. The following actions and programs were considered as "in-design" mitigation measures in evaluating likely environmental effects, and for EA purposes, it is assumed that these actions and programs will be relevant for the NND Project:

- OPG and the Municipality of Clarington entered into a Host Municipality Agreement, dated August 31, 2009. The Agreement provides compensation to the Municipality to mitigate effects resulting from the NND Project, as identified in the EIS;
- A Traffic Management Plan (also included as a mitigation of potential effects on Traffic and Transportation, see Section 5.9.2.7) will be implemented with the objective of reducing disruption and maintaining safe traffic conditions during the Site Preparation and Construction phase; and
- A Nuisance Effects Management Plan (e.g., to address dust and noise concerns) will be implemented for residential properties along transportation routes affected by the NND Project as identified in the Traffic Management Plan during the Site Preparation and Construction phase. The Plan will include a process for receiving, resolving and following-up on complaints and issues raised by the public.

5.11.5.3 Residual Adverse Effects

No residual adverse effects are likely on Financial Assets.

5.11.6 Assessment of Likely Effects on Physical Assets

The assessment of effects on Physical Assets is presented as follows in framework of the individual attributes of Physical Assets that were considered appropriate for this EA.

Housing

A dwelling or place of residence provides the basic shelter and sanitary facilities necessary for physical health. Adequate housing provides privacy and security which contribute to psychological health and a sense of personal safety. To the municipalities and communities, housing affects an area's character, cohesion and a municipality's financial health.

The total housing stock in the RSA is expected to increase by approximately 22% during the Site Preparation and Construction phase and by 78% during the Operation and Maintenance phase of the Project. The total number of units in the RSA will rise from 604,000 (2006) to 782,000 by 2025 and 1.25 million by 2084.

During the Site Preparation and Construction phase the NND Project will be associated with approximately 3.9% of the Municipality of Clarington's housing stock and 1.3% of the City of Oshawa's housing stock. During the Operation and Maintenance phase, the Project will be associated with approximately 0.65% of the total RSA housing stock; and approximately 4.4% of the housing stock in the Municipality of Clarington and less than 1% of the stock in Oshawa.

The Project is considered to be a positive contributor to the anticipated housing growth in these municipalities from 2010 to 2018 and will support the diversification of the housing stock in the Municipality of Clarington. Over time, as the housing stocks of the municipalities in the RSA and LSA continue their rapid growth, the influence of the Project on the housing stock will diminish substantially.

Municipal Infrastructure and Services

All businesses, including OPG, have access to all electricity service providers in the LSA. The direct electrical demand of the NND Project and its associated population represent business opportunities to a variety of service providers and there is currently more than adequate supply of generation and distribution capacity among these providers to meet these demands. As such, the consumption of electrical supply by NND and its related uses are not considered to be an adverse effect.

A conservative estimate of the total increased demand on the municipal water system from direct and indirect sources is approximately 1.2 MIGD. This increment in demand is a small fraction of the existing and proposed capacity of the entire water supply system in Durham Region, including most individual water supply plants serving the Municipality of Clarington, and the Cities of Pickering and Oshawa where the greatest demands are anticipated. Assuming the rate of sewage discharge to the municipal system is similar to that of potable water use, the increased associated population would place an additional flow demand on the municipal sewage system of a similar magnitude. Neither the Project-related service demands for potable water supply or sewage treatment are expected to exceed the existing or planned capacities of the systems.

It is estimated that the population increase associated with the NND project will generate approximately 0.06% of the total waste volumes processed in Durham Region in 2007. In the context of overall waste management system that is emerging in Durham Region, the NND Project and its associated population are not expected to place demands on the municipal system that would exceed its existing or planned capacities.

Community Character

Community character refers to the unique or distinctive qualities of a community. Community character is considered to be a Physical Asset of a community because it is largely determined by its land uses.

The NND Project might adversely affect the character of the community if it fundamentally changes other assets of the community, particularly those assets that are valued by its residents for their positive influence on community character. Overall, few residual adverse effects of the NND Project were identified that would directly influence or fundamentally change those assets that are valued by its residents for their positive influence on community character. However, it is anticipated that the overall rural, small town feel of some neighbourhoods/communities in the LSA may change to some degree by the increased population and economic growth associated with the Project. In specific terms, residents in the LSA are likely to notice increased traffic on local roads, and potential marine and rail transport vehicles as well. However, in the overall context of the growth and economic development planned for the LSA, the NND Project is likely to be a minor contributor to the changes in community character expected to occur over the next several decades.

Given the ongoing presence of the DNGS, the fact that the NND Project does not involve the introduction of a new facility into a previously undeveloped area, and existing industrial land uses along the waterfront in the LSA and in close proximity to the DN site (e.g., St. Marys Cement), the NND Project is considered to be compatible with the existing community character. Furthermore, placed in the context of the changes in land uses that are likely to occur in this area in the foreseeable future, the NND Project represents a strengthening of an existing, growing and planned industrial presence along the Municipality of Clarington's waterfront and the Highway 401 corridor.

It may be speculated that the presence of visible cooling towers and their associated vapour plumes or storage of additional nuclear waste storage associated with the NND Project would be detrimental to community character, particularly if a "stigma" was to be created because of the Project. Stigma refers to the negative images attached to a neighbourhood, community, other geographic area and its residents or to local products and services.

If the NND Project were to be developed generally similar to the DNGS (i.e., without cooling towers) and based on the operating experience and studies undertaken as part of this EA, there is no strong indication that the NND would result in any stigma. For example, public attitude research results indicate that only 2% of respondents identified DNGS as a negative influence on community image or character; and only 8% indicated that the NND Project might have a negative effect on the community character or image (8% also indicated the project would have positive effect on their community's image).

Conversely, if the NND is developed to include cooling towers (either natural or mechanical draft), a likely adverse effect on community character is to be expected. The assessment of likely effects on landscape and visual setting (see Section 5.8.6) concludes that the visual landscape on the DN site will be permanently altered by the NND Project, with the greatest visual effect being as a result of the presence of natural draft cooling towers and their associated vapour plumes.

Given the complex nature of the process of stigmatisation, it is not possible to predict when or under what circumstances it might occur. However, in the absence of a precipitating event such as a nuclear accident or a series of smaller abnormal events, the presence of cooling towers are not of themselves likely to be a trigger for the attribution of a stigma. Many respondents to the public attitude research indicated they would consider the cooling towers and their associated vapour plumes as being more of an "eye sore" that would change the character of the waterfront than a trigger for a stigma or major change in their community's image. Approximately 39% of RSA residents and 54% of LSA residents expressed these sentiments. Although either natural draft and mechanical draft cooling towers together with their associated vapour plumes can result in a change in community character, it is the natural draft cooling towers, with their large size, hyperbolic shape and their likely negative associations with other places and images that are considered most likely to result in an adverse change in community character. Experience and studies elsewhere suggest that any negative associations between the LSA and the NND Project with cooling towers are expected to diminish over time as the cooling towers become familiar structures on the landscape; and the NND Project establishes a positive environmental and safety record that is well communicated to the public, both within and outside the LSA.

Therefore, it is concluded that the NND Project with either natural draft or mechanical draft cooling towers will result in an adverse change in the character of neighbourhoods/communities from where the cooling towers and vapour plumes would be prominent features on the landscape, particularly in the immediate vicinity of the DN site. However, in the absence of a precipitating event such as a nuclear accident or a series of smaller abnormal events, there are no strong indications that these communities would be stigmatized by the NND Project.

5.11.6.1 Likely Effects on VECs

The VECs for the Physical Assets sub-component are housing, municipal infrastructure and services, and community character and image. Likely environmental effects on these VECs as a result of the Project are described as follows.

If the NND Project were to be implemented with cooling towers, the natural draft cooling towers alone, and the vapour plumes associated with either natural draft or mechanical draft cooling towers would result in a change in the character of communities in the LSA and RSA.

This is considered an adverse effect of the Project and is further evaluated in terms of mitigation measures and residual effects.

The following are considered to be beneficial effects of the NND Project:

- *Serve as a driver for the initiation of new housing developments in the Municipality of Clarington, the provincially-identified growth centres of the Cities of Pickering and Oshawa, and other communities within Durham Region;*
- *Diversification of the housing stock in the Municipality of Clarington;*

Beneficial effects are not considered further in terms of mitigation measures and residual effects

5.11.6.2 Mitigation Measures

No specific planning and design features have been incorporated into the NND Project as "in design" mitigation measures to address likely environmental effects on Physical Assets. Neither have mitigation measures been identified through the EA to address effects on Physical Assets as a result of the Project.

5.11.6.3 Residual Adverse Effects

The following residual adverse effect is advanced for consideration of significance:

- Change in the character of communities in the RSA and LSA as a result of the presence of the natural draft cooling tower structures, and the associated plumes released from either natural draft or mechanical draft cooling towers (if the NND Project were to be implemented with cooling towers).

5.11.7 Assessment of Likely Effects on Social Assets

The assessment of effects on Social Assets is presented as follows in framework of the individual attributes of Social Assets that were considered appropriate for this EA.

<u>Community and Recreational Facilities and Programs</u>

The availability of community and recreational facilities and programs influence people's feelings of personal health and satisfaction with community. To the municipalities and communities, the presence of such features may serve to attract residents and tourists, thereby influencing a community's Human and Financial Assets.

The Project may require the displacement of the Upper and Lower Soccer Fields and the fitness loop currently located on the DN site to accommodate Project activities. This will be a direct loss to those who use these facilities. Although OPG will strive to maintain public access to the Waterfront Trail within the DN site, the trail is likely to be modified and reconfigured on occasion for the safety of users. Overall, it is likely that during the Site Preparation and Construction phase current users of the recreational facilities on the DN site would use it less and would likely go elsewhere to undertake the recreational activities that they would normally undertake on the DN site. The results of the DN Recreational Use Survey indicate that there are many options available and residents will not need to travel far to reach an alternate facility or location should they choose to do so. Those who continue to use the DN site will likely enjoy their visit less due to nuisance effects, changes in the quality of the trail and biodiversity of the site. Overall, it is expected that people would resume their use and enjoyment of the DN site for recreational purposes once the DN site is restored following the initial few years of construction.

Widespread changes to people's use and enjoyment of community and recreational features off the DN site are not anticipated either during the Site Preparation and Construction phase or the Operation and Maintenance phase as nuisance effects are likely to be barely noticeable and very infrequent. Although results of public attitude research indicate that a small proportion of users intended to change their use of the parks, beaches, trails and other outdoor community and recreational features in the vicinity of the DN site, particularly if the Project were to include natural draft cooling towers, the NND Project will not substantially affect peoples access to these amenities nor their attractive qualities. Moreover, in the context of growing local and regional populations, and because people do not always act on their stated intentions, a noticeable reduction in the use of these outdoor recreational features attributable to the Project is not considered likely. Finally, any negative associations between the outdoor community and recreational facilities in LSA and the NND Project with cooling towers are expected to diminish over time as the cooling towers become familiar structures on the landscape; and the NND Project establishes a positive environmental and safety record that is well communicated to the public, both within and outside the LSA.

It is also not expected that the Project will have any measureable adverse effect on other community and recreational facilities in the LSA nor is it expected that there will be any substantial indirect demand strain placed on existing off site facilities as a result of population increases associated with the Project.

Use and Enjoyment of Private Property

People's use and enjoyment of private property may be adversely affected if the assets that are seen to be negative influences become more pronounced as a result of the NND Project. In the LSA, these include: high property taxes, the availability and quality of municipal services in some neighbourhoods, traffic/congestion and traffic noise, increased development, general pollution, poor air quality and noise. DN site neighbour survey results also indicated that people currently dislike the traffic volumes and speeding on local roads, the lack of municipal services, and general growth and development.

The NND Project may adversely affect people's use and enjoyment of private property if it fundamentally changes those features of the community that are valued for their positive influence on use and enjoyment of property. Based on the results of public attitude research, residents in the LSA most value the lack of crime, their privacy, friendliness of the community / neighbours, general property upkeep, and the availability and access to recreational features and activities in the LSA. Based on the results of the DN site neighbour survey, these residents enjoy their privacy, good neighbours and the proximity of their home to workplaces and services that their community offers. Overall, there are no strong indications that the Project will directly affect or adversely affect these valued features. As noted previously, the NND Project is not likely to affect people's access to recreational features and activities in the LSA.

As noted previously, in the overall context of the growth and economic development planned for the LSA over the next several decades, the NND Project is considered to be a minor contributor to the growth and development likely to occur over the next several decades. Nevertheless, some people are likely to consider the Project as a negative influence on the use and enjoyment of property should increases in nuisance effects such as noise and dust, and increased traffic become associated with a Project.

During the Site Preparation and Construction phase, dust levels are not expected to be a visual nuisance but may be noticeable at any residential locations nearest the DN site, albeit very infrequently. Increased noise levels are also considered to be barely audible in the immediate vicinity of the DN site and are should not affect people's use and enjoyment of their property.

Apart from noise and dust from the DN site, increased traffic and associated traffic noise and increased dust levels along the truck haul route may also be noticeable to residents along these routes. In areas other than along truck haul routes, the presence of additional vehicles, particularly trucks, may be noticeable to some people, and as such, represent a potential to diminish their use and enjoyment of property.

During the Operation and Maintenance phase, although they may be noticeable, increased noise, dust and traffic levels associated with the Project are not likely to be of sufficient magnitude to cause widespread changes to people's use and enjoyment of private property. However, the NND Project with cooling towers will likely have an adverse effect on people's use and enjoyment of private property, due largely to the change in community character. This is most likely in those neighbourhoods/communities where the cooling towers and their associated vapour plumes would be prominent features on the landscape, particularly in the immediate vicinity of the DN site.

Community Cohesion

Community cohesion refers to people's sense of belonging to a self-defined community, shared norms and values. A cohesive community maintains and generates relationships and community pride, it helps in defining a common vision among its residents that serves to maintain and enhance other Community Assets and overall community well-being.

Based on the results of public attitude research undertaken as part of the EA studies, residents in the LSA value the fact that people know each other and are friendly, helpful and family oriented neighbours. Overall, few residual adverse effects of the NND Project were identified that would fundamentally change those assets that are valued by its residents for their positive influence on community cohesion. Nonetheless, it is likely that increased population, density and the overall small town feel of some neighbourhoods/communities might be indirectly adversely affected by the NND Project thereby contributing to adverse effects on community cohesion. Overall, however, in the long term, the NND Project may be a positive influence on community cohesion. As of 2007, OPG was the second-largest private employer in the RSA and with the addition of up to 2,800 nuclear energy workers, OPG will become an increasingly dominant employer in the LSA and the NND Project will increase opportunities for OPG to strengthen its role as an economic driver and corporate citizen in the LSA. Although, the positive influences on community cohesion are more likely to be noticeable than the negative ones, a measureable change in community cohesion as a result of the Project is not considered likely.

5.11.7.1 Likely Effects on VECs

The VECs for the Social Assets sub-component are community and recreational facilities and programs, use and enjoyment of property, and community cohesion. Likely environmental effects on these VECs as a result of the Project are described as follows:

Because of safety concerns during physical works in the vicinity of the publicly-accessible spaces, and possible periodic and short-term disruption because of the construction activities, there is likely to be some reduced use and enjoyment of the community and recreational features on the DN site during the Site Preparation and Construction phase.

This is considered an adverse effect of the Project and is further evaluated in terms of mitigation measures and residual effects.

Because of nuisance-related effects (e.g., dust, noise, traffic) some residents living along truck haul routes may experience disruption to their use and enjoyment of their property during the Site Preparation and Construction phase.

This is considered an adverse effect of the Project and is further evaluated in terms of mitigation measures and residual effects.

If the NND Project were to be implemented with cooling towers, it would result in reduced enjoyment of private property in the RSA and LSA due to the visual dominance of the natural draft cooling towers and the vapour plumes associated with either natural draft or mechanical draft cooling towers, on the landscape.

This is considered an adverse effect of the Project and is further evaluated in terms of mitigation measures and residual effects.

5.11.7.2 Mitigation Measures

In considering likely effects on Social Assets, it was assumed that planning and design features will be incorporated into the Project based on industry practice and OPG experience, including this experience as it relates to its current relationship with the local and regional municipalities. The following actions and programs were considered as "in-design" mitigation measures in evaluating likely environmental effects, and for EA purposes, it is assumed that these actions and programs will be relevant for the NND Project:

- OPG and the Municipality of Clarington entered into a Host Municipality Agreement, dated August 31, 2009. The Agreement provides compensation to the Municipality to mitigate effects resulting from the NND Project, as identified in the EIS;

- A Traffic Management Plan (also included as a mitigation of potential effects on Traffic and Transportation, see Section 5.9.2.7) will be implemented with the objective of reducing disruption and maintaining safe traffic conditions during the Site Preparation and Construction phase;

- A Nuisance Effects Management Plan will be implemented for residential properties along transportation routes affected by the NND Project as identified in the Traffic Management Plan during the Site preparation and Construction phase. The Plan will include a process for receiving, resolving and following-up on complaints and issues raised by the public;

- OPG will continue to work with various stakeholders to deliver its community, recreational, educational and biodiversity initiatives;

- OPG will continue to keep its neighbours and the broader public informed concerning activities at the DN site as appropriate to each phase of the Project;

- OPG will re-establish full access to and use of the Waterfront Trail in stages once safe access can be provided; and
- OPG will seek to establish a resolution with recreational users of the DN Site should there be any effects.

5.11.7.3 Residual Adverse Effects

Although the above-noted mitigation measure will be effective in addressing likely effects of the Project on Social Assets, the following residual adverse effects may remain in spite of mitigation and are advanced for consideration of significance:

- Reduced use and enjoyment of community and recreational features on the DN site (e.g., Waterfront Trail, soccer fields) during the Site Preparation and Construction phase;
- Disruption to use and enjoyment of property because of nuisance-related effects (e.g., dust, noise, traffic) during the Site Preparation and Construction phase for some residents living along the truck haul routes; and
- Reduced enjoyment of private property in the RSA and LSA as a result of the visual dominance of the natural draft cooling tower structures and the associated vapour plumes released from either the natural draft or mechanical draft cooling towers (if the NND Project were to be implemented with cooling towers).

5.11.8 Assessment of Likely Effects on Natural Assets

The assessment of likely environmental effects in the bio-physical and human environments which effectively encompass all applicable components of Natural Assets is described in other sections of this EIS, specifically:

- Atmospheric Environment (EIS Section 5.2);
- Surface Water Resources (EIS Section 5.3);
- Aquatic Environment (EIS Section 5.4);
- Terrestrial Environment (EIS Section 5.5);
- Geological and Hydrogeological Environment (EIS Section 5.6); and
- Radiation and Radioactivity (EIS Section 5.7).

Interactions with the Socio-economic Environment occur when a Project work or activity results in a measurable biophysical effect that provides a mechanism to interact with the Socio-economic Environment. An example of a biophysical effect is dust produced by excavation activities. This effect can interact with the existing Socio-economic Environment when dust levels become a nuisance to people and affect their social behaviours.

The direct effects of the Project on the natural and human environment are addressed in the above-noted sections. Any consequential effects in the Socio-economic Environment as a result of those direct effects have been considered in the foregoing assessment of effects in the Socio-economic Environment.

5.12 Aboriginal Interests

This Section provides an overview description of the potential effects of the Project on Aboriginal Interests. For the purposes of the EA, Aboriginal Interests are defined as being inclusive of interests beyond Aboriginal and treaty rights and include any other interests that might be indentified by Aboriginal Peoples. The detailed assessment of environmental effects on Aboriginal interests is presented in the *Aboriginal Interests Technical Support Document, New Nuclear - Darlington Environmental Assessment*.

OPG also understands that an important source of information relevant to the assessment of potential environmental effects involving Aboriginal Peoples in their environment and culture is Aboriginal Traditional Knowledge. Aboriginal Traditional Knowledge is generally accepted to be knowledge held by, and unique to, Aboriginal Peoples. Aboriginal Peoples (including their elders and ancestors that may have occupied a region or territory for hundreds of years) hold knowledge about their past and present use of their traditional territories, lands, resources, cultural and spiritual places and current economic activities. This knowledge can contribute a unique Aboriginal perspective to the EA process, and for this reason, Aboriginal Peoples were engaged extensively throughout the EA. The Aboriginal Engagement Program is described in Section 10.6.

The Aboriginal Interests environmental component includes three sub-components: Aboriginal Communities, Traditional Lands and Resource Use, and Ceremonial Sites and Significant Features.

5.12.1 Potential Project-Environment Interactions

Each Project work and activity was considered to determine if there was a plausible mechanism for it to interact with the individual sub-components of Aboriginal Interests. The potential interactions are illustrated as dots in the matrix on Table 5.1-1. As shown, three of the works and activities associated with the Site Preparation and Construction phase have the potential to interact with Aboriginal Interests.

Each potential interaction was evaluated to determine if it was likely to result in a measurable change to the current (i.e., baseline) conditions in the applicable sub-components. The works and activities that were considered likely to result in a measurable change are summarised in Table 5.12-1.

TABLE 5.12-1
Project Works and Activities Likely to
Measurably Change Conditions in Aboriginal Interests

Project Works and Activities	Rationale
SITE PREPARATION AND CONSTRUCTION PHASE	
Excavation and Grading	Soil excavation, movement and grading can disturb potential archaeological sites or other potential features or characteristics of significance to Aboriginal Peoples.
Workforce, Payroll and Purchasing	Potential for construction jobs and business opportunities for Aboriginal workers/businesses.

Where a measurable change was considered likely, the interaction between the work and activity and Aboriginal Interests was further evaluated to determine if the change in baseline conditions would represent an environmental effect.

5.12.2 Assessment of Likely Effects on Aboriginal Communities

The single VEC selected for this environmental sub-component is community characteristics.

As described in Section 4.12.2, nine Aboriginal communities and four Métis organizations were identified as having a potential interest in the NND Project and contacted concerning their interest and engaged throughout the EA studies. The consultations carried out through this engagement established that there are no current uses of lands or resources in the vicinity of the DN site by Aboriginal Peoples. It is also noted that the closest of these communities is at a distance of approximately 50 km. Considering the distance of Aboriginal communities from the proposed site and the nature of discussion shared with its leaders supported this conclusion. Engagement with Aboriginal groups throughout the EA study did not reveal concerns about potential interactions between their respective communities and the Project with regards for environmental change.

The NND Project will create a substantial number of new employment opportunities, and any such opportunities will be available to Aboriginal Peoples. Several of the Aboriginal communities have expressed interest in future employment and training opportunities afforded by the Project.

The likely environmental effects of the Project on Aboriginal Communities are described as follows:

The NND Project will create a substantial number of new employment opportunities and these will be available to Aboriginal Peoples.

This is considered a beneficial effect of the Project. Beneficial effects are not considered further in terms of mitigation measures and residual effects.

No likely adverse environmental effects are identified on Aboriginal Communities.

5.12.3 Assessment of Likely Effects on Traditional Lands and Resource Use

The VECs selected for this environmental sub-component are hunting and fishing for subsistence; and fishing, trapping and traditional harvesting and collecting for sustenance, recreational and economic purposes.

Research and engagement with the identified Aboriginal communities, councils and organizations did not reveal the presence of Aboriginal right or title, current use of land and/or resources, or impacts to traditional land use activities or physical and cultural heritage resources. Neither did it indicate this area as holding social, economic, archaeological, cultural and/or spiritual significance to identified Aboriginal communities and Métis organisations. Accordingly, it is considered unlikely that the Project will result in any adverse environmental effects on Traditional Lands and Resource Use. Throughout the EA study, some Aboriginal communities did express interest in OPG's work as it pertained to an assessment of physical and cultural heritage but did not cite this area of study as a concern.

5.12.4 Assessment of Likely Effects on Ceremonial Sites and Significant Features

The single VEC selected for this environmental sub-component is locations and features of cultural or spiritual importance.

Some archaeological artifacts pertaining to Aboriginal Peoples and heritage were identified as isolated find spots in the SSA (see Section 4.10). These findings confirmed that hunting and gathering activities took place in this area and may have occurred in the distant past, dating back thousands of years. However, they were not of a nature to suggest historical Aboriginal settlement or use for ceremonial purposes. This information was shared with participants of OPG's May 2008 Information Sharing Session. Following the session, a follow-up letter was sent to all Aboriginal communities, councils and organizations to ensure those who could not attend the session had received the information. Throughout the EA studies, Aboriginal communities expressed interest in the Project and OPG's work as it pertained to an assessment of physical and cultural heritage but did not cite this area of study as a concern.

It is also recognised that the construction and operations aspects of the NND Project will take place entirely on lands owned and controlled by OPG and which have been associated with the operation of a nuclear generating facility for some time.

For the above reasons, it is considered unlikely that the Project will result in any adverse environmental effects on Ceremonial Sites and Significant Features.

5.13 Health - Human

This Section provides an overview description of the potential effects of the Project on Human Health. The detailed assessment of environmental effects on Human Health is presented in the *Human Health – Technical Support Document New Nuclear – Darlington Environmental Assessment*.

The consideration of Human Health is framed in a context of two environmental sub-components: Health and Well-being of the General Public and Health and Safety of Workers. The VECs selected as being relevant to Human Health are Members of the Public and Workers for the NND Project. As noted in Section 4.13.1, factors of potential influence on the health of Aboriginal Peoples are considered in the same context as for other members of the public for this assessment. Human Health aspects of malfunctions, accidents and malevolent acts are discussed in Chapter 7.

The framework for considering potential effects on Human Health is described in Section 4.13.1. Health is addressed in a context of physical, mental and social well-being. Current community health profiles representing the existing conditions affecting overall health are described in Section 4.13.2. This Section describes how the existing factors that influence Human Health may be changed as a result of the Project and the consequences of any such changes on the VECs selected to represent Human Health.

5.13.1 Physical Well-Being

Physical well-being refers to the state of a person functioning without disease, illness or injury. It is influenced by biophysical environmental factors such as the presence of chemical or radiological contaminants in air or water, noise, dust, safety concerns, injuries, or accidents.

5.13.1.1 Radiation and Radioactivity

The assessment of radiation doses to humans associated with the Project is derived from forecasts of future conditions in the Radiation and Radioactivity Environment as described in Section 5.7. The selected VECs (i.e., workers and the general public) are addressed separately as indicated.

Radiation Doses to Workers

Through monitoring, radiation doses to NEWs at the DN site are known to be well below the regulatory limits; the same overall regulatory compliance will be the case for the NND Project. As described in Section 5.7.5.2, the maximum annual individual NEW doses for normal operation, routine maintenance activities and refurbishment are expected to be well below the regulatory limit of 100 mSv per 5 years with a maximum of 50 mSv in any one year. Furthermore, the estimated bounding annual collective dose for NND is approximately 0.67 P-Sv per unit or 2.68 P-Sv in total, considering the maximum number of units for each reactor type. This includes both normal operations and routine outage maintenance activities.

During the Operation and Maintenance phase (as well as during the decommissioning activities), the access and movement of non-NEWs involved in NND will be controlled by OPG. Radiation doses to these workers (non-NEWs) as a result of licensed activities on the site will also be controlled by OPG, thus ensuring that they do not exceed 1 mSv/y, the regulatory limit for individuals who are non-NEWs.

Radiation Doses to Members of the Public

As described in Section 5.7.5.1, the calculated dose from NND to the most exposed critical group is approximately 4 µSv/y (0.004 mSv/y). This dose is well below (0.4%) the regulatory limit for members of the public of 1 mSv/y (CNSC 2000). Furthermore, this maximum dose is a small fraction of the annual dose from natural background radiation in Canada of about 1,840 µSv/y (see Section 4.7).

These doses are primarily due to air emissions. As a result of increased atmospheric dispersion with distance, the air concentrations of radionuclides and associated dose and risk will decrease with increasing distance from the site. To provide a context for the possible significance of this dose, the dose and consequent (statistical) risk to an individual member of the critical group who lives near the site were considered. The lifetime risk of cancer to a member of the critical group would change from 0.25 (i.e., 25%) to 0.25001, a negligible change. The risks to people living further away would be smaller, since the dose decreases with increasing distance. Such incremental doses and risks are extremely small and of no consequence in terms of physical well-being.

5.13.1.2 Occupational Worker Health and Safety

OPG's current Occupational Health and Safety Management System (see Section 2.8.3) is designed to ensure employees work safely in a healthy and injury-free workplace. OPG maintains all appropriate programs, practices and procedures to protect workers from hazards. Procedures and programs will be in place to ensure safe working conditions and compliance with applicable health and safety regulations during all phases of the NND Project. Typical occupational health and safety programs in place at OPG nuclear facilities and which can reasonably be expected to be applied similarly at the NND Project are profiled in Section 2.8.

5.13.1.3 Atmospheric Environment

The assessment of consequences on Human Health as a result of changes in atmospheric conditions associated with the Project is derived from forecasts of future conditions in the Atmospheric Environment as described in Section 5.2. The selected VECs (i.e., workers and the general public) are addressed collectively. The assessment of the effects of air quality and noise on human health are given below, as well as a summary of a risk assessment of conventional (i.e., non-radiological) emissions from NND.

Air Quality

During site preparation activities, products of vehicle combustion (e.g., NO_2, SO_2, fine particulate matter, and acrolein) are predicted to occasionally exceed their respective AAQC. Therefore, the products of combustion are considered further in terms of human health risk below.

During the Operation and Maintenance phase, operation of the steam generators will result in emissions of steam generator chemicals (e.g., hydrazine and ammonia). The *Atmospheric Environment Assessment of Environmental Effects TSD* predicted that air concentrations of these chemicals would be below applicable AAQC; however, hydrazine is a probable human carcinogen and, therefore, is also considered further for human health risk below.

Human Health Risk Assessment

A Human Health Risk Assessment of several airborne emissions was undertaken. The risk assessment determined that there will be some short-term exceedances of health-based values at nearby receptors during site preparation activities, which are estimated to last about two years, after which there will be no incremental change in risk from baseline 2008 conditions.

Therefore, it is unlikely that there will be any increase in health effects above those currently observed in the Site Study Area for the NND Project due to exposure to constituents of potential concern associated with the construction and operation of the NND.

Noise

Current noise conditions in the vicinity of the DN site are typical of an urban setting, and are dominated by traffic on Highway 401 and local roads, as well as noise from the nearby St. Marys Cement plant and DNGS.

Noise associated with site preparation activities will only be audible at one receptor (Solina Rd. receptor), with a maximum predicted daytime sound level increase of 8.1 dB (above a baseline sound level of approximately 53 dBA), yielding a total daytime sound level of 61.4 dBA.

Construction-related activities will likely be audible at only the nearest receptors (Port Darlington Marina, Waverly Road Resident and South Service Road Resident), with 1-hour noise level increases of between 3 and 5 dB (above baseline sound levels of up to 67 dBA). Noise effects during construction activities will typically be intermittent and would only be experienced in the short term. The maximum estimated 1-hour sound level at any receptor is estimated to be 70 dBA (daytime). This occurs at a receptor along Baseline Road and is primarily due to traffic along Baseline Road and Highway 401.

Occupational exposure levels for noise are 85 to 90 dBA before hearing protection is required. The maximum predicted sound level of 70 dBA is well below any level that could cause hearing impairment. Therefore, no adverse effects from noise on Human Health are expected.

No increase in sound levels above baseline are predicted during operations and it can be expected that NND Project operations will be in compliance with applicable noise standards, and no adverse noise effects on sensitive receptors are anticipated.

5.13.1.4 Surface Water Quality

During the Operation and Maintenance Phase, there will be an increased thermal input to Lake Ontario as a result of the operation of the service water and cooling water systems; consequently, potential effects associated with the thermal plume, such as an increased potential for longevity and productivity of bacteria, would increase within a region 50 m east and 15 m west of the discharge diffuser. This is not expected to affect the Bowmanville Water Treatment Plant and Oshawa Water Treatment Plant due to the limited spatial extent of the plume.

Coliform bacteria are the bacteria of concern, particularly *E. coli (Escherichia coli)*, which are typically indicative of fecal contamination. However, during both cold water and warm water conditions, there is a very low probability that the water temperature increase due to the NND thermal plumes will affect *E. coli* growth in Lake Ontario due to the limited spatial extent of the plume. Similarly, aesthetic effects (i.e., taste and odour) are influenced by lake water temperature; bad odour or taste can make water undrinkable. Since the thermal plume has limited effect at the WSPs, it is unlikely that the NND operation will influence the quality or the aesthetics of the drinking water, and hence the health of members of the public.

The operation of cooling towers may result in the concentration of constituents in the water withdrawn from the lake and water quality control additives may be used. However, treatment will be provided as necessary to ensure regulatory requirements are achieved for the discharge and no measurable adverse effects occur. If the discharge were to reach nearby water treatment plants, monitoring for a wide range of chemical and biological components is conducted on water prior to its entering the drinking water system. Water available for public consumption is required to conform to the Ontario Drinking Water Quality Standards, set out by the MOE. These standards have been established to protect the health and safety of the public. Therefore, no adverse residual effect on human health (physical well-being) is expected.

In terms of recreational use of the lake water (i.e., swimming), the primary concern is bacteria. As discussed, water temperature increase due to the NND thermal plumes is not expected to reach recreational areas and, therefore, is not expected to affect *E. coli* growth in Lake Ontario in these areas. Therefore, no adverse effects on recreational users of Lake Ontario as a result of the NND are anticipated.

5.13.1.5 Groundwater Quality

The two potential pathways to human health from groundwater are changes in potable water quality and changes in the quality of water being discharged to Lake Ontario.

As discussed in the *Geological and Hydrogeological Environment Assessment of Environmental Effects TSD*, groundwater flow at the DN site is generally to the south to Lake Ontario. Groundwater contributes only a small fraction of the total discharge to Lake Ontario, and does not have a measurable effect on lake water quality.

Construction activities and the presence of NND facilities will result in changes in groundwater flow conditions on the DN site due to the construction of foundations and other features. As a result, groundwater flowing from the north will be intercepted prior to discharge directly to the lake. This will further reduce the flow of groundwater to Lake Ontario, lessening any effects on Lake Ontario water quality.

As determined in the *Geological and Hydrogeological Assessment of Environmental Effects TSD*, the NND Project is not expected to adversely affect the quality of groundwater in and around the site. Therefore, no consequential changes to related factors contributing to human health are expected as a result of groundwater flow to the lake.

Groundwater within the DN site is not used for potable purposes, given its industrial setting. Accordingly, groundwater quality was evaluated in terms of Ontario non-potable standards and found to meet them. As indicated above, the NND Project is not expected to adversely affect the quality of groundwater. Therefore, this pathway to human health is not assessed further.

5.13.1.6 Socio-Economic Conditions

The assessment of consequences on Human Health as a result of changes in socio-economic conditions associated with the Project is derived from forecasts of future conditions in the Socio-economic Environment as described in Section 5.11. It is also to be noted that based on the analysis of existing socio-economic conditions carried out during this EA, and as reported by residents during public attitude surveys, the Municipality of Clarington and the City of Oshawa (i.e., the LSA) afford excellent access to health care and recreational facilities and provide the appropriate level of municipal infrastructure and facilities to ensure that people living in these communities experience a high level of personal health.

Based on evidence from the past, it is reasonable to anticipate that the NND Project, through employment, steady incomes and taxes paid to the communities, will assist in maintaining the financial health of the communities and the subsequent continued provision of services to and maintenance of the health of the residents.

The selected VECs (i.e., workers and the general public) are addressed collectively in the following discussion.

Health and Safety Facilities and Services (Fire Protection, Policing, Health Care)

The NND Project is not anticipated to place additional demands on fire services beyond that which would occur due to the normal projected population growth. The proposed increase in the number of fire fighters in Clarington over the next several years, along with associated support staff, is considered sufficient to meet the indirect Project-related demands on fire services.

Some short-term increases in service requirements from the Durham Regional Police Service (DRPS) resulting from the workforce at the DN site are likely. This may include demand for traffic management and additional training with respect to emergency exercises and drills at the new facilities.

A measurable change on the overall demand relating to health care services in Oshawa or Clarington is not anticipated. As well, the nearest healthcare or safety-related facility to the DN site is located several kilometres from the property boundary. As such, neither the presence nor the operation of the Project is likely to disrupt activities conducted at health and safety facilities.

Therefore, no adverse effects on human health (physical well-being) related to health and safety facilities and services are anticipated as a result of the Project.

Municipal Infrastructure and Services

A conservative estimate of the total increased demand on the municipal water system from direct and indirect sources as a result of the Project is approximately 1.2 million imperial gallons per day (MIGD). This increment is a small fraction of the existing and proposed capacity of the entire water supply system in Durham Region, including most individual water supply plants serving Clarington and the Cities of Pickering and Oshawa, where the greatest demands are anticipated.

The NND Project will rely on the municipal sewage collection and treatment system for domestic sewage disposal. Increased demand for municipal sewage treatment capacity may also result from the increased population associated with the Project. This will be felt primarily in Durham Region. A conservative estimate of the total increased demand is approximately 1.2 MIGD. This increment in demand is smaller than the existing and proposed capacity of the sewage treatment system in Durham Region, including most individual water pollution control plants serving Clarington, and the Cities of Pickering and Oshawa where the greatest demands are anticipated.

Conventional waste currently generated at the DN site is managed through industrial/commercial contracts and does not enter into the municipal waste management system. Based on the reasonable expectation that conventional waste at the NND Project will be handled in a similar manner, no effect on municipal waste management capacity will occur as a result of onsite activities related to the Project. The Project will likely increase the proportion of the population associated with, or directly dependent on the Project-related employment. Therefore, an indirect increase in demand on the municipal waste management system is also likely. The increased demand will be felt primarily in Durham Region. The increase in waste volume is estimated to be only a fraction (less than 1%) of the total waste volumes handled by the Durham Region waste management system. In the context of the Region's overall waste management system, the Project and its associated population are not expected to place demands on the municipal system that would exceed its existing or planned capacities.

Housing

The Site Preparation and Construction phase workforce will peak at 3,800 workers for two reactors. If two additional reactors are constructed, the Project-related workforce would be approximately 5,200, which includes approximately 1,400 workers involved in the operation of the first two reactors. The labour force associated with the Operation and Maintenance phase for four reactors will involve an estimated 2,800 workers. It is anticipated that much of the workforce, particularly that associated with the Operation and Maintenance phase, would reside in either Clarington or Oshawa.

Taken together, both phases of the NND Project will create an increased demand for housing, particularly during those years when construction and operation phases overlap. However, housing stock in Oshawa and Clarington is expected to keep pace with the anticipated population growth. In this context, the Project is considered to be a positive contributor to the anticipated housing growth as well as the diversification of the housing stock to reflect the varied needs of the workers related to the NND Project.

5.13.2 Mental Well-Being

Psychosocial factors are the basic social, psychological and cultural aspects of human interactions and their effect on mental well-being. These factors primarily relate to the emotional well-being of residents as individuals and form a complex network that can affect the health of individuals and communities.

The selected VECs (i.e., workers and the general public) are addressed individually as noted in the following discussion.

5.13.2.1 Mental Well-Being of the Public

Feelings of Personal Health and Safety

Public attitude research for the Project indicated that community interaction appears to have a strong influence on people's feelings of personal health, whether it is opportunities for physical activity (recreation), the people in the community, or access to services that safeguard, promote and protect their physical health. Also, the quality of policing, and the level of crime are the dominant influence on people's sense of safety.

As noted in Section 5.13.1.6 and 5.13.3.1, the NND Project is unlikely to affect the provision of health care services, fire and policing services, or community and recreational facilities and services in either Clarington or Oshawa. Public attitude research indicates that the vast majority of respondents do not anticipate a change in their feelings of personal health or safety as a result of either phase of the NND Project.

Therefore, no effects on people's feelings of personal health or personal safety (mental well-being) are anticipated as a result of the NND Project.

Satisfaction with Community

Public attitude research indicates that almost all respondents are either "very" or "somewhat satisfied" with living in their community. Indeed, 63% of the LSA respondents are "very satisfied". Public attitude research also indicates that a large majority of residents across the RSA and LSA do not anticipate a change in their satisfaction with community as a result of the NND Project. However, results of the DN Site Neighbour Survey indicate that most of those who responded to the survey (11 out of 15), indicated that their satisfaction with community would decrease as a result of the Project. This result is linked to the potential for cooling towers on the DN site. Additionally, 54% of LSA respondents indicated that the visibility of the NND Project, particularly cooling towers, would change the character of their community.

Section 5.11.7 addresses potential effects on the use and enjoyment of private property. During the Operation and Maintenance phase when the cooling towers and their vapour plumes will be visible, some people may experience reduced use and enjoyment of property. This potential effect would likely be felt most by those living in the neighbourhood in the immediate vicinity of the DN site. However, this visual effect will not likely preclude the use and enjoyment of private property in LSA communities.

The likely change in community character was acknowledged as a residual adverse effect of the Project in the Socio-Economic Environment (see Section 5.11.6.3). An associated change on use and enjoyment of private property was also recognized as a residual effect in the Socio-Economic Environment (see Section 5.11.7.3). The consequence of the residual adverse effect on use and enjoyment of property is also a consideration in terms of mental well-being.

Traffic

Traffic volumes in the LSA will increase in the future both as a result of the NND Project and of unrelated growth and development in the community. Because of the added traffic, and in the absence of system improvements, elements of the system infrastructure are predicted to operate at unsatisfactory levels of service (e.g., some intersections in the LSA). However, consistent with standard transportation engineering practice, it is reasonable to expect that the authorities having jurisdiction over the system (i.e., Ontario Ministry of Transportation, Region of Durham and Municipality of Clarington) will progressively address operational deficiencies as they arise. In this regard, a number of infrastructure improvements have been identified as commitments by the appropriate agencies and are assumed for EA purposes to occur. Other improvements are suggested as a result of traffic modeling conducted for the EA and are also reasonably expected to be implemented as necessary. Accordingly, it is expected that there will be no residual adverse effects on transportation system operations or safety as a result of the NND Project during the Operation and Maintenance phase. Therefore, it is also reasonable to expect that future conditions with respect to traffic will not negatively affect the mental well-being of members of the public.

The likely change in use and enjoyment of property because of nuisance-related effects along truck haul routes was acknowledged as a residual adverse effect of the Project in the Socio-Economic Environment (see Section 5.11.7.3). The consequence of this residual adverse effect on use and enjoyment of property is also a consideration in terms of mental well-being.

5.13.2.2 Mental Well-Being of Workers

OPG has extensive health and safety programs, policies and procedures in place at their nuclear facilities and these, or similar, are expected to be applied at NND. These programs will help to ensure workers' sense of well-being and security. These may include programs encouraging healthy living (such as information for employees working shifts that may involve rotating night and day work), access to onsite health and safety representatives, and ergonomics assessment.

5.13.3 Social Well-Being

The social well-being aspects of health are those that may affect the social behaviour of workers or members of the public in the context of their community.

The selected VECs (i.e., workers and the general public) are addressed individually as noted in the following discussion.

5.13.3.1 Social Well-Being of the Public

Employment and Income

The labour force associated with the NND Site Preparation and Construction phases is anticipated to peak at 3,500 management, tradespeople and labourers (for two units which will be the most under construction at a given time) plus a project team of approximately 300 employees. The Project is predicted to create approximately 1,200 new jobs within Clarington and approximately 1,000 new jobs within Oshawa. During the Site Preparation and Construction phase, the Project will be associated with an additional 4% of Clarington's total employment and approximately 1% of Oshawa's.

During the Operation and Maintenance phase, the NND Project will likely generate approximately 7,400 direct, other direct and indirect jobs across the RSA. When all four reactors are operating, the Project is anticipated to have an operation workforce of approximately 2,800 management, nuclear operators, skilled tradespeople and administrative OPG employees. Within the LSA, the Project is predicted to create approximately 2,400 jobs within Clarington (i.e. 4% of Clarington's total employment), and approximately 1,200 jobs within Oshawa (i.e. 1% of Oshawa's total employment).

The NND Project will increase employment in the LSA. This, in turn, will support the maintenance of steady levels of income for many residents and the social structure and stability of the local communities.

Community and Recreational Facilities and Programs

The NND Project may require the displacement of the soccer fields and the fitness loop (part of the Waterfront Trail) currently located on the DN site. The lands on which these facilities are located may be required for Project purposes, and thus will be a direct loss to those who use these facilities. However, the results of the DN Recreational Use Survey indicated that, with the exception of the soccer fields, there are many other recreational options available within the LSA and in close proximity to the DN site. As such, local residents will not need to travel far to access alternate facilities or locations to undertake their recreational activities.

Although OPG is committed to maintaining public access to the portion of the Waterfront Trail that traverses the DN site, the Trail may need to be modified or reconfigured on several occasions during the Site Preparation and Construction phase to facilitate on-site physical works and activities.

The likely change in use and enjoyment of community and recreational features on the DN site was acknowledged as a residual adverse effect of the Project in the Socio-Economic Environment (see Section 5.11.7.3). The consequence of this residual adverse effect on use and enjoyment of community and recreational features is also a consideration in terms of social well-being.

<u>Community Cohesion</u>

Residents in the LSA feel a strong sense of belonging in their communities regardless of their distance from the DN site. Results of public attitude research indicate that the vast majority of LSA residents (81 %) do not anticipate any change to the cohesiveness of their community as a result of the NND Project. Factors such as population, employment and income, and community and recreational facilities and programs have the potential to affect community cohesion. With the exception of reduced use of the recreational features on the DN site during site preparation and construction activities, no adverse effects on these factors are anticipated as a result of the NND Project.

In the long term, the Project is likely to be a positive influence on community cohesion. As of 2007, OPG was the second largest private employer in the RSA, and with the addition of up to 2,800 nuclear energy workers, OPG will likely become an increasingly dominant employer in the LSA. With the continuation and expansion of corporate community programs and partnerships, OPG will continue to foster socially meaningful interactions within the community, and thus strengthen its positive influence on community cohesion.

5.13.3.2 Social Well-Being of Workers

OPG is a major employer of workers residing in the RSA and LSA, with the DN site currently employing approximately 2,800 people. The projected number of additional direct jobs associated with the NND Project is 3,800 during the Site Preparation and Construction phase and up to 2,800 (for four units) during the Operation and Maintenance phase (as described in Section 5.11.5, this direct employment will also result in substantial indirect and induced job opportunities throughout the RSA). Therefore, OPG and the DN site in particular, contribute to overall community and personal well-being. It is anticipated that many of the projected workforce, particularly those associated with the Operation and Maintenance Phase, would reside in either Clarington or Oshawa. It is likely that these workers would experience the same sense of social well-being and satisfaction with their communities as those workers and other residents currently living in these communities.

5.13.4 Assessment of Likely Effects on VECs

The VECs for Human Health are members of the public and workers on the DN site. The foregoing discussion has addressed how the factors that influence Human Health in a context of physical, mental and social well-being may be changed as a result of the Project. Following is a description of the likely environmental effects on the VECs of any such changes in these factors.

5.13.4.1 Likely Effects (of NND) on Members of the Public

<u>Likely Environmental Effect</u>

In terms of physical well-being, the estimated radiation dose from the Project to the most exposed critical group is approximately 4 µSv/y (0.004 mSv/y). The dose is well below (i.e., approximately 0.5% of) the regulatory limit for members of the public of 1 mSv/y. Furthermore, this maximum dose is a small fraction of the annual dose from natural background radiation in Canada (about 1,840 µSv/y) and is not considered to represent an adverse environmental effect.

Some releases of non-radiological substances will occur due to the NND Project via the atmospheric and surface water pathways, such as acrolein, SPM and hydrazine. There will also be an increase in the thermal plume due to the operations of NND. An assessment of these releases was completed and it was determined that there would be no adverse health effects on Members of the Public from conventional releases or thermal plume.

Accordingly, no further evaluation of the effects of the Project in terms of the physical well-being of Members of the Public is warranted.

However, as this is a proposed nuclear facility and there is public interest in doses to the public, the doses to Members of the Public from the NND Project are considered further in terms of cumulative effects.

If the NND Project were to be implemented with cooling towers, it would result in reduced enjoyment of private property in the RSA and LSA due to the visual dominance of the natural draft cooling towers and the vapour plumes associated with either natural draft or mechanical draft cooling towers, on the landscape.

The likely change on community character was acknowledged as a residual adverse effect of the Project in the Socio-Economic Environment (see Section 5.11.6.3). The consequence of this same residual adverse effect on use and enjoyment of private property is also a consideration in terms of mental well-being and is further evaluated relative to human health.

Because of nuisance-related effects (e.g., dust, noise, traffic) some residents living along truck haul routes may experience disruption to their use and enjoyment of their property during the Site Preparation and Construction phase.

The likely change on use and enjoyment of property because of nuisance-related effects along truck haul routes was acknowledged as a residual adverse effect of the Project in the Socio-Economic Environment (see Section 5.11.7.3). The consequence of this same residual adverse effect on use and enjoyment of property is also a consideration in terms of mental well-being and is further evaluated relative to human health.

Because of safety concerns during physical works in the vicinity of the publicly-accessible spaces, and possible periodic and short-term disruption because of the construction activities, there is likely to be some reduced use and enjoyment of the community and recreational features on the DN site during the Site Preparation and Construction phase.

The likely change on use and enjoyment of community and recreational features on the DN site was acknowledged as a residual adverse effect of the Project in the Socio-Economic Environment (see Section 5.11.7.3). The consequence of this same residual adverse effect on use and enjoyment of community and recreational features is also a consideration in terms of social well-being and is further evaluated relative to human health.

Mitigation Measures

The above-noted are residual effects in the Socio-Economic Environment as described in the referenced sections. As residual effects, they are those effects that remain after mitigation measures have been applied. The mitigation measures considered in evaluating these effects are fully described in Section 5.11.7.2 and they are not repeated here.

Residual Environmental Effects

The following residual adverse effects were identified in the Socio-Economic Environment. Because these residual adverse effects relate to the use and enjoyment of property which is a consideration in terms of mental well-being, and the use and enjoyment of community and recreational facilities, which is a consideration in terms of social well-being, the same effects are also considered as residual adverse effects on Human Health and are advanced for consideration of significance.

- Reduced enjoyment of private property in the RSA and LSA as a result of the visual dominance of the natural draft cooling tower structures and the associated vapour plumes released from either the natural draft or mechanical draft cooling towers;

- Disruption to use and enjoyment of property because of nuisance-related effects (e.g., dust, noise, traffic) during the Site Preparation and Construction phase for some residents living along the truck haul routes; and

- Reduced use and enjoyment of community and recreational features on the DN site during the Site Preparation and Construction phase;

Although there are no Project-related radiological effects on Members of the Public, because NND involves a proposed nuclear facility and there is public interest in doses to the public, doses to Members of the Public as a result of the NND Project in combination with other projects is considered further in terms of cumulative effects in Chapter 8.

5.13.4.2 Likely Effects (of NND) on Workers on the DN Site

Likely Environmental Effect

In terms of physical well-being, NND will contribute to radiation doses to workers. The predicted radiation doses are well below the regulatory limit for workers and therefore, radiation doses to workers are not considered to represent an adverse effect of the Project. However, as this is a proposed nuclear facility and there is public interest in doses, the doses to Workers at the DN site as a result of the NND Project are considered further in terms of cumulative effects.

OPG maintains all appropriate programs, practices and procedures to protect workers from hazards. Many occupational health and safety programs are in place at OPG nuclear facilities, and similar programs can reasonably be expected to be applied at the NND Project and no adverse effects on Workers at the DN site are expected from non-radiological hazards as a result of the Project.

Accordingly, no further evaluation of the effects of the Project in terms of the physical well-being of Workers at the DN site is warranted.

In terms of mental and social well-being, the changes in existing conditions as a result of the Project are not considered to represent an adverse effect on Workers at the DN site.

Accordingly, no further evaluation of the effects of the Project in terms of the mental and social well-being of Workers at the DN site is warranted.

Mitigation Measures

An ALARA analysis will be undertaken and specific measures to reduce collective worker dose to the extent practicable will be determined during detailed planning and design of the Project. As per current practice at the DN site, all internal and external doses received by NND workers who are NEWs will be monitored and reported as part of the operational dose management program. This system will be in effect during the Operation and Maintenance, and the Decommissioning phases of the Project.

Residual Adverse Effects

Considering implementation of the identified mitigation measures, no residual adverse effects on the health and well-being of Workers at the DN site as a result of the NND Project are predicted.

Nevertheless, because this is a proposed nuclear facility and there is public interest in doses, the individual dose to Workers at the DN site as a result of the Project is considered further in terms of cumulative effects in Chapter 8.

5.14 Health - Non-Human Biota

This Section provides an overview description of the potential ecological effects of the Project on non-human biota. The detailed description of existing factors as they may affect non-human biota is presented in the *Ecological Risk Assessment and Assessment of Effects on Non-human Biota Technical Support Document*.

The results of the ecological risk assessment are summarized in the following sections with respect to radiological and non-radiological effects on aquatic and terrestrial (i.e., non-human) biota.

5.14.1 Evaluation for Likely Measurable Changes to the Environment

The Project may have an effect on surface water, sediment, soil, groundwater and air quality as a result of radioactive or non-radioactive (chemical) releases and these media are considered potential pathways for effects on non-human biota in the Aquatic and Terrestrial Environments. Effects related to the potential loss of habitat or physical disruption of wildlife and aquatic species are addressed in Sections 5.4 and 5.5, respectively.

The extent and magnitude of potential effects on non-human biota is a function of the characteristics of the sources and the pathways to these receptors. Each Project work and activity is a possible source of an effect; and each Project/Environment interaction is a potential pathway for an effect. These potential interactions are shown in Table 5.1-1. The likely consequences of these interactions are not all measureable, however, and those that are likely to result in measureable effects (and which, therefore, were subjects of further analysis) are shown in Table 5.14-1.

5.14.2 Assessment Methods

Section 4.14.1 has presented an overview of the ERA methodology as applied for the ecological assessment of both the existing condition and the future condition as it would be likely as a result of the Project. The difference between existing and future conditions represents the likely effects of the Project. In terms of environmental effects, each of the likely measurable changes identified in Table 5.14-1 was assessed in greater detail to determine if changes to the environment may change the findings of the ERA conducted for the existing conditions.

5.14.3 Assessment Criteria

The criteria applied in the screening process to identify COPCs included:

- Standards provided by the MOE in the *Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act* (MOE 2004);
- The Provincial Water Quality Objectives (PWQO) (MOE 1994);
- Provincial sediment quality guidelines (MOE 2008e);
- Guidelines contained in the Canadian Council of Ministers of the Environment (CCME) *Canadian Environmental Quality Guidelines* (CCME 2007);
- Sediment quality benchmarks developed by Canadian Nuclear Safety Commission (CNSC) for uranium mining and milling in Canada (Thompson *et al*. 2005);
- MOE and Environment Canada *Ambient Air Quality Criteria* (MOE 2008b,c; FPCAP 1976); and
- Toxicity Reference Values (TRVs).

TABLE 5.14-1
Project Works and Activities With Likely Measurable Changes to Non-Human Biota

Project Works & Activities	Terrestrial		Aquatic		Screening Rational
	Non-Radiological	Radio-logical	Non-Radiological	Radio-logical	
SITE PREPARATION AND CONSTRUCTION PHASE					
Management of Stormwater	•		•		During both the construction and operation phases of the Project, the stormwater management system may contain chemical constituents. However, non-radiological discharges from the site will comply with all water quality criteria.
OPERATION AND MAINTENANCE PHASE					
Operation of Active Ventilation and Radioactive Liquid Waste Management Systems	•	•	•	•	Operation of Active Ventilation and Radioactive Liquid Waste Management Systems is expected to result in radiological releases to air, and radiological and non-radiological releases to water. As indicated in Section 5.3, non-radiological water discharges from the station will comply with applicable water quality criteria.
Operation of Secondary Heat Transport System and Turbine Generators	•				Operation of secondary heat transport system and turbine generators is expected to result in discharge of steam generator treatment chemicals to air. Discharges to the aquatic environment, are captured in the operation of Radioactive Liquid Waste Management System or Condenser Circulating Water, Service Water and Cooling Systems.
Operation of Condenser and Condenser Circulating Water, Service Water and Cooling Systems	•		•		As indicated in section 5.3, non-radiological water discharges from the station will comply with applicable water quality criteria. The assessment considers the releases provided by the vendors and potential blowdown to cooling tower pond.
Operation of Electrical Power Systems	•				Testing of Emergency and stand-by diesel power supply will result in combustion exhausts to air as described in Section 5.2.
Management of Operational Low and Intermediate-Level Waste		•			Management of operational low and intermediate-level waste is expected to result in minor airborne tritium emissions from the L&ILW building. Also the storage of L&ILW is expected to increase the gamma radiation and potentially increase radioactive exposure to biota.
Transportation of Operational Low and Intermediate-Level Waste to a Licensed Off-site Facility		•			Transportation of operational low and intermediate-level waste to a Licensed off-site facility is expected to increase the gamma radiation and potentially increase radioactive exposure to biota.
Dry Storage of Used Fuel		•			Dry storage of used fuel is expected to increase gamma radiation.

5.14.4 Assessment of Likely Effects on Non-Human Biota – Non-Radiological

Management of Stormwater

During the site preparation activities, a considerable quantity of soil will be excavated from the southeast portion of the DN site (i.e., generally the NND development area) and placed in the Northeast and Northwest Landfill Areas. Analyses of soil samples collected from boreholes within the area to be excavated, and at two locations north of the CN rail line (reported in the Geology and Hydrogeology Existing Environment TSD) indicate that the soil quality of all analysed samples is generally similar, and all measured concentrations with the exception of beryllium were below their respective quality criteria for industrial sites. Measured beryllium concentrations were only marginally above the applicable criterion and were consistent in all the samples and, therefore, are considered representative of natural overburden conditions on the DN site. Consequently, relocation of soil within the DN site will not alter the surface water or ground water chemistry such that stormwater quality would be measurably affected.

During the Site Preparation and Construction, and the Operation and Maintenance phases of the Project, no activities will result in a release of non-radiological constituents that may affect soil or groundwater quality such that stormwater would be measurably affected. Also and as noted in Section 5.3.7.2, Good Industry Management Practices will be applied throughout all phases of the Project with respect to stormwater management with a focus on maintaining appropriate quality standards for discharge of surface water to the environment.

Chemical Releases to Air and Water

The Project works and activities that may result in chemical releases to the environment:

- Operation of Active Ventilation and Radioactive Liquid Waste Management System – potential discharges of liquid effluents (steam generator treatment chemicals, water treatment chemicals, etc.) to receiving waters;
- Operation of Secondary Heat Transport System and Turbine Generators – potential discharge of steam generator treatment chemicals to air;
- Operation of Condenser and Condenser Circulating Water, Service Water and Cooling Systems – water treatment chemicals and chemical constituents associated with cooling tower operation discharged to receiving waters (once-through cooling water is non-contact with such chemicals and is not expected to affect water quality); and
- Operation of Electrical Power Systems – testing of emergency and stand-by power supply will result in the release of combustion products to air.

These are further discussed below in a context of their possible releases to the atmosphere and to surface water.

Releases to Atmosphere

The operation of the steam generators will result in a release of steam generator treatment chemicals to the atmosphere. Operation of DNGS also results in the release of these chemicals, therefore, when combined with the operation of NND, the concentration of these chemicals in the air environment will increase. Testing of emergency and stand-by power equipment will result in the release of combustion gases to air and, therefore, will increase the total release of these emissions from the DN site. DN site operations are only a small contribution to the local air quality given that there are numerous other local sources of these emissions in the LSA (e.g. Hwy. 401, St. Mary's Cement).

The assessment of effects in the Atmospheric Environment (see Section 5.2) included a prediction of concentrations of steam generator chemicals and combustion products in air for both the contribution from NND and for the combined NND and DNGS. In all cases, the predicted annual average concentrations in air across the site are less than applicable ambient air quality criteria and will not result in adverse effects on non-human biota.

Releases to Surface Water

The assessment of effects in the Surface Water Environment (see Section 5.3) included water quality analysis for samples collected at the DNGS diffuser in Lake Ontario. The only COPC identified in the existing environment in Lake Ontario was hydrazine. It is to be noted that measured concentrations of steam generator treatment chemicals (hydrazine) in the samples were less than the detection limit and concentrations of ammonia and hydrazine were similar to measurements elsewhere in the RSA. Nonetheless, it is to be expected that the NND will have much lower concentrations of these chemicals than DNGS since steam generator blowdown will be recycled through the steam/feedwater system for re-use.

Blowdown from cooling towers may include some residual water treatment chemicals. Because of the concentrating effect of the cooling tower operation, the metals concentration in the discharge will be approximately four times greater than that of the intake water. Prior to its release to the lake, discharge from the cooling towers will be directed to an associated cooling tower discharge management pond where it will be tested and treated as required. It is possible that biota (e.g. individual waterfowl) may come into contact with contaminated water in the pond; however, no population-level effects on non-human biota are expected due to the limited number of individuals that may be exposed in this manner.

As noted in Section 5.3, all Project-related discharges to the surface water environment will be appropriately treated to meet applicable water quality criteria. The cooling water discharge diffuser will add further dilution. The predicted concentrations of constituents associated with the cooling water discharges at the edge of the turbulent mixing zone are within the PWQO or Interim PWQO (where available) and within the variability of background lake concentrations. While aquatic biota may enter the turbulent mixing zone, it is unlikely they will reside in this zone for any length of time so the minor increases in water concentration are unlikely to affect aquatic biota.

Discharges associated with the once-through lakewater cooling option will be similar to the existing conditions at DNGS. The water quality analyses for samples collected at the DNGS diffuser were generally similar to the Lake Ontario background. It is expected that water concentrations for the NND with once-through cooling water will be similar to DNGS, and thus will not result in adverse effects on affect aquatic biota.

Since the water quality in Lake Ontario is not predicted to measurably change, the sediment quality in Lake Ontario is also expected to remain unaffected by the Project.

5.14.4.1 Likely Effects on Ecological Receptors

The ecological receptors in the Terrestrial Environment adopted for this assessment of effects on non-human biota are birds, mammals, soil invertebrates, amphibians, reptiles and terrestrial vegetation. The ecological receptors in the Aquatic Environment adopted for this assessment are aquatic plants, benthic invertebrates and fish. Likely effects on these ecological receptors as a result of the Project are summarised as follows.

> *The Project is not expected to result in changes to the non-radiological environment that would represent an adverse environmental effect on the ecological receptors identified for the non-human biota component of the environment, considering the mitigation measures identified for the Surface Water, Atmospheric, and Geology and Hydrogeology components of the environment.*

5.14.5 Assessment of Likely Effects on Non-Human Biota – Radiological

5.14.5.1 Releases of Radionuclides to Air and Water

Operation of the Active Ventilation and Radioactive Liquid Waste Management System will result in release of radioactivity to both air and water. Based on the predicted emissions of radionuclides (as described in Section 5.7), concentrations of radionuclides in air, water and soil were determined. These concentrations are based on a bounding release scenario for the NND assuming 60 years of operation. There will also be small releases of radioactivity to air from the management of operational L&ILW; however, these releases will not result in a measurable change in air quality compared to the releases from the active ventilation and radioactive liquid waste management system.

Exposure to non-human biota as a result of the Project was determined (using the same environmental transfer models as described in the *Radiation and Radioactivity Assessment of Environmental Effects TSD*) to be in the same general range as is currently the case for baseline (i.e., existing) conditions. As noted in Section 4.14, the baseline concentrations of radionuclides in the environment result in only very small dose rates to non-human biota, and are well below the reference dose rates. Similarly, the incremental dose rates associated with the Project were determined to be only a small fraction of the reference dose rates, therefore the potential effects to populations of non-human biota arising from NND are considered to be unlikely and of no consequence.

5.14.5.2 Gamma Exposure

The gamma radiation (from all sources associated with the NND) and atmospheric emissions (i.e. emissions to terrestrial vegetation, biota and soil) arising from future activities at the site is not expected to be meaningfully different from the existing conditions. Accordingly, no incremental environmental effects as a result gamma exposure on non-human biota are predicted.

5.14.5.3 Likely Effects on Ecological Receptors

The ecological receptors in the Terrestrial Environment adopted for this assessment of effects on non-human biota are birds, mammals, soil invertebrates, amphibians, reptiles and terrestrial vegetation. The ecological receptors in the Aquatic Environment are aquatic plants, benthic invertebrates and fish. Likely effects on these ecological receptors as a result of the Project are described as follows.

The Project is not expected to result in changes in the radiological environment that would represent an adverse environmental affect on the ecological receptors identified for the non-human biota component of the environment, considering the mitigation measures identified for the Surface Water, Atmospheric, and Geology and Hydrogeology components of the environment.

5.15 Summary of Likely Adverse Effects, Mitigation Measures and Residual Effects

Sections 5.2 through 5.14 have described: i) the likely adverse effects of the NND Project on the VECs (for some environmental components) and/or pathways to VECs (for other environmental components); ii) mitigation measures that are inherent in the Project design (i.e., in-design mitigation measures) to pre-empt environmental consequences; iii) additional mitigation measures identified through this EA program to further reduce or eliminate adverse effects; and iv) residual adverse effects remaining after all mitigation measures have been considered. The reader is directed to Sections 5.2 through 5.14 for a complete description of the process that has led to these conclusions.

A principle of note with respect to mitigation measures is that for the purpose of this EA, and consistent with OPG operating policy, compliance with all applicable environmental regulations and other statutory requirements will be a matter of course and the Project will be designed, constructed and operated accordingly. For this reason, regulatory obligations (e.g., secondary containment for fuel storage tanks) and the commitment to meet them are not identified as specific mitigation measures. They are, however, assumed as features of the Project and their benefits in terms of environmental effects management are considered in the evaluation.

Table 5.15-1 presents a summary of likely adverse environmental effects, mitigation measures and residual adverse effects in a framework of the individual environmental components. Although the Project will also result in beneficial effects, these are not included in the table. The table also identifies the VECs that relate to each likely adverse effect and the phase of the Project during which the effect will occur.

Each residual adverse effect is subsequently considered for possible cumulative effects in Chapter 8 and evaluated for its significance in Chapter 9.

TABLE 5.15-1
Summary of Likely Environmental Effects, Mitigation Measures and Residual Adverse Effects[1]

Likely Adverse Environmental Effect[2]	Site Preparation & Construction	Operation & Maintenance	Valued Ecosystem Component Affected	Mitigation Measures: In-Design Mitigation Measures (Incorporated into Project design to pre-empt environmental effect)	Mitigation Measures: Additional Mitigation Measures (Identified through EA program)	Residual Adverse Effects[2]
Atmospheric Environment (from Section 5.2)						
Some measurable increases to background concentrations of the contaminants are predicted at on-site and off-site receptor locations. The background concentrations remain within regulatory parameters (not including hydrazine which does not have a 24-hour AAQC). *These increases are not considered to represent an adverse effect in the Atmospheric Environment, however, they are considered further in terms of pathways to Human Health, Non-Human Biota Health and VECs in the Terrestrial Environment and the Socio-Economic Environment.* *Changes in the Atmospheric Environment associated with operation of cooling towers (e.g. fog, water deposition, icing) are considered in terms of pathways to VECs in the Terrestrial Environment and in Land Use.*	✓	✓	Pathway to: • Human Health • Non-Human Biota Health • Terrestrial Environment • Socio-economic Environment • Land Use	A Dust Management Program will be implemented during the Site Preparation and Construction phase of the Project to control dust emissions at their source. Examples of typical dust management strategies include application of dust suppressants; stabilization of completed soil surfaces; and suspension of dust-generation activities during periods of inclement weather.	None identified	No residual adverse effects in the Atmospheric Environment. *Residual effects in other environmental components as they may result from air quality as a pathway are described in the appropriate sections of this table.*
Some measurable increases to existing noise levels are predicted at receptor locations. *These increases are not considered to represent an adverse effect in the Atmospheric Environment, however, they are considered further in terms of pathways to Human Health, Non-Human Biota Health and VECs in the Terrestrial Environment and the Socio-Economic Environment.*	✓	✓	Pathway to: • Human Health • Non-Human Biota Health • Terrestrial Environment • Socio-economic Environment	A Noise Management Plan will be implemented during the Site Preparation and Construction phase of the Project. The Plan will be based on practices typical of major construction projects and operating plants and will include, for example, measures to control sound generation at source, to alert area residents of specific noise generating activities (e.g., blasting), requirements to maintain construction and operating equipment in proper mechanical condition, and the need to comply with applicable noise standards and regulations.	None identified	No residual adverse effects in the Atmospheric Environment. *Residual effects in other environmental components as they may result from Noise as a pathway are described in the appropriate sections of this table.*

Note:
[1] Extracted from Sections 5.2 to 5.14.
[2] Likely Adverse Effects and Residual Adverse Effects transferred to Table 8.3-1(a) for Cumulative Effects Assessment, and Residual Adverse Effects are transferred to Table 9.3-1 for Determination of Significance.

TABLE 5.15-1 (Cont'd)
Summary of Likely Environmental Effects, Mitigation Measures and Residual Adverse Effects[1]

Likely Adverse Environmental Effect[2]	Site Preparation & Construction	Operation & Maintenance	Valued Ecosystem Component Affected	Mitigation Measures		Residual Adverse Effects[2]
				In-Design Mitigation Measures (Incorporated into Project design to pre-empt environmental effect)	**Additional Mitigation Measures** (Identified through EA program)	
Surface Water Environment (from Section 5.3)						
Changes to Lake Ontario current circulation patterns in the LSA are likely as a result of alterations to the shoreline associated with lake infilling and a deflection of alongshore currents associated with operation of a once-through lake water cooling system. *These changes are not considered to represent an adverse effect in the Surface Water Environment, however, potential effects related to withdrawal of cooling water and entrainment and impingement of aquatic biota are considered further in terms of pathways to VECs in the Aquatic Environment*		✓	• Pathway to Aquatic Environment	None identified	None identified	No residual adverse effects in the Surface Water Environment. *Residual effects in other environmental components as they may result from Lake Circulation as a pathway are described in the appropriate sections of this table.*
Warmer water temperatures than currently exist in Lake Ontario at the mouth of Darlington Creek are likely to result from the creation of the embayment between the infill area and the St. Marys Cement property. Thermal discharges associated with the operation of the service water and cooling water systems will combine with the DNGS discharge resulting in a measurable change (i.e., increase) in the turbulent mixing zone of the current DNGS discharge diffuser. *The above changes are not considered to represent adverse effects in the Surface Water Environment, however, they are considered further in terms of pathways to VECs in the Aquatic Environment.*		✓ ✓	• Pathway to Aquatic Environment	The once-through cooling design will incorporate lake water intake and discharge structures (with mitigation measures) similar to DNGS, but sized to the necessary water volumes. The intake structure will be designed to limit the velocity of the water in the vicinity of the intake, minimising the impingement of fish and effects of local currents. The discharge diffuser design of the DNGS limits the temperature increase to minimise effects on the aquatic environment. The cooling tower option intake will be located at a minimum water depth of 10 m to decrease effects to aquatic habitat. Similarly, the cooling tower option will likely have a single port diffuser at a minimum water depth of 10 m.	None identified	No residual adverse effects in the Surface Water Environment. *Residual effects in other environmental components as they may result from Lake Water Temperature as a pathway are described in the appropriate sections of this table.*

Note:
[1] Extracted from Sections 5.2 to 5.14.
[2] Likely Adverse Effects and Residual Adverse Effects transferred to Table 8.3-1(a) for Cumulative Effects Assessment, and Residual Adverse Effects are transferred to Table 9.3-1 for Determination of Significance.

TABLE 5.15-1 (Cont'd)
Summary of Likely Environmental Effects, Mitigation Measures and Residual Adverse Effects[1]

Likely Adverse Environmental Effect[2]	Site Preparation & Construction	Operation & Maintenance	Valued Ecosystem Component Affected	Mitigation Measures: In-Design Mitigation Measures (Incorporated into Project design to pre-empt environmental effect)	Mitigation Measures: Additional Mitigation Measures (Identified through EA program)	Residual Adverse Effects[2]
Surface Water Environment (from Section 5.3) (Cont'd)						
The operation of the cooling tower option will result in the concentration of constituents in the water withdrawn from the lake and chemicals will be added to the tower process water to ensure performance objectives are met; and these flows which will be returned to Lake Ontario. Stormwater, active liquid effluent systems and inactive liquid effluent systems draining into Lake Ontario may contain contaminants. However, considering the in-design mitigation measures, changes in Lake Water Quality associated with these processes are not likely to be meaningful (i.e., concentrations will meet regulatory requirements). The embayment created at the mouth of Darlington Creek between the NND infilling area and St. Marys Cement wharf may experience increased algae growth and entrapment due to less mixing of the nutrients from Darlington Creek, warmer temperatures and the protected nature of the embayment. Construction of the infill area coffer dam, as well as the cooling water intake and discharge for either cooling option is likely to result in turbidity in the lake water. Any turbidity created will be temporary in nature, and the extent of the turbidity plume will be limited because of the high energy environment of the nearshore. *The above changes are not considered to represent adverse effects in the Surface Water Environment, however, they are considered further in terms of pathways to VECs in the Aquatic Environment, and on Human Health and Non-Human Biota.*	✓ ✓	✓ ✓	Pathway to: • Aquatic Environment • Human Health • Non-Human Biota Health	Good Industry Management Practices will be implemented during all phases of the NND Project with respect to stormwater management. Examples of such practices include, among other actions: sediment control, appropriate treatment of dewatering discharges, stormwater conveyance systems and conventional stormwater treatment methods such as stormwater management ponds and oil-grit separators. All water having come into contact with blasting agents (e.g., ammonium nitrate/fuel oil - ANFO) will be appropriately collected, managed and disposed of. Dust and sediment control measures will be employed to minimize suspended sediment concentrations. All cooling tower bleed-off will be directed to appropriate treatment and will not discharge to the groundwater system. Discharge is likely to ultimately be to Lake Ontario via management measures designed to accommodate sufficient volume for the system. All water impacted by radioactive or conventional contaminants, discharged from any liquid effluent stream (e.g., Inactive drainage System, Demineralized Water Treatment Sumps) to the environment (via the yard drainage system or directly to Lake Ontario or Darlington Creek) will be treated as necessary to meet regulatory requirements. Intermittent releases of Steam Generator blowdown will tested and treated, if necessary, to comply with the appropriate criteria for surface water discharge to Lake Ontario. All domestic sewage will be directed to the municipal wastewater treatment plant.	None identified	No residual adverse effects in the Surface Water Environment. *Residual effects in other environmental components as they may result from Lake Water Quality as a pathway are described in the appropriate sections of this table.*

Note:
[1] Extracted from Sections 5.2 to 5.14.
[2] Likely Adverse Effects and Residual Adverse Effects transferred to Table 8.3-1(a) for Cumulative Effects Assessment, and Residual Adverse Effects are transferred to Table 9.3-1 for Determination of Significance.

TABLE 5.15-1 (Cont'd)
Summary of Likely Environmental Effects, Mitigation Measures and Residual Adverse Effects[1]

Likely Adverse Environmental Effect[2]	Site Preparation & Construction	Operation & Maintenance	Valued Ecosystem Component Affected	Mitigation Measures: In-Design Mitigation Measures (Incorporated into Project design to pre-empt environmental effect)	Mitigation Measures: Additional Mitigation Measures (Identified through EA program)	Residual Adverse Effects[2]
Surface Water Environment (from Section 5.3) (Cont'd)						
				All effluents associated with the Service Water System and the pumphouse trash racks of the once-through cooling water system will be tested and treated, if necessary, to comply with appropriate criteria for surface water discharge to Lake Ontario. Implementation of Good Industry Management Practices during any activities associated with lake dredging, lake infilling and lake blasting (for intake and discharge structure construction) to manage suspended sediment to meet appropriate regulatory requirements for discharge to Lake Ontario. Openings for ports of the cooling water discharge diffuser will be excavated into the lake floor using a method that will minimize deleterious effects to the environment. During refurbishment or maintenance activities, all liquid effluents from the RLWMS and inactive drainage systems will be treated, and adequate flow will be maintained through the discharge system, to ensure that regulatory requirements are met for release to the environment.		
Placement of the lake infill and construction of the cooling water intake and discharge structures will result in disturbance and loss of lake substrates. *These changes are not considered to represent adverse effects in the Surface Water Environment, however, they are considered further in terms of pathways to the Aquatic Environment*	✓		• Pathway to Aquatic Environment	None identified	None identified	No residual adverse effects in the Surface Water Environment. *Residual effects in other environmental components as they may result from Shoreline Processes as a pathway will be described in the appropriate sections of this table.*

Note:
[1] Extracted from Sections 5.2 to 5.14.
[2] Likely Adverse Effects and Residual Adverse Effects transferred to Table 8.3-1(a) for Cumulative Effects Assessment, and Residual Adverse Effects are transferred to Table 9.3-1 for Determination of Significance.

TABLE 5.15-1 (Cont'd)
Summary of Likely Environmental Effects, Mitigation Measures and Residual Adverse Effects[1]

Likely Adverse Environmental Effect[2]	Site Preparation & Construction	Operation & Maintenance	Valued Ecosystem Component Affected	Mitigation Measures		Residual Adverse Effects[2]
				In-Design Mitigation Measures (Incorporated into Project design to pre-empt environmental effect)	**Additional Mitigation Measures** (Identified through EA program)	
Aquatic Environment (Section 5.4)						
The on-site ponds (Treefrog Pond, Dragonfly Pond and Polliwog Pond) will be removed during site development representing a net loss of on-site aquatic habitat.	✓		• Darlington Creek and Creek Tributary Habitat		Incorporation of aquatic habitat areas into the new lake infill area during the post-construction phase of the Project (also included as a mitigation measure for effects in the Terrestrial Environment). Salvage and relocation of aquatic plants and biota where practicable, to a suitable existing or created habitat in advance of site preparation activities.	No residual adverse effects
Construction of the new Maple Grove Road box culvert crossing of Darlington Creek could result in a HADD under the *Fisheries Act*. This is considered an adverse effect of the Project and is further evaluated in terms of mitigation measures and residual effects. Approximately 400 m of the upper reaches of each of two intermittent tributaries of Darlington Creek will be lost and/or altered as a result of the Project. The Project may result in the degradation of fish habitat in the upper reaches of an intermittent tributary to Lake Ontario (west of Park Road) as a result of its re-alignment or removal.	✓		• Darlington Creek and Creek Tributary Habitat	Development of an appropriate Fish Habitat Compensation Plan to satisfy the requirements of a federal *Fisheries Act* Section 35(2) authorization.	Construction of a clear-span bridge in lieu of the box culvert crossing of Darlington Creek to avoid in-water works and the loss of creek habitat. Alternatively, the stream crossing can be avoided entirely by relocating the access route during detailed design.	No residual adverse effects

Note:
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[2] Likely Adverse Effects and Residual Adverse Effects transferred to Table 8.3-1(a) for Cumulative Effects Assessment, and Residual Adverse Effects are transferred to Table 9.3-1 for Determination of Significance.

TABLE 5.15-1 (Cont'd)
Summary of Likely Environmental Effects, Mitigation Measures and Residual Adverse Effects[1]

Likely Adverse Environmental Effect[2]	Site Preparation & Construction	Operation & Maintenance	Valued Ecosystem Component Affected	Mitigation Measures: In-Design Mitigation Measures (Incorporated into Project design to pre-empt environmental effect)	Mitigation Measures: Additional Mitigation Measures (Identified through EA program)	Residual Adverse Effects[2]
Aquatic Environment (Section 5.4) (Cont'd)						
Placement of the lake infill and construction of the cooling water intake structure and diffuser ports will result in the loss of approximately 40 ha of nearshore aquatic habitat. .	✓		• Lake Ontario Nearshore Habitat	Development of an appropriate Fish Habitat Compensation Plan to satisfy the requirements of a federal *Fisheries Act* Section 35(2) authorization. Location of the cooling and/or service water intakes and discharge structures in less sensitive habitats removed from more productive nearshore habitats and spawning areas.	None identified	No residual adverse effects *As noted, the assessment concluded that there will not be a residual adverse environmental effect on Aquatic Habitat. However, because there may be a perception that the loss of aquatic habitat as a result of lake infilling and the construction of the intake and discharge structures will result in a residual adverse effect, the following effect is advanced for consideration of significance as if it was, in fact, a residual adverse effect:* Loss of approximately 40 ha of Lake Ontario nearshore aquatic habitat as a result of lake infilling and construction of cooling water intake and discharge structures.
The embayment created between the NND infilling area and St. Marys Cement wharf may experience increased algae growth and entrapment due to less mixing of the nutrients from Darlington Creek, warmer temperatures and the protected nature of the embayment.		✓	• Lake Ontario Nearshore Habitat	None identified	As part of the detailed design of the lake infill, the potential effects on the Aquatic Habitat associated with shoreline processes will be considered and a plan developed to monitor these effects.	No residual adverse effects
Placement of the lake infill and construction of the cooling water intake structure and diffuser ports will result in localized loss of some VEC species (i.e., benthic invertebrates, fish).	✓		• Forage Species (Invertebrates and Fish) • Various Fish Species	Capture and release fish from in-water work areas as work advances. Conduct underwater blasting program in compliance with applicable guidance to minimize incidental mortality to satisfy a federal *Fisheries Act* Section 32 Authorization.	None identified	Loss of some aquatic biota (i.e., benthic invertebrates, fish) during the construction of the lake infill and the cooling water intake and discharge structures.

Note:.
[1] Extracted from Sections 5.2 to 5.14.
[2] Likely Adverse Effects and Residual Adverse Effects transferred to Table 8.3-1(a) for Cumulative Effects Assessment, and Residual Adverse Effects are transferred to Table 9.3-1 for Determination of Significance.

TABLE 5.15-1 (Cont'd)
Summary of Likely Environmental Effects, Mitigation Measures and Residual Adverse Effects[1]

Likely Adverse Environmental Effect[2]	Site Preparation & Construction	Operation & Maintenance	Valued Ecosystem Component Affected	Mitigation Measures		Residual Adverse Effects[2]
				In-Design Mitigation Measures (Incorporated into Project design to pre-empt environmental effect)	**Additional Mitigation Measures** (Identified through EA program)	
Aquatic Environment (Section 5.4) (Cont'd)						
Operation of the once-through cooling water intake (and to a lesser degree, the cooling tower intake) will result in the loss of aquatic biota through impingement and entrainment. No SARA species are expected to be impinged.		✓	• Forage Species (Invertebrates and Fish) • Various Fish Species	Location of the cooling and/or service water intakes and discharge structures in less sensitive habitat removed from more productive nearshore habitats and spawning areas. Incorporation of intake and discharge structures (with mitigation measures) for the once-through cooling option, of a design similar to DNGS but sized to the necessary water volumes. The intake structure will be designed to limit the velocity of the water in the vicinity of the intake, minimizing the impingement of fish and effects of local currents. Effects associated with impingement and entrainment will be considered in the Fish Habitat Compensation Plan noted above.	Implementation of an Adaptive Management Strategy to address changes to the environment associated with aquatic ecosystems over time.	Impingement and entrainment losses associated with operation of the once-through lakewater cooling option, and to a lesser degree, the cooling tower option.
Terrestrial Environment (from Section 5.5)						
An estimated 113 ha of Cultural Meadow and Thicket Ecosystem will be removed as a result of site development. This Ecosystem represents: • Feeding and winter foraging area for raptors; and • Mammal habitat.	✓		• Cultural Meadow and Thicket Ecosystem • Winter Raptor Feeding and Roosting Area • Breeding Mammals	Re-planting of approximately 40 to 50 ha of Cultural Meadow and approximately 15 to 20 ha of Cultural Thicket with native shrub plantings.	None identified	Loss within the DN site of approximately 40 to 50 ha of mostly Cultural Meadow Ecosystem.
Development of the DN site will result in the loss of an estimated 17 ha of Wetland Ecosystem. Three amphibian breeding areas (Treefrog Pond, Polliwog Pond and Dragonfly Pond) will be removed through DN site development. A rare species of dragonfly, Amber-winged Spreadwing, whose only known occurrence on the site is at Treefrog Pond will be lost to the DN site.	✓		• Wetland Ecosystem • Breeding and Key Summer Habitat • Dragonflies and Damselflies	The biodiversity of Coot's Pond will be maintained during the Site Preparation and Construction phase of the Project. Stormwater management techniques will be implemented to provide for adequate flow to, and water quality (e.g., TSS) management in Coot's Pond.	Creation of new fish-free wetland ponds with riparian plantings in appropriate locations on the DN site. Incorporation of wetland areas into the new lake infill area after the construction phase (also included as a mitigation measure for effects in the Aquatic Environment).	No residual adverse effects

Note:
[1] Extracted from Sections 5.2 to 5.14.
[2] Likely Adverse Effects and Residual Adverse Effects transferred to Table 8.3-1(a) for Cumulative Effects Assessment, and Residual Adverse Effects are transferred to Table 9.3-1 for Determination of Significance.

TABLE 5.15-1 (Cont'd)
Summary of Likely Environmental Effects, Mitigation Measures and Residual Adverse Effects[1]

Likely Adverse Environmental Effect[2]	Site Preparation & Construction	Operation & Maintenance	Valued Ecosystem Component Affected	Mitigation Measures		Residual Adverse Effects[2]
				In-Design Mitigation Measures (Incorporated into Project design to pre-empt environmental effect)	Additional Mitigation Measures (Identified through EA program)	
Terrestrial Environment (from Section 5.5) (Cont'd)						
Clearing of the DN site will result in the loss of an estimated 74 ha of: • Monarch (and other) butterfly habitat; and • Migrant bird habitat.	✓		• Migrant Butterfly Stopover Area • Breeding Birds • Migrant Songbirds and their Habitat	(As initially identified above and repeated below because of its complementary benefit): Re-planting of approximately 40 to 50 ha of Cultural Meadow and approximately 15 to 20 ha of Cultural Thicket with native shrub plantings, and Woodland dominated by Sugar Maple. Include native forb seeds in seed mixture for Cultural Meadow re-planting.		The net loss of approximately 24 to 34 ha of on-site habitat currently used as butterfly stopover area. Decrease in populations of breeding birds on the DN site.
Clearing and grubbing of the DN site may result in the loss of rare plant species: Shag-bark Hickory, Butternut, Common Water Flax-seed, Cup Plant and Loesel's Twayblade.	✓		• Cultural Meadow and Thicket Ecosystem	None identified	Salvage and relocation or replanting of rare plant species (Shag-bark Hickory, Common Water Flax-seed, Cup Plant and Loesel's Twayblade) to a suitable existing or created habitat in advance of site preparation activities.	No residual adverse effect
The removal of the shoreline bluffs in the development area of the DN site will result in a decrease in Bank Swallow nesting habitat that supports approximately 1,300 active burrows.	✓		• Breeding Birds	None identified	The mitigation options being advanced for consideration are: Development of artificial Bank Swallow habitat in potentially suitable locations on the DN site and the monitoring of existing colonies. Development of artificial habitat for aerial forage species (e.g., Chimney Swift and Purple Martins) in potentially suitable locations on the DN site. Acquisition of lands that contain an existing large Bank Swallows colony for study and protection.	Loss of nesting habitat for up to 1,000 active Bank Swallow burrows, however, some mitigation not directly comparable to effect, will result in advances for the species elsewhere.

Note:
[1] Extracted from Sections 5.2 to 5.14.
[2] Likely Adverse Effects and Residual Adverse Effects transferred to Table 8.3-1(a) for Cumulative Effects Assessment, and Residual Adverse Effects are transferred to Table 9.3-1 for Determination of Significance.

TABLE 5.15-1 (Cont'd)
Summary of Likely Environmental Effects, Mitigation Measures and Residual Adverse Effects[1]

Likely Adverse Environmental Effect[2]	Site Preparation & Construction	Operation & Maintenance	Valued Ecosystem Component Affected	Mitigation Measures		Residual Adverse Effects[2]
				In-Design Mitigation Measures (Incorporated into Project design to pre-empt environmental effect)	**Additional Mitigation Measures** (Identified through EA program)	
Terrestrial Environment (from Section 5.5) (Cont'd)						
					Integrate interpretive opportunities related to the effects of the Project on shoreline bluff habitat and Bank Swallows such as erecting interpretative signage and constructing observation decks. Development of partnerships to undertake research into declines in aerial foragers in Ontario.	
The presence of large (i.e., high) structures and buildings on the DN site, including and notably natural draft cooling towers, will result in bird strikes causing injury and death to birds.		✓	• Breeding Birds • Migrant Songbirds and their Habitat	Implementation of Good Industry Management Practice in the design and development of lighting systems and structures including strategies to reduce the incidence of bird strikes to the extent practicable while considering the needs of navigation safety and site security.	None identified	Bird strike mortalities associated with natural draft cooling towers (estimated at <110 in the spring and <300 in the fall, assuming natural draft cooling towers).
The presence of security fencing on the DN site, including and notably around the Protected Area, will result in bird entrapment causing injury and death to birds.		✓	• Breeding Birds • Migrant Songbirds and their Habitat	Implementation of Good Industry Management Practice in the initial design of security fencing systems to reduce the incidence of bird entanglement and entrapment to the extent practicable.	None identified	No residual adverse effects
Access for wildlife travel along the wildlife corridor extending east-west across the DN site is likely to be interrupted at points in time during the Site Preparation and Construction phase.	✓		• Wildlife Corridors	Incorporate to the extent practicable in the Project design, measures to maintain access for wildlife travel on the east-west wildlife corridor during construction activities; and to enhance the corridor function for the long-term.	None identified	Periodic and short-term disruption to wildlife travel along the east-west wildlife corridor during the Site Preparation and Construction phase of the Project.

Note:
[1] Extracted from Sections 5.2 to 5.14.
[2] Likely Adverse Effects and Residual Adverse Effects transferred to Table 8.3-1(a) for Cumulative Effects Assessment, and Residual Adverse Effects are transferred to Table 9.3-1 for Determination of Significance.

TABLE 5.15-1 (Cont'd)
Summary of Likely Environmental Effects, Mitigation Measures and Residual Adverse Effects[1]

Likely Adverse Environmental Effect[2]	Site Preparation & Construction	Operation & Maintenance	Valued Ecosystem Component Affected	Mitigation Measures: In-Design Mitigation Measures (Incorporated into Project design to pre-empt environmental effect)	Mitigation Measures: Additional Mitigation Measures (Identified through EA program)	Residual Adverse Effects[2]
Geological and Hydrogeological Environment (From Section 5.6)						
Stormwater management facilities can potentially affect Soil Quality. Stormwater management facilities can potentially affect Groundwater Quality. Operation of the NND may increase the concentration of tritium in groundwater in the vicinity of NND Protected Area. *The above changes are not considered to represent adverse effects in the Geological and Hydrogeological Environment, however, they are considered further in terms of pathways to VECs in other environmental components (e.g., Non-Human Biota)*	✓ ✓	✓ ✓ ✓	• Pathway to Non-Human Biota Health.	Implementation of Good Industry Management Practices during all phases of the NND Project with respect to stormwater management. Good practice typically includes, among other actions: sediment control practices, dewatering water treatment, stormwater conveyance systems and conventional stormwater treatment methods such as stormwater management ponds and oil-grit separators.	None identified	No residual adverse effects in the Geological and Hydrogeological Environment. *Residual effects in other environmental components as they may result from Soil and Groundwater Quality as a pathway will be described in the appropriate sections of this table.*
Groundwater Flow conditions will be changed permanently by the NND Project. Although flow patterns will change, the ultimate flow direction and discharge point will remain to be Lake Ontario, as is currently the case. *The changes in groundwater flows are not considered to represent an adverse effect in the Geological and Hydrogeological Environment, however, they are considered further in terms of pathways to VECs in the Terrestrial and Aquatic Environments.*	✓	✓	Pathways to: • Aquatic Environment • Terrestrial Environment.	Design and implementation of stormwater management features in the area of the Northeast Landfill Area with objectives of: i) contributing additional baseflow into Darlington Creek and ii) reducing the extent of the groundwater drawdown area north of the DN site. Design and implementation of all stormwater management features such as swales, ditches and retention ponds so as to optimize opportunities to recharge the groundwater flow regime with surface water runoff.	None identified	No residual adverse effects in the Geological and Hydrogeological Environment. *Residual effects in other environmental components as they may result from Groundwater Flow as a pathway will be described in the appropriate sections of this table.*
Radiation and Radioactivity Environment (from Section 5.7)						
NND will contribute to radiation doses to the general public. The predicted radiation doses are well below the regulatory limit for members of the public and a small fraction of the annual dose from natural background radiation.		✓	Pathways to: • Human Health • Non-Human Biota Health.	None identified	None identified	No residual adverse effects in the Radiation and Radioactivity Environment. *Residual effects in other environmental components as they may result from Radiation and Radioactivity as a pathway will be described in the appropriate sections of this table.*

Note:
[1] Extracted from Sections 5.2 to 5.14.
[2] Likely Adverse Effects and Residual Adverse Effects transferred to Table 8.3-1(a) for Cumulative Effects Assessment, and Residual Adverse Effects are transferred to Table 9.3-1 for Determination of Significance.

TABLE 5.15-1 (Cont'd)
Summary of Likely Environmental Effects, Mitigation Measures and Residual Adverse Effects[1]

Likely Adverse Environmental Effect[2]	Site Preparation & Construction	Operation & Maintenance	Valued Ecosystem Component Affected	Mitigation Measures		Residual Adverse Effects[2]
				In-Design Mitigation Measures (Incorporated into Project design to pre-empt environmental effect)	**Additional Mitigation Measures** (Identified through EA program)	
Radiation and Radioactivity Environment (from Section 5.7) (Cont'd)						
NND will contribute to radiation doses to workers. The predicted radiation doses are well below the regulatory limit for workers (100 mSv per 5 years with a maximum of 50 mSv in any one year). NND will result in emissions of radionuclides to the environment. These emissions will result in low environmental concentrations and do not represent an adverse effect. *Radiation doses to the general public and to workers; and emissions of radionuclides to the environment are not considered to represent an adverse effect of the Project in the Radiation and Radioactivity Environment. They are, however considered further in terms of pathways to VECs in the Human Health and Non-human Biota environmental components.*	✓	✓ ✓				
Land Use Environment (from Section 5.8)						
Cooling towers associated with NND will be a visually dominant feature in the landscape. The structures themselves will be highly visible in the case of natural draft towers, while mechanical draft towers will be less so as a result of visual screening afforded by topographic features. The visual dominance of the cooling towers is likely to affect both the municipal planning regime and land use development patterns and opportunities, in the vicinity of the DN site.	✓	✓	• Land Use Planning Regime In Local Study Area	Implementation of Good Industry Management Practices during the design and construction of the NND Project to visually screen cooling towers from selected key off-site vantage points.	OPG to continue to engage in discussions with the Region of Durham, the Municipality of Clarington and City of Oshawa regarding appropriate planning policies and land use structure in the Primary and Contiguous Zones to ensure maintenance of effective emergency response.	No residual adverse effects

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TABLE 5.15-1 (Cont'd)
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Likely Adverse Environmental Effect[2]	Site Preparation & Construction	Operation & Maintenance	Valued Ecosystem Component Affected	Mitigation Measures: In-Design Mitigation Measures (Incorporated into Project design to pre-empt environmental effect)	Mitigation Measures: Additional Mitigation Measures (Identified through EA program)	Residual Adverse Effects[2]
Land Use Environment (from Section 5.8) (Cont'd)						
Increased intensity of activities on the DN site is likely to result in changes to land use and development patterns that would transpire otherwise. As the intensity of use increases on the DN site, the existing as well as currently-proposed sensitive land uses surrounding the site will likely transition to employment and industrial uses. For emergency planning purposes, it can be expected that new sensitive land uses will be directed away from the DN site which will result in a change to the land use and development patterns from those that would otherwise exist		✓			OPG to continue to engage the Region of Durham with respect to the Regional Official Plan Amendment application to implement the Growing Durham Study, Preferred Growth Scenario and Policy Directions and proposed Future Land Uses in the Primary and Contiguous Zones	
The visual landscape on the DN site will be altered as a result of the Project. Changes will result from several aspects of the Project, including the development of the Northeast Landfill Area, expansion of the existing Northwest Landfill Area and grading of the existing bluff formations on the lakefront. However, the greatest visual effect will be as a consequence of the existence and operation of cooling towers, either natural draft or mechanical since their vapour plumes are of similar geometry. The visual dominance of the cooling towers is likely to have a consequential effect on Land Use (as noted above) and is also considered for effects in VECs in the Socio-economic Environment.	✓	✓	Visual Aesthetics	Implementation of Good Industry Management Practices during the design and construction of the NND Project to visually screen cooling towers from selected key off-site vantage points. Incorporation of landscape design principles (e.g., naturalization of the Northwest and Northeast Landfill Area surfaces and the lake infill area, planting plans and revegetation programs) in the design and construction of the Project to reduce the visibility of the operating facility; Implementation of Good Industry Management Practice in the design and development of lighting systems that will, among other considerations (e.g., bird strikes, navigation safety) serve to reduce, to the extent practicable, the night-time visibility of the overall site and its dominant features, including cooling towers.	None identified	Changes in the quality of existing views of the DN site throughout the operating life of the Project from viewing locations in the LSA and RSA as a result of the presence of natural draft cooling tower structures and the associated plumes released from either natural draft or mechanical draft cooling towers.

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TABLE 5.15-1 (Cont'd)
Summary of Likely Environmental Effects, Mitigation Measures and Residual Adverse Effects[1]

Likely Adverse Environmental Effect[2]	Site Preparation & Construction	Operation & Maintenance	Valued Ecosystem Component Affected	Mitigation Measures: In-Design Mitigation Measures (Incorporated into Project design to pre-empt environmental effect)	Mitigation Measures: Additional Mitigation Measures (Identified through EA program)	Residual Adverse Effects[2]
Traffic and Transportation (from Section 5.9)						
Notwithstanding system improvements that will be made by the jurisdiction responsible for the roads network, some intersections will experience decreased Levels of Service (LOS) in the future as a result of Project-related traffic. These conditions will be experienced primarily at intersections and in the roads network south of Highway 401 between Courtice Road and Waverly Road. The Project will add traffic to the existing roadways and contribute to ongoing degradation of the roads system. Consequently, there is an increased likelihood of collisions and/or other safety-related incidents. Some (currently) unknown quantity of surplus excavated soil may be exported from the DN site for disposal. Until a destination for such soil is known, specific haul routes for the transport vehicles are also unknown. However, the three north-bound arterial roads in the vicinity of the DN site, Holt Road, Waverly Road and Courtice Road, are possible routes. If Holt Road were to be used as a haul route for the surplus soils, depending on the frequency of truck trips, the CP Rail level crossing on Holt Road north of Highway 401 could contribute to an increased frequency of train/truck collisions.	✓ ✓ ✓	✓ ✓	• Transportation System Operations (road, rail, marine) • Transportation System Safety (road, rail, marine)	The transportation system modelling carried out to evaluate intersection capacities considered the incorporation of system improvements over time that will be carried out by the jurisdictions in authority (i.e., MTO, Region of Durham, Municipality of Clarington) in response to the needs of continuing growth and development in the community. These improvements were incorporated as modelling assumptions. They comprise a variety of elements that are routinely undertaken by municipal and provincial agencies as they progressively upgrade their transportation networks as well as some planned major infrastructure works. These measures will include (among others): • Widening of Highway 401; • New interchange at Highway 401 and Holt Road; • Widening of sections of Holt Road from two to four lanes; • Installation of traffic signals at key intersections and Highway 401 ramps; and • Addition of turning lanes at key intersections. These improvements will serve to address system performance issues both related and unrelated to traffic associated with the NND Project. A Traffic Management Plan will be implemented with the objective of reducing disruption and maintaining safe traffic conditions during the Site Preparation and Construction phase (also included as a mitigation measure for effects in the Socio-Economic Environment).	As part of the Traffic Management Plan, collaborate with the responsible agencies to ensure that the NND Project-related traffic is fully considered in the design and implementation of off-site road improvements. As part of the Traffic Management Plan, collaborate within a framework of specific undertakings between the appropriate parties, to identify transportation system deficiencies and facilitate improvements, with respect to traffic safety and roadway degradation related to the NND Project.	No residual adverse effects

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[2] Likely Adverse Effects and Residual Adverse Effects transferred to Table 8.3-1(a) for Cumulative Effects Assessment, and Residual Adverse Effects are transferred to Table 9.3-1 for Determination of Significance.

TABLE 5.15-1 (Cont'd)
Summary of Likely Environmental Effects, Mitigation Measures and Residual Adverse Effects[1]

Likely Adverse Environmental Effect[2]	Site Preparation & Construction	Operation & Maintenance	Valued Ecosystem Component Affected	Mitigation Measures		Residual Adverse Effects[2]
				In-Design Mitigation Measures (Incorporated into Project design to pre-empt environmental effect)	**Additional Mitigation Measures** (Identified through EA program)	
Physical and Cultural Heritage Resources (from Section 5.10)						
As a result of physical disturbance of the site during the Site Preparation and Construction phases, two Euro-Canadian archaeological resources will be displaced.	✓		• Aboriginal And Euro-Canadian Archaeological Resources	Qualified specialists will undertake a controlled removal and recording of archaeological site context, cultural features and artifacts to document the cultural heritage value or interest of the site and to preserve its information for future study.	None identified	No residual adverse effects
The Project may include the placement of surplus excavated soils at the existing Northwest Landfill Area. Should this occur and should the soil placement encroach into the area thought to be occupied by the Burk Cemetery and Burk Pioneer Cemetery Monument and Plaque, the cemetery and the monument and plaque will be deemed to be totally displaced.	✓		• Euro-Canadian Built Heritage Resources	Should it be necessary to do so, and in advance of construction-related activities in the area, the Burk Cemetery will be closed in accordance with the Cemeteries Act (Revised 1992) and all burial remains re-interred in a local cemetery. The Burk Pioneer Cemetery Monument and Plaque will be relocated to a suitable off-site location.	None identified	No residual adverse effects
Socio-economic Environment (from Section 5.11)						
NND Project-related traffic may disrupt normal school bus operation in the vicinity of the DN site. The greatest disruption is likely to be experienced during the Site Preparation and Construction phase and, specifically, along the transport route used for shipment of surplus soil from the DN site.	✓		Education	A Traffic Management Plan will be implemented with the objective of reducing disruption and maintaining safe traffic conditions during the Site Preparation and Construction phase (also included as a mitigation measure for effects in the Traffic and Transportation component). OPG and the Municipality of Clarington entered into a Host Municipality Agreement, dated August 31, 2009. The Agreement provides compensation to the Municipality to mitigate effects resulting from the NND Project, as identified in the EIS. OPG will share information with local and regional land use planners, economic development staff, and social service providers with respect to the timing and magnitude of its on-site labour force during the Site Preparation and Construction phase. OPG will work in partnership with government, other electricity sector employers, labour groups and educational institutions through existing liaison mechanisms and programs during the Site Preparation and Construction and Operation and Maintenance phases.	None identified	No residual adverse effects

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[1] Extracted from Sections 5.2 to 5.14.
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TABLE 5.15-1 (Cont'd)
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				In-Design Mitigation Measures (Incorporated into Project design to pre-empt environmental effect)	**Additional Mitigation Measures** (Identified through EA program)	
Socio-economic Environment (from Section 5.11) (Cont'd)						
If the NND Project were to be implemented with cooling towers, the natural draft cooling towers alone, and the vapour plumes associated with either the natural draft or mechanical draft cooling towers would result in changes in the character of communities in the LSA and RSA from where they would be prominent features of the landscape, particularly in the immediate vicinity of the DN site.	✓	✓	• Housing • Municipal Infrastructure and Services • Community Character	None identified	■ None identified	Change in the character of communities in the RSA and LSA as a result of the presence of the natural draft cooling tower structures, and the associated plumes released from either natural draft or mechanical draft cooling towers (if the NND Project were to be implemented with cooling towers).
Because of safety concerns during physical works in the vicinity of the publicly-accessible spaces, and possible periodic and short-term disruption because of the construction activities, there is likely to be some reduced use and enjoyment of the community and recreational features on the DN site during the Site Preparation and Construction phase. Because of nuisance-related effects (e.g., dust, noise, traffic) some residents living along truck haul routes may experience disruption to their use and enjoyment of their property during the Site Preparation and Construction phase. If the NND Project were to be implemented with cooling towers, it would result in reduced enjoyment of private property due to the visual dominance of the natural draft cooling towers and the vapour plumes associated with either the natural draft or mechanical draft cooling towers, on the landscape.	✓ ✓	✓ ✓	• Community and Recreational Facilities And Programs • Use and Enjoyment of Property	OPG and the Municipality of Clarington entered into a Host Municipality Agreement, dated August 31, 2009. The Agreement provides compensation to the Municipality to mitigate effects resulting from the NND Project, as identified in the EIS. A Traffic Management Plan will be implemented with the objective of reducing disruption and maintaining safe traffic conditions during the Site preparation and Construction phase (as noted above, and also included as a mitigation measure for effects in the Traffic and Transportation component). A Nuisance Effects Management Plan (e.g., to address dust and noise concerns) will be implemented for residential properties along transportation routes affected by the NND Project during the Site Preparation and Construction phase. The Plan will include a process for receiving, resolving and following-up on issues raised by the public. OPG will continue to work with various stakeholders to deliver its community, recreational, educational and biodiversity initiatives. OPG will continue to keep its neighbours and the broader public informed concerning activities at the DN site as appropriate to each phase of the Project. OPG will re-establish full access to and use of the Waterfront Trail in stages once safe access can be provided. OPG will seek to establish a resolution with recreational users of the DN site, should there be an effect.	None identified	Reduced use and enjoyment of the recreational features on the DN site (e.g., Waterfront Trail, soccer fields) during the Site Preparation and Construction phase. Disruption to use and enjoyment of property because of nuisance-related effects (e.g., dust, noise, traffic) during the Site Preparation and Construction phase for some residents living along the truck haul routes. Reduced enjoyment of private property in the RSA and LSA as a result of the visual dominance of the natural draft cooling tower structures and the associated vapour plumes released from either the natural draft or mechanical draft cooling towers (if the NND Project were to be implemented with cooling towers).

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[2] Likely Adverse Effects and Residual Adverse Effects transferred to Table 8.3-1(a) for Cumulative Effects Assessment, and Residual Adverse Effects are transferred to Table 9.3-1 for Determination of Significance.

TABLE 5.15-1 (Cont'd)
Summary of Likely Environmental Effects, Mitigation Measures and Residual Adverse Effects[1]

Likely Adverse Environmental Effect[2]	Site Preparation & Construction	Operation & Maintenance	Valued Ecosystem Component Affected	Mitigation Measures		Residual Adverse Effects[2]
				In-Design Mitigation Measures (Incorporated into Project design to pre-empt environmental effect)	**Additional Mitigation Measures** (Identified through EA program)	
Aboriginal Interests (from Section 5.12)						
No likely adverse environmental effects.						No residual adverse effects
Health - Human (from Section 5.13)						
The estimated radiation dose from the Project to the most exposed critical group is approximately 4 µSv/y (0.004 mSv/y). This dose is well below (i.e., only approximately 0.5% of) the regulatory limit for members of the public of 1 mSv/y and a small fraction of the annual dose from natural background radiation (about 1,840 µSv/y) and is not considered to represent an adverse environmental effect. *However, because the Project includes a proposed nuclear facility and there is public interest in doses to the public, the doses to Members of the Public from the NND Project are considered further in terms of cumulative effects.* The predicted radiation doses are well below the regulatory limit for workers and therefore, radiation doses to workers are not considered to represent an adverse effect of the Project. *However, as this is a proposed nuclear facility and there is public interest in doses, the doses to Workers at the DN site as a result of the NND Project are considered further in terms of cumulative effects.*	✓	✓	• Members of the Public • Workers on the DN site	An ALARA analysis will be undertaken and specific measures to reduce collective worker dose to the extent practicable will be determined during detailed planning and design of the Project. As per current practice at the DN site, all internal and external doses received by NND workers who are NEWs will be monitored and reported as part of the operational dose management program. This system will be in effect during the Operation and Maintenance, and the Decommissioning Phases of the Project.	None identified	No residual adverse effects *Although there are no residual adverse effects as a result of radiation dose, individual doses to workers at the DN site; and dose to the general public are both considered further in terms of cumulative effects because this is a proposed nuclear facility and there is public interest in doses.*
If the NND Project were to be implemented with cooling towers, it would result in reduced enjoyment of private property in the RSA and LSA due to the visual dominance of the natural draft cooling towers and the vapour plumes associated with either natural draft or mechanical draft cooling towers, on the landscape. Reduced use and enjoyment of property is a consideration in terms of mental well-being.		✓	• Members of the Public	The likely changes on use and enjoyment of property, and community and recreational features on the DN site were also identified as residual adverse effects in the Socio-Economic Environment (see above). The mitigation measures identified for these residual effects in the Socio-Economic Environment as described above will also be relevant for Human Health.	None identified	Reduced enjoyment of private property in the RSA and LSA as a result of the visual dominance of the natural draft cooling tower structures and the associated vapour plumes released from either the natural draft or mechanical draft cooling towers.
Because of nuisance-related effects (e.g., dust, noise, traffic) some residents living along truck haul routes may experience disruption to their use and enjoyment of their property during the Site Preparation and Construction phase. Reduced use and enjoyment of property is a consideration in terms of mental well-being.	✓		• Members of the Public			Disruption to use and enjoyment of property because of nuisance-related effects (e.g., dust, noise, traffic) during the Site Preparation and Construction phase for some residents living along the truck haul routes.

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TABLE 5.15-1 (Cont'd)
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Likely Adverse Environmental Effect[2]	Site Preparation & Construction	Operation & Maintenance	Valued Ecosystem Component Affected	Mitigation Measures: In-Design Mitigation Measures (Incorporated into Project design to pre-empt environmental effect)	Mitigation Measures: Additional Mitigation Measures (Identified through EA program)	Residual Adverse Effects[2]
Health - Human (from Section 5.13) (Cont'd)						
Because of safety concerns during physical works in the vicinity of the publicly-accessible spaces, and possible periodic and short-term disruption because of the construction activities, there is likely to be some reduced use and enjoyment of the community and recreational features on the DN site during the Site Preparation and Construction phase. Reduced use and enjoyment of community and recreational features is a consideration in terms of social well-being.	✓		• Members of the Public			Reduced use and enjoyment of community and recreational features on the DN site during the Site Preparation and Construction phase
Health - Non-Human Biota (from Section 5.14)						
The Project will not result in changes to the non-radiological environment that will adversely affect the ecological receptors selected to represent the Non-Human Biota component of the environment.	✓	✓	The receptors selected for assessment of effects on non-human biota were representative of the VECs selected for the Aquatic and Terrestrial Environmental components, and included: birds, mammals, insects, invertebrates, amphibians, reptiles, terrestrial vegetation, aquatic macrophytes, benthos and fish	Measures identified for the Surface Water, Atmospheric, and Geology and Hydrogeology components will also mitigate effects on non-human biota.	None identified	No residual adverse effects
The Project will not result in changes to the radiological environment that will adversely affect the ecological receptors selected to represent the Non-Human Biota component of the environment.		✓		Measures identified for the Surface Water, Atmospheric, and Geology and Hydrogeology components will also mitigate effects on non-human biota.	None identified	No residual adverse effects

Note:
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[2] Likely Adverse Effects and Residual Adverse Effects transferred to Table 8.3-1(a) for Cumulative Effects Assessment, and Residual Adverse Effects are transferred to Table 9.3-1 for Determination of Significance.

6. ASSESSMENT OF OTHER LIKELY EFFECTS

This Chapter provides an assessment of effects both from and on the Project that are different from those potential effects of the Project on the environment in Chapter 5. These include potential effects of the Project on the sustainable use of resources (Section 6.1), likely effects of the environment on the Project (Section 6.2), seismicity (Section 6.3) and climate change considerations (Section 6.4).

6.1 Sustainability

The concept of sustainability stems from the 1987 Brundtland Report of the World Commission on Environment and Development (WCED). In that document, sustainable development was defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED 1987). Since that publication, sustainable development and sustainability have been increasingly ingrained into a range of activities, including municipal planning and environmental assessments. For example, the CEA Agency's mission statement is centered upon sustainability and reads:

> *"To provide Canadians with high-quality federal environmental assessments that contribute to informed decision making and sustainable development."*

Furthermore, the CEA Agency's (2006) Sustainable Development 20-year Vision is that:

> *"Environmental considerations, alongside economic and social ones, are taken into account in all federal government decisions respecting policies, plans, programs and projects in a way that supports balanced, integrated decision-making and progress towards sustainable development."*

OPG has also embraced sustainable development as an important aspect of its business. OPG (2007) defines this as:

> *"Embracing business strategies and activities that meet the needs of the enterprise and its stakeholders today while protecting and enhancing the human and natural resources that will be needed in the future."*

OPG's commitment to sustainable development is reported annually in its Sustainable Development Reports and is part of its overall Environmental Policy.

The EIS Guidelines also call for attention to sustainable development. In Section 2.4, the Guidelines state that;

> *"A project that is supportive of sustainable development must strive to integrate the objective of net ecological, economic and social benefits to society in the planning and decision-making process and must incorporate citizen participation."*

This statement is important because it draws attention to the difference between mitigating negative effects and undertaking a project that makes a net beneficial impact. In fact, this differentiation is integral to sustainability. There is a call now for sustainable projects to not just avoid or mitigate adverse effects, but to demonstrate that the project may have an overall positive effect on ecology, society and economy. This approach has been called for even in other industries, such as mining, which has traditionally been viewed as very unsustainable. Hodge (2004) describes mining's contribution to sustainability as:

> *"An approach [that] centers on a conceptual shift from analysis and mitigation of impacts to analysis and encouragement of contribution."*

This contribution to sustainability has been used in other federal EAs as a basic "test" of sustainability, one of the more well-known being the Voisey's Bay nickel mine (Gibson 2005). A "test" of "contribution to sustainability" is a way to assess how well a project, overall, has achieved its goal of sustainability and takes the entire project into account over a generational time frame. The entire project is assessed as a whole, and a long time frame is adopted to ensure that the fundamental tenets of sustainability are met. In addition, the concept of sustainability has been incorporated into the tests for the significance of adverse residual effects discussed in Chapter 9. There, the critical question becomes whether or not the sustainability of the VEC is threatened.

6.1.1 Scope of the Sustainability Assessment

The purpose of the sustainability assessment is to consider, in an integrated manner, the net ecological, economic and social benefits to society and the overall extent to which the NND Project, as a whole, is supportive of sustainable development. It is focused specifically on the development of up to four nuclear reactor units supplying up to 4,800 MW of electrical capacity to meet the baseload requirements of Ontario. Chapters 1 and 2 of this EIS considered the need for the Project, described the Project for EA Purposes, and considered alternative means for carrying out the Project. These aspects, along with other stages of the energy chain (e.g., fuel production, transmission and distribution, energy consumption and waste management) are not considered further in this assessment. Similarly, the ultimate fate of nuclear wastes arising from the NND Project which are to be stored on an interim basis on the DN site may also be considered in future environmental assessments. As such, these Project-related aspects are not considered in this sustainability assessment.

Within this context, the sustainability assessment considers the NND Project as a whole, giving consideration to the effects of the project during its Site Preparation and Construction phase (2010 – 2025) and its Operation and Maintenance phase (2016 - 2100).

Most importantly, this assessment is being undertaken within an ecological, social and economic context that continues to change. While existing conditions provide the backdrop for the consideration of sustainability for the NND Project, it is acknowledged that the ecological, social and economic conditions that will be experienced by future generations will, to some extent, be defined by the goals of relevant municipalities and other stakeholders. To this end, the assessment is grounded in those future goals and sustainability objectives relevant to the study areas today.

6.1.2 Approach to the Sustainability Assessment

The sustainability assessment for the NND Project was undertaken within an overall framework as illustrated in Figure 6.1-1. There are three phases to the Project:

- Site Preparation and Construction;
- Operation and Maintenance; and
- Decommissioning and Abandonment.

The consideration of sustainability is focused on the first two phases on the reasonable premise that it is the establishment and operation of a project, rather than the cessation of that project, that presents the potential for effects on sustainability.

The Project activities associated with site preparation, construction, operation and maintenance act on the ecological, social and economic attributes of the local and regional study areas across a time horizon stretching from 2010 to 2100. In accordance with the EIS Guidelines and professional practice in sustainability assessments these attributes form the "pillars of sustainability" and they are considered to be inter-related and interdependent.

For the purposes of this sustainability assessment, each pillar was correlated to a vision statement derived from a synthesis of sustainable development considerations articulated by the Region of Durham (Durham 2003, 2007, 2009), the City of Oshawa (Corporation of the City of Oshawa

2005, McSweeny & Associates 2009) and the Municipality of Clarington (Municipality of Clarington 2007c) in their respective Official Plans, Strategic Plans and Sustainability Strategies. They also address the two specific requirements of the EIS Guidelines which state that the proponent (OPG) should consider:

- the extent to which the biological diversity may be affected by the Project; and

- the capacity of renewable resources that are likely to be significantly affected by the Project to meet the needs of present and future generations.

Accomplishing these visions requires attainment of the three goals articulated in the diagram and table below. They represent generic long term sustainability targets. A successful project should help the communities move toward these targets and this being the case the overall outcome is one of shared value namely:

- a sustainable project;
- sustainable communities

In order to provide some granularity to the sustainability assessment, a set of objectives has also been correlated with each vision and goal. For the purpose of this analysis these have been amalgamated from the various community plans and strategies cited earlier. They are set out in the following table.

TABLE 6.1-1
Sustainability Visions, Goals and Objectives

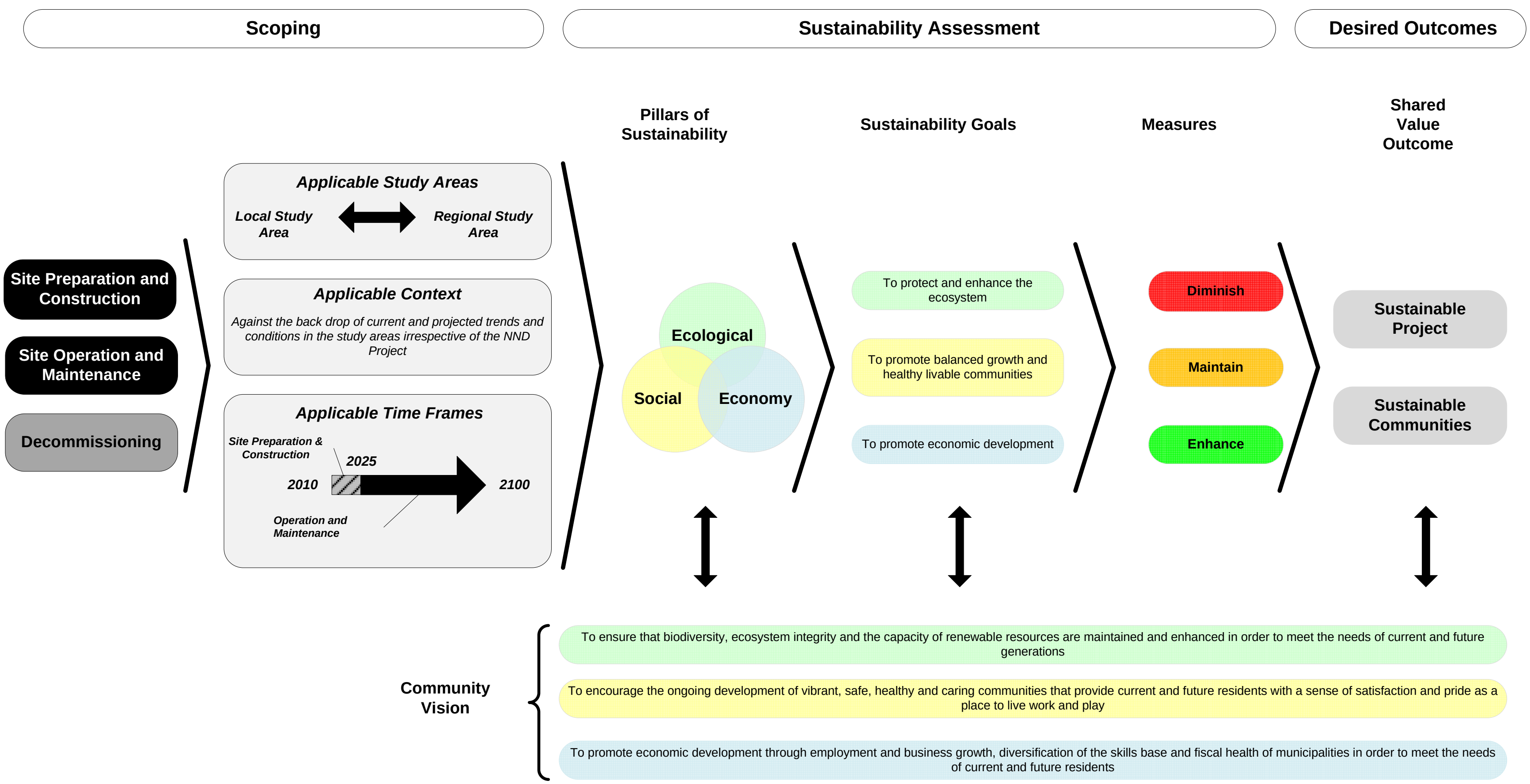
Community Visions	Sustainability Goals	Objectives
To ensure that biodiversity, ecosystem integrity and the capacity of renewable resources are maintained or enhanced in order to meet the needs of current and future generations.	To protect and enhance the ecosystem	• Green spaces in urban areas • Biodiversity and ecosystem integrity • Environmental stewardship • Energy conservation • Capacity of renewable resources
To encourage ongoing development of vibrant, safe, healthy and caring communities that provide current and future residents with a sense of satisfaction and pride as a place to live, work and play.	To promote balanced growth and healthy livable communities	• Balanced development • Efficient use of infrastructure and access to services • Live, work and play communities • Community pride and identity • Personal well-being
To promote economic development through employment and business growth, diversification of the skills base and fiscal health of municipalities in order to meet the needs of current and future residents.	To promote economic development	• New job opportunities • Business retention, expansion and creation • Durham as an energy hub • Diversification of the skills base • Healthy municipal finance

For each sustainability goal and associated vision, the assessment attempts to measure progress towards accomplishment by concluding whether the NND Project is likely to diminish, maintain or enhance such progress. The conclusions reached regarding progress towards sustainable development are based on a largely qualitative evaluation undertaken by the EA team that takes into consideration the following items:

Measure	Key Considerations
Diminish	• There are residual adverse effects from the NND Project, which would detract from environmental integrity or community well-being over the long term. • The NND Project precludes or constrains people from achieving their sustainable development goals or objectives. • The NND Project presents new barriers to the effectiveness of existing community and stakeholder engagement processes and institutional arrangements. • The NND Project adversely affects a specific group of people or community disproportionately.
Maintain	• The NND Project is not likely to affect environmental integrity or a community's social or economic well-being. • Relevant community and stakeholder engagement processes and institutional arrangements are in place and working effectively. • The people and communities experiencing adverse and positive effects remain largely unchanged from the current situation.
Enhance	• There are positive effects likely to result from the NND Project, significant or otherwise that would affect environmental integrity or a community's social or economic well-being over the long term. • The NND Project presents new opportunities for people to achieve sustainable development goals or objectives. • There are opportunities to strengthen or enhance relevant community and stakeholder engagement processes and institutional arrangements. • There are opportunities for more people and communities to share project benefits.

Finally, the sustainability assessment is summarized in a series of scorecard graphics that illustrate, in an integrated manner, the net ecological, economic and social outcomes to society and the overall extent and manner that the NND Project influences sustainable development.

FIGURE 6.1-1
NND Sustainability Map



6.1.3 Sustainability Assessment

6.1.3.1 Ecology

This Section considers the extent to which the NND Project contributes to progress towards achieving the following ecological vision and sustainability goal:

Community Vision:	*To ensure that biodiversity, ecosystem integrity and the capacity of renewable resources are maintained or enhanced in order to meet the needs of current and future generations.*
Sustainability Goal:	*To Protect and Enhance the Ecosystem*

The sustainability assessment looks at issues on a broad scale and therefore uses the RSA boundaries that were identified for the various environmental components as the basis for analysis. The following provides an overview of the ecological context for the assessment.

The geological and hydrogeological conditions in the RSA are characterized by the complexity of its landforms, which includes a portion of the Oak Ridges Moraine and drumlinized plains in the north; and bluffs, bars and beaches in the south along the shore of Lake Ontario. The moraine is a major source of groundwater recharge and a large number of creeks and rivers are derived from groundwater discharge from the moraine. These various landforms are associated with a diverse range of vegetation communities and wildlife species.

The north shore of Lake Ontario within the RSA supplies drinking water to several municipalities in Durham Region, the Municipality of Port Hope and the Town of Cobourg. Here, the Lake Ontario nearshore area is a dynamic environment that can be very productive. It provides important feeding, spawning and rearing habitat for many warm water and cold water fish species. From a socio-economic perspective, that nearshore area produces important fish species that are targeted by anglers for recreational purposes, particularly the Salmonid sport fish.

Air quality in the Region of Durham and the County of Northumberland does not differ substantially from the general air quality in southern Ontario within the Quebec–Windsor corridor and the GTA. The noise environment in the southern part of the RSA is typical of an urban setting being dominated by traffic on Highway 401 as well as local roads.

The natural environment within the Region is complex and diverse and the natural environment on the DN site is reflective of this being a small microcosm in a greater whole. Vegetation communities with particularly high floristic quality are the marshes and beach communities that also support rare species. The site is also home to several large Bank Swallow colonies and it provides habitat for a variety of mammals (e.g., deer, coyote, fox, cottontail, and skunk), amphibians and herptofauna species (e.g., turtles, snakes, frogs). Many of these species were identified on the western portion of the site near Coot's Pond and along the Waterfront Trail.

6.1.3.1.1 Green Space in Urban Areas

In a rapidly urbanizing setting, protecting and enhancing the ecosystem not only means protecting and increasing the amount of green space and tree cover in urban areas, but also the beautification of urban areas. Municipalities aim to have cleaner, greener cities, with reduced greenfield development and increased brownfield development.

For the most part, the NND Project will have the most direct effect on the DN site. Currently, the site is approximately 485 ha in size and provides approximately 285 ha of green space. The portion of green space north of the railway tracks is largely publicly accessible and used by local and regional study area residents for a variety of passive and active recreational uses. This amount of green space, while important to those that use it, represents a small area in context of the green space available across Durham Region or the RSA. During the Site Preparation Phase, the NND Project may result in a loss of up to 130 ha of various on-site vegetation communities, over half of which can be replaced or regenerated in the future leading to an end state that is consistent with not only the site's ecological capabilities but also community objectives. There may also be the loss of the on-site soccer fields which contribute to the urban green space available to local and regional residents. OPG has committed to work with the municipality to determine how best to accommodate for this loss of recreational space, should it occur.

On balance, the NND Project as a whole is not likely to affect progress towards ecological sustainability across the RSA. A large area of the DN site is likely to be ***maintained*** as a green urban area within the Municipality of Clarington.

Should natural draft cooling towers be required, there is a greater potential that the NND Project might serve to ***diminish*** the beautification objectives for urban areas. This is because the natural draft cooling towers, on the DN site during the Operation and Maintenance phase, would be dominant industrial looking features on the landscape and visible from many viewing locations in the RSA and LSA.

6.1.3.1.2 Biodiversity and Ecosystem Integrity

In order to maintain and enhance biodiversity and ecosystem integrity, municipalities have recognized the need to protect sensitive environmental features and their ecological functions, natural corridors and environmentally sensitive areas. The word *biodiversity* is often used to describe all the species living in a particular area, while ecosystem integrity is often referred to as the composition and abundance of native species and biological communities, rates of change and supporting processes.

As noted above, the natural environment on the DN site is complex and diverse and the Site Preparation and Construction phase works and activities may result in the loss of some bio-diversity on the DN site itself due to disturbance to species and habitat on the DN site. These include aquatic biota and VEC species that may be affected by lake infilling, some loss of cultural meadow ecosystem vegetation, loss of butterfly habitat, decreased population of some breeding birds on the DN site, loss of Bank Swallow habitat and some loss of landscape connectivity affecting wildlife travelling along the east-west corridor.

Once Site Preparation and Construction phase works and activities are completed and into the Operation and Maintenance phase, it is anticipated that much of the disturbance to habitats and species on the DN site may be restored through replanting, the creation of new wetland ponds, relocation of rare plant species onsite, and other remediation efforts. The loss of habitat for the Bank Swallow colony on the DN site during construction will be mitigated considering a variety of options (e.g., acquisition of lands that contain other Bank Swallow colonies for long-term protection and the development of artificial Bank Swallow habitat elsewhere on the DN site). These adverse effects do not occur in protected areas nor do they affect any species at risk. Effects on aquatic biota will be mitigated through fish habitat compensation. The temporary disruption to landscape connectivity across the DN site will be reversed following the completion of major construction activities. These site-specific restoration activities, although small and site specific in a regional context, are nevertheless a meaningful contribution to regional ecosystem integrity.

Should natural draft cooling towers be used, there may also be bird strike mortalities during the Operation and Maintenance phase. Overall, adverse effects do not occur in a protected area nor does the NND Project affect any species at risk. Over the long term and in the context of the RSA, the likely effects of the NND Project on the composition or abundance of native species, biological communities, rates of change and supporting processes are not likely to be measurable.

Greenhouse gas emissions to the atmospheric environment from the NND Project, as demonstrated in Section 6.2 are considered to be negligible in any given year (less that 0.1% of CO_2-eq emissions from Ontario Sources in 2005).

On balance and over the long term, the NND project as a whole is not likely to affect progress towards sustainability across the RSA. It is expected that the DN site's role in protecting biodiversity and ecosystem integrity can be ***maintained***.

6.1.3.1.3 Environmental Stewardship

The protection and enhancement of ecosystems is a shared responsibility among all levels of government, community groups and organizations, corporate and individual citizens. There is a need for all stakeholders to become more environmentally aware, participate and become engaged as partners in environmental initiatives within their communities.

OPG can safeguard the environment during both the construction and operations phases of this Project through the implementation of both in-design and other mitigation measures identified in Chapter 5 of this EIS. These measures include maintaining OPG's contribution to the community through its Corporate Citizenship Program and the ongoing delivery of its community, recreational, educational and biodiversity initiatives both on and off the DN site. As part of the NND Project, a Community Advisory Council may be formed to facilitate these initiatives and serve as a mechanism for citizens to become more environmentally aware, participate and become engaged as partners in OPG's environmental initiatives. Among the options being considered for mitigation of lost Bank Swallow habitat is the development of partnerships to undertake research into the decline of aerial foragers in Ontario, and integrate interpretive opportunities into on-site environmental initiatives.

Overall, OPG is committed to sustainability and reports annually on their progress towards sustainability and is committed to having an active and visible role in the community and community environmental stewardship. This Project may reinforce OPG's corporate commitment to environmental stewardship in the host community and surrounding region.

Through example, commitment and communication, OPG and the NND Project as a whole can be positive contributors to **enhanced** environmental stewardship across the regional study area.

6.1.3.1.4 Energy Conservation

Energy is a fundamental need in society today and promotion of energy conservation has emerged as an important sustainable development issue among most Ontario municipalities. Both the Region of Durham and the Municipality of Clarington seek to reduce per capita energy consumption.

Fundamentally, the NND Project is about energy generation and does not directly affect progress by the Province, municipalities and others aimed at energy conservation. As such, the project as a whole may ***maintain*** efforts towards sustainability through energy conservation.

6.1.3.1.5 Capacity of Renewable Resources

Renewable resource depletion, such as deforestation, over-fishing, soil degradation, and surface water and groundwater drawdown or contamination, changes to the earth's atmosphere and the loss of living resources (plants, animals) can cause long-term damage to eco-systems. Sustainability requires that the present generation ensure that the capacity of renewable resources can meet the needs of future generations.

Four renewable resources could be affected by the NND Project. These are surface water resources, fish, wildlife and terrestrial vegetation, and groundwater resources. A discussion of each of the four renewable resources that could be affected by the Project is provided below.

- Surface Water Resources

Surface water (i.e., Lake Ontario) serves as a natural source of drinking and service water for people and industry surrounding the DN site, and as a resource for both the aquatic and terrestrial environment. As a renewable resource for drinking and service water, surface water is directed to the Water Supply Plants (WSPs) taking water from Lake Ontario. The WSPs nearest to DN site are located in Oshawa (approximately 10 km west of the proposed NND discharge) and Bowmanville (approximately 4 km to the east of the proposed NND discharge). Under average annual conditions, measurable temperature effects due to the thermal plume for either once-through lake water cooling or cooling tower options, would not extend beyond the edge of the turbulent mixing zone (within approximately 50 m or 15 m of the discharge for once-through and cooling tower options, respectively). Therefore, adverse effects on water quality at WSPs are not expected as a result of thermal emissions. Similarly, the effects on water quality resulting from the influence of increased temperatures due to the NND thermal plume on biological activity and chemical activity are predicted to be small, with no effects on the ability to treat water for potable purposes.

With respect to surface radiological water quality, historical data demonstrates that all tritium concentrations measured in the RSA are below regulatory requirements. Overall, the concentrations of gross beta, which does not include tritium, measured from the WSPs and the surface water samples within the DN site are well below OPG's internal screening level. Gross beta concentrations are also within the range of expected concentrations that result from the presence of naturally occurring radionuclides and fallout from atmospheric nuclear weapons testing. Non-radiological effects from the Project on surface water (i.e., cooling tower blowdown, surface water runoff, changes to discharge and intake flowrates) are not expected to cause a measurable change within Lake Ontario.

Overall, no Project-related activities are expected to affect the sustainability of surface water as a renewable resource and therefore this aspect of the Project is expected to ***maintain*** progress towards sustainability.

- Aquatic Biota

Changes to the Aquatic Environment as a result of the Project may affect the aquatic biota, specifically the fish population and diversity which are identified as renewable resources. The assessment of non-radiological Project effects considered the possibility of localized effects on aquatic habitat (i.e., its usage by fish) associated with thermal and current velocity changes resulting from the operation of Condenser Circulating Water and Service Water Systems. No adverse effects for habitat usage due to changes to velocities within the NND intake and the thermal plume emanating from the NND diffuser were identified. Fish may be lost due to impingement and entrainment; however, the predominant species affected are round goby (an invasive species commonly found in the LSA), and alewife, although regional or Lake-wide population level effects on alewife are not predicted.

The assessment of radiological Project effects indicated that any discharges to the environment will meet regulatory water quality requirements and no effect to the aquatic environment is expected. Overall, it is unlikely that there will be any adverse effect on the sustainability of fish populations and diversity as a result of the Project. Moreover, there is currently no commercial fishery in the vicinity of the DN site that rely on this resource and no effects to the sport fishery were identified as a result of this Project and therefore this aspect of the Project is expected to ***maintain*** progress towards sustainability.

- Terrestrial Biota

Lake Ontario serves as a resource for waterfowl while the land (i.e., the DN site) supports vegetation communities and wildlife. As previously discussed, no likely Project-related adverse effects on Lake Ontario as a renewable resource are expected. Therefore, the sustainability of Lake Ontario as a renewable resource for waterfowl will likely not be affected by the Project.

During site preparation, the NND Project may result in losses to vegetation communities, including Cultural Meadow and Thicket ecosystem (approximately 113 ha), Wetland and Thicket

Ecosystem (approximately 17 ha) and loss of rare plant species (Shag-bark Hickory, Butternut, common Water Flax-seed, Cup Plant and Loesel's Twayblade). Restoration measures will be effective in addressing likely effects on vegetation communities and species to a degree; however, there will be a net loss of approximately 40 to 50 ha of mostly Cultural Meadow Ecosystem.

Gamma radiation (including contribution from radioactive waste) and atmospheric emissions (i.e., emissions to terrestrial vegetation) arising from the Project are not expected to have a measurable effect, nor is it likely that there will be any effect on the sustainability of vegetation communities and species or surface water resources and, subsequently, wildlife communities and species.

In the context of the amount of natural habitat available across the RSA, the long term sustainability of vegetation communities and species may not be affected but this loss may somewhat ***diminish*** progress towards sustainability.

- Groundwater

The NND Project may change groundwater flow on the DN site as a result of dewatering during construction and alterations to the existing topography and recharge/discharge conditions. The drawdown of groundwater levels is expected to be largely limited to the DN site, with a minor change in the shallow water on the St. Marys Cement property. Since the groundwater flow is toward Lake Ontario, groundwater supplies, in particular to local farms, are unlikely to be affected.

The stormwater management system during both construction and operation phases will collect stormwater which may contain contaminants. Industry standard stormwater management practices may be in effect such that changes in groundwater quality are not expected to represent an adverse effect in the geological and hydrogeological environment, as the DN site is downstream.

Emissions of tritium from the operation of DNGS have resulted in increased tritium concentrations in localised groundwater which are attributed to atmospheric washout or wet deposition of emissions from vents and stacks and subsequent infiltration into the groundwater system. The maximum measured tritium concentration in groundwater outside the Protected Area was approximately 500 Bq/L which is below regulatory levels. The analysis, presented for the Radiation and Radioactivity Environment (in Section 5.7) of potential radiological releases from the Project which may deposit on soil surfaces and transfer to groundwater determined that the Project is unlikely to adversely affect the Geological and Hydrogeological Environment. Overall, it is unlikely that there will be any effect on the sustainability of groundwater as a result of the Project and therefore this aspect of the Project is expected to ***maintain*** progress towards sustainability.

- Sustainable Resources Summary

On balance, the NND Project as a whole is not likely to affect progress towards sustainability across the RSA. As such, progress towards sustainability is ***maintained.***

6.1.3.2 Society

This Section considers the extent to which the NND Project contributes to progress towards achieving the following social vision and sustainability goal:

Community Vision:	*To encourage ongoing development of vibrant, safe, healthy and caring communities that provide current and future residents with a sense of satisfaction and pride as a place to live, work and play*
Sustainability Goal:	*To Promote Balanced Growth and Healthy Liveable Communities*

The sustainability assessment considers the RSA that was identified for the socio-economic component, but focuses specifically on the Region of Durham, the City of Oshawa and the Municipality of Clarington (i.e., the host municipality). The following discussion is based on the detailed description of existing socio-economic conditions and summary information contained in Chapter 4 of this EIS.

Over the next several decades, the host municipality and other areas of Durham Region are expected to continue to urbanize, with existing built-up areas becoming denser and more intensified. In the immediate area surrounding the DN site there is an ongoing transition from the "look and feel" of a rural area to a planned mix of light industrial and commercial land uses.

OPG and the DN site are major contributors to many local charitable and community groups and organizations both financially through corporate and employee donations and through in-kind support and involvement. For the most part, OPG's employees live and work in Durham Region and its neighbouring municipalities, contributing their time and personal financial resources to community activities.

There are several hundred community and recreational facilities throughout Durham Region, including community centres, churches, sports complexes/arenas, parks and conservation areas, museums and libraries. The DN site provides a regionally important contribution to community recreation and cohesion through its contribution to the waterfront trail, a unique fitness loop, and sports (e.g., soccer) fields. The biodiversity of the DN site attracts people for a variety of passive recreational activities such as wildlife viewing and bird watching. OPG runs several popular recreational and educations programs on the DN site.

Residents are also served by a broad range of health care, fire, police, emergency and social services. Despite population growth, most school boards report declining enrolment, however some growth in enrolment has been reported in the Municipality of Clarington and several municipalities in Durham Region.

Overall, public attitude research results indicate that in general, residents feel that they are healthy, safe and satisfied living in their communities, and have expressed a high level of confidence in ongoing operations at the DN site. There is a strong sense of belonging and most people feel that there is a common vision among residents in the LSA.

6.1.3.2.1 Balanced Development

Progress towards sustainability can be achieved in part through balanced development. This reflects a general desire on the part of Durham Region, the City of Oshawa and the Municipality of Clarington to sustain the existing rural-urban fabric by avoiding urban sprawl to the extent possible and balancing residential growth with employment growth. They have expressed desires to define, redevelop and grow within firm settlement boundaries, encouraging compact development, adopting smart growth principles and effective land use planning.

During both the Site Preparation and Construction and the Operation and Maintenance phases, the NND Project can contribute to the anticipated growth in population, housing, employment and Industrial, Commercial and Institutional (ICI) floor space across Durham Region and beyond. Nevertheless, the Project may represent a small fraction (i.e., generally between 3% to 4%) of local and regional population, housing stock, employment and ICI floor space; and project-related increases have been accounted for in local and regional forecasts. Over time, the influence of the NND Project in the context of the overall growth and development in the Region may diminish as a stable Operation and Maintenance phase workforce is established.

The NND Project will be constructed on an existing nuclear site designated for energy generation and will likely be a catalyst for economic development on surrounding employment lands, particularly within the proposed Clarington Energy Business Park west of the DN site. As such, it represents a strengthening of an existing, planned and growing industrial presence on the waterfront within the Municipality of Clarington.

The NND Project is not likely to interfere with municipal plans for balanced development nor cause urban sprawl. These outcomes are consistent with the Region's desire for compact development and sustaining the existing rural-urban fabric. Within the Municipality of Clarington, increased Project-related employment and the anticipated growth in the ICI sector may promote a greater balance between residential and employment growth.

On balance, the NND Project as a whole is not likely to affect progress towards sustainability across the RSA and is likely to ***enhance*** balanced development within the Municipality of Clarington.

6.1.3.2.2 Efficient Use of Infrastructure and Access to Services

Greater sustainability is achieved when more efficient use is made of infrastructure and residents have timely access to services. Within the RSA, efficient use of infrastructure and access to services is to be encouraged through the integration of land uses and phased development within compact urban areas. For example, the Municipality of Clarington has expressed its desire to extend public services and infrastructure in a cost-efficient and orderly manner, enhance public health and safety services.

Taking into account the identified mitigation measures, no residual adverse effects on transportation system operations or access to fire protection, policing, health and safety, social, recreational or educational services are anticipated during either the Site Preparation and Construction or the Operation and Maintenance phases. In the context of population growth and continued expansion of municipal infrastructure and services across the region, the increased direct and indirect demands on these services are likely to be measureable, but considered marginal such that noticeable adverse effects on the operation of the transportation system or access to services are not anticipated.

The NND Project may place additional direct and indirect demands on existing water, sewage and transportation infrastructure, but may represent a small fraction of the existing and planned capacities in these systems. The NND Project itself will connect to and rely upon municipal water and sewage systems, and existing transportation (i.e., road and rail) facilities rather than constructing new infrastructure. The only exception to this is the need for the construction of a new dedicated wharf on the DN site for the receipt of some oversize operating components. The proposed extension of sanitary sewage services onto the DN site provides an opportunity for the existing DNGS and future businesses locating on surrounding employment lands to connect to the municipal sewage system as well, thereby making more efficient use of existing infrastructure.

Finally, a large construction and operations workforce on the DN site and increased Project-related population present an opportunity for the expansion or extension of transit in the RSA by making such expansions or extensions potentially more feasible. Should transit providers (e.g., GO Transit, Municipality of Clarington) take advantage of this opportunity, a large number of people and communities could share in the benefits.

On balance, the NND Project as a whole is likely to ***enhance*** progress towards sustainability through the efficient use of infrastructure and access to services.

6.1.3.2.3 Live, Work and Play Communities

Healthy livable communities provide people with opportunities to live, work and play in the same community. This means sustaining and investing in such areas as recreation, education, arts and culture, affordable housing and encouraging balanced development (e.g., balancing residential growth with employment growth).

Fundamentally, the NND Project may increase the number of persons residing within the Municipality of Clarington that will work at the DN site or gain indirect employment, thereby promoting live, work and play communities. The Project may also generate additional property tax and other revenues from new residents and OPG that may serve as the means for sustaining and investing in the recreational and other assets of communities, particularly within the Municipality of Clarington. In addition, OPG may maintain its contribution to the community through its Corporate Citizenship Program and may continue to work with various stakeholders to deliver its community, recreational, educational and biodiversity initiatives.

On balance, the NND Project as a whole is not likely to affect progress towards sustainability across the regional study area, but is likely to ***enhance*** the potential for live, work and play communities within the Municipality of Clarington.

6.1.3.2.4 Community Pride and Identity

Healthy livable communities tend to generate a sense of pride among residents. There is the common desire on the part of Durham Region, the City of Oshawa and the Municipality of Clarington to foster a sense of place and identity among its residents, create and promote a positive image.

The NND Project will likely be a catalyst for increased local and regional economic development and the further development of the Durham Energy Industry Cluster through the establishment of new business operations that are involved in the nuclear service industry. To this end, the NND Project may promote the image of Durham Region, the Municipality of Clarington and the City of Oshawa as an economic engine for growth in the province and the country. The anticipated additional investments in Durham College and UOIT might play an important role in developing Durham's image as a leader in knowledge based industries.

On balance, the NND Project as a whole is not likely to affect progress towards sustainability across the RSA, but is likely to ***enhance*** community pride and identity of Durham Region, the Municipality of Clarington and the City of Oshawa.

Should natural draft cooling towers be required, there is a greater potential that community pride and identity might ***diminish.*** This is because the presence of natural draft cooling towers on the DN site during the Operation and Maintenance phase is anticipated to directly and adversely affect community character of the neighbourhoods in the vicinity of the DN site where the towers would be dominant features on the landscape. As such, the NND Project may adversely affect these residents more than others in the RSA.

The natural draft cooling towers and the presence of additional nuclear waste management facilities could also result in a negative effect on community image with the potential for stigma-related effects that could affect community pride should a stigma be attributed to the area. This is evidenced by some of the comments offered by public attitude research respondents found in the *Socio-Economic Assessment of Effects TSD*.

Overall however, any negative associations between the neighbouring communities and the NND Project are expected to diminish over time as the presence of cooling towers and associated vapour plumes become familiar features; and OPG continues to improve on its positive environmental and safety record that is well communicated to the public.

6.1.3.2.5 Personal Well-being

Healthy livable communities may promote the personal well-being of residents, including their physical, mental and social well-being that contribute to human health and quality of life.

As summarized in Section 5.13 of this EIS, the NND Project is not anticipated to adversely affect the physical, mental or social well-being of workers or members of the public during either the Site Preparation and Construction or the Operation and Maintenance phases. More specifically, public attitude research indicates that the vast majority of residents across the RSA do not anticipate a change in their feelings of personal health, their sense of personal safety or satisfaction with community as a result of the NND Project, either during the Site Preparation and Construction phase or during the Operation and Maintenance phase, nor are extreme or widespread changes in people's feelings of personal health, sense of personal safety or satisfaction with their community expected as a result of the NND Project.

Nevertheless, some residents living along the potential transportation haul routes to the DN site and those living in neighbourhoods from which natural draft cooling towers would be seen as prominent features on the landscape may experience reduced use and enjoyment of their private property. As such, the NND Project adversely affects DN site neighbours to a greater extent than others in the RSA.

Conversely, the NND Project may serve to promote the personal well-being of residents across the RSA through increased employment and business opportunities and higher levels of household income. Increased opportunities for the investment of additional tax and other revenues in community assets that contribute to human health and quality of life may also serve to improve personal well-being. To this end, the NND Project may result in opportunities for more people and communities to share project benefits.

On balance, the NND Project as a whole is likely to ***enhance*** the personal well-being of residents across the RSA.

6.1.3.3 Economy

This Section considers the extent to which the NND Project contributes to progress towards achieving the following economic vision and sustainability goal:

Community Vision:	*To promote economic development through employment and business growth, diversification of the skills base and fiscal health of municipalities in order to meet the needs of current and future residents*
Sustainability Goal:	*To Promote Economic Development*

The sustainability assessment considers the RSA that was identified for the socio-economic component of this EIS, but focuses specifically on the Region of Durham, the City of Oshawa and the Municipality of Clarington (i.e., the host municipality). The following discussion is based on the detailed description in the *Socio-Economic Existing Conditions TSD* and summary information contained in Chapter 4 of this EIS.

Along with the rest of the Greater Golden Horseshoe Area, the municipalities in Durham Region have experienced extensive population and economic growth over the past decade. Over the next several decades, the economy of Durham Region is expected to continue to mature, expand and diversify. With a focus on intensification to leverage existing infrastructure and services, Durham Region, the City of Oshawa and the Municipality of Clarington are currently developing plans for how they may manage this expected growth.

The two nuclear sites in Durham Region (i.e., the Pickering and Darlington sites) have been integral components of the region over the past decade and have contributed to their growth through the provision of employment. Within Clarington, the DN site represents about 80% of the industrial tax base and is critical to the keeping the residential to industrial tax ratio in balance and thus limiting the tax burden on residential property owners. Beyond Durham, there are nuclear fuel processing facilities in Port Hope, and a major nuclear equipment and nuclear fuel manufacturing facility in Peterborough. To this end, Durham Region envisages itself becoming a "Centre of Excellence" in nuclear generation and energy; building on all facets of the energy chain and its linkages to transportation, advanced manufacturing and energy efficient equipment.

Since 1996, employment in the manufacturing sector has decreased while employment in the construction sector has increased across the RSA. Although the current economic downturn has exacerbated problems in both the manufacturing and construction sectors, upon recovery, shortages of skilled labour, particularly in the construction sector are expected to persist into the foreseeable future.

6.1.3.3.1 New Job Opportunities

The promotion of economic development requires that existing jobs are retained and new job opportunities are created. Municipalities within the RSA desire higher–than-average incomes, low unemployment rates and knowledge based opportunities. The Municipality of Clarington seeks to have one job for every three residents.

The NND Project may promote economic development through job creation during both the Site Preparation and Construction phase and the Operation and Maintenance phase. Moreover, work in the nuclear sector involves staff that must be highly skilled, and must possess a wider array of skills than employees in many other utilities and industrial sectors. For example, OPG's operations workforce is comprised of engineers, scientists, other professional staff, and skilled tradespeople. Approximately 73% of OPG's staff require post secondary education to perform their jobs. For the majority of these, two or more years of community college or a university degree are required, and this education ranges from skilled technician or technologist training, to advanced university degrees in fields such as engineering and finance. As such, the NND Project may serve to retain and attract highly skilled workers to the RSA. Because these highly skilled staff are in high demand across the country, and OPG must compete for these employees with other private generators and energy service organizations as well as the general marketplace, competitive salaries will be an important consideration. As such, it can be expected that higher than average incomes may be derived from the NND Project.

In addition, the duration of the NND Project itself indicates that the project has the potential to generate a substantial number of new certified tradespeople that would be available for the Project itself and/or Ontario's construction labour market subsequently.

With respect to the Municipality of Clarington's desire to have one job for every three residents, current population and employment projections indicate that this goal will likely be achieved prior to 2025 when all four reactor units would be in operation. To this end, the NND Project may enhance progress towards achieving Clarington's desired population to employment ratio.

On balance, the NND Project as a whole is likely to ***enhance*** the economic development objective through the creation of new job opportunities.

6.1.3.3.2 Business Retention, Expansion and Creation

Within the RSA, municipalities intend to promote economic development by creating the conditions that help retain existing businesses, support their expansion, attract and create new businesses. This is currently being achieved in a number of ways, including the provision of high quality industrial lands, maintaining a skilled workforce, competitive tax regimes and generally promoting their municipalities in key economic sectors such as energy, advanced manufacturing, bioscience and agriculture and information technology.

The NND Project is likely to result in the creation of new business activity and opportunities. This positive effect is largely due to increased spending associated with households, directly or indirectly associated with the NND Project employment, and increased Project expenditures of goods and services during the Site Preparation and Construction phase and the Operation and Maintenance phase. Positive effects will likely be experienced by commercial retail and service business operators, across Durham Region and the City of Oshawa and the Municipality of Clarington in particular. Not only will businesses involved in the nuclear service industry benefit, but other businesses including: operators providing commodities and services associated with major construction projects (Site Preparation and Construction phase); business operators involved in the wholesale and retail trade; manufacturing; professional and technical services; and management, administration and support service sectors (Operation and Maintenance phase) are also likely to share in project benefits.

On balance, the NND Project as a whole is likely to ***enhance*** the economic development objective through business retention, expansion and creation in the RSA.

6.1.3.3.3 Durham as an Energy Hub

Many area municipalities within Durham Region have indicated, in their official plans and strategies, the desire for the area to be an energy hub. Going forward this requires a focus on energy-related projects to help build Durham's reputation as a leader in the energy sector. The two existing nuclear stations at Darlington and Pickering, along with the energy-focused programs at the UOIT and the Clarington Energy Business Park all underscore the Region's interest and commitment to energy.

The NND Project may contribute to and ***enhance*** Durham's stature as an energy hub. It may further the Region's goal to implement energy-related projects and provide opportunities for the development of affiliated businesses and training opportunities.

6.1.3.3.4 Diversification of the Skills Base

The promotion of economic development requires a diverse skills base. This means retaining and attracting an educated, highly skilled and experienced workforce, supporting training and education programs and services.

It is expected that the NND Project may serve to maintain the skilled employment base of the RSA's energy sector in the short term and contribute to the expansion of the skills base over the long term. These positive effects may likely be experienced to the greatest extent by electricity sector workers, business operations involved in the energy sector and the nuclear service industry in particular. Durham Region, the Municipality of Clarington and the City of Oshawa may also benefit the most given that their economic development initiatives have been focused on the energy sector for several years.

As noted above, the NND Project is likely to generate a substantial number of new certified tradespeople available for the Project itself and/or Ontario's construction labour market subsequently. Positive effects will likely be experienced across Ontario by individuals entering the workforce and others seeking training and employment opportunities, Ontario's electricity and construction sector employers, and Ontario's electricity and construction sector labour organizations.

The NND Project is expected to be a catalyst for increased enrolment in specialized post secondary educational programs across Ontario and the RSA in particular. Post-secondary educational institutions offering educational programs that provide energy or nuclear related degrees or certificates and Ontario-wide post secondary educational institutions offering training programs that support certification in a skilled trade will likely benefit the most. Durham College / University of Ontario Institute of Technology are likely to benefit the most from the NND Project given their academic focus, proximity to the DN site and ongoing relationships with OPG.

On balance, the NND Project as a whole is likely to ***enhance*** the economic development objective through the diversification of the skills base in the RSA.

6.1.3.3.5 Healthy Municipal Finance

The promotion of economic development requires municipalities that are financially sound and can generate new revenues in a timely manner and attract investment by offering competitive tax rates, maintaining positive credit ratings and manageable debt levels.

The NND Project may directly result in increased tax and other revenues to the Municipality of Clarington. In addition to the taxes paid on new buildings and structures, it is anticipated that OPG may pay its share of development charges to support the construction of new Project-related infrastructure. Similarly, building permit fees from the NND Project may also be a source of additional revenue to the Municipality of Clarington. For a project of this magnitude, revenues from development charges and building permit fees could amount to several millions of dollars. Development charge revenues would be shared between the Municipality of Clarington and Durham Region, while building permit fees would be retained by the Municipality of Clarington.

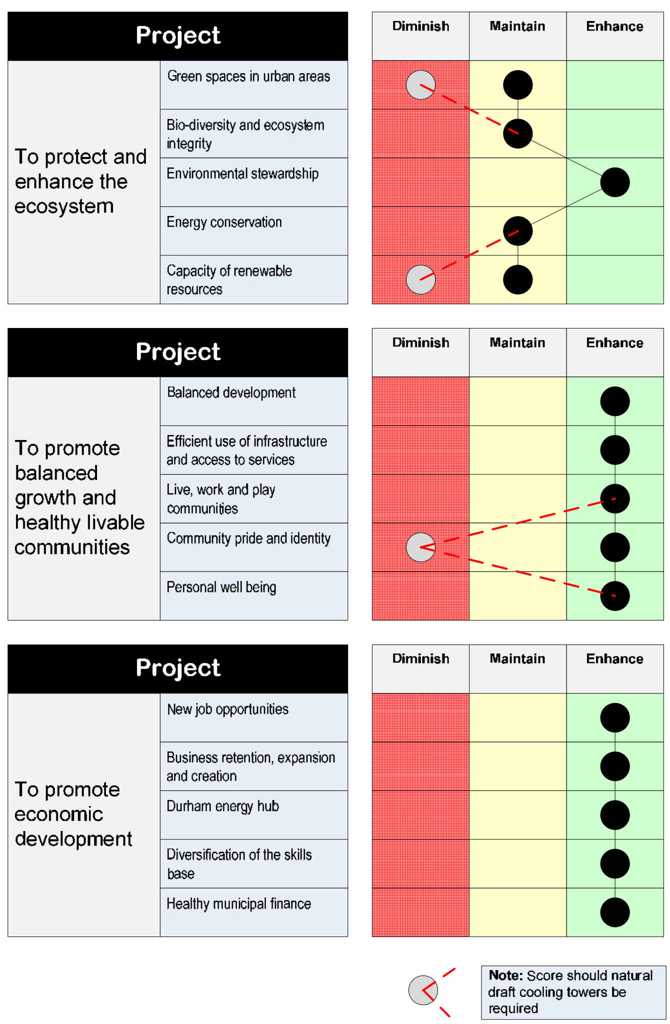
The NND Project may indirectly result in increased tax revenues from households that are linked to the NND Project. This latter positive effect might occur during both the Site Preparation and Construction phase and the Operation and Maintenance phase in all municipalities experiencing NND Project related population growth. While some municipalities may face some fiscal challenges in funding infrastructure in the short term, Durham Region and the Municipality of Clarington will likely benefit the most over the long term due to the additional direct property tax and other revenues generated in relation to the Project.

Overall, the new revenues generated by the NND Project may provide RSA municipalities with new opportunities to make investments that support their sustainable development initiatives and/or relieve current debt burdens to allow future generations to make their desired investments in a more certain fiscal context. As such, the NND Project is likely to ***enhance*** the economic development objective by contributing to the financial health of RSA municipalities.

6.1.4 Scorecard and Summary

Figure 6.1-2 summarizes the results of the sustainability assessment in the form of a "scorecard" for the NND Project as a whole. This scorecard is considered to be a planning tool that may allow OPG and its stakeholders to measure and track the implications of the NND Project on sustainability over the course of its implementation.

FIGURE 6.1-2
Sustainability Scorecard



Examining the NND Project as a whole from ecological, social and economic perspectives, this scorecard indicates that on balance, the Project can enhance progress towards sustainability largely through economic and social means, while not diminishing overall progress from an ecological perspective. Nevertheless, the NND Project is likely to have a greater adverse effect on progress towards sustainable development should natural draft cooling towers be required.

6.2 Likely Effects of the Environment on the Project

The EIS Guidelines (Section 11.4.9) require that consideration be given to how the environment could adversely affect the NND Project. This assessment was carried out as an evaluation of how severe weather conditions and other environmental events may interact with, and potentially alter the condition and function of the Project such that there would be resultant effects on the environment or human health and safety. The approach to the assessment of the effects of the environment on the Project involved:

- Identifying and describing those environmental conditions (i.e., events) with a reasonable probability of occurring and that have potential to affect the Project, including associated hazards to workers or the public;

- Describing the features of the Project design and operation, including contingency measures, that are intended to resist or safely withstand the likely effects of natural hazards; and

- Describing and assessing the significance of any likely effects on the Project, including hazards to workers and the public (if any).

Additional discussion of potential effects of the environment on the Project with respect to Malfunctions, Accidents and Malevolent Acts is provided in Chapter 7.

Table 6.2-1 identifies the potential conditions in the environment that may affect the Project and its principal component(s). Potential conditions arise from two major aspects of the environment: the physical environment (i.e., natural hazards) and the biophysical environment (i.e., natural conditions). The physical environment encompasses natural physical phenomena on land, in bodies of water and in the atmosphere. The biophysical environment encompasses living organisms that inhabit the physical environment.

TABLE 6.2-1
Potential Environmental Conditions and Interference with the Project

Potential Environmental Condition	Principal Affected Component(s) of the Project
Flooding	• Shoreline works • Integrity and function of external structures and systems: o Electrical power systems o Power block o Ancillary facilities • Stormwater management system
Severe Weather	• Integrity and function of external structures and systems o Electrical power systems o Power block o Ancillary facilities
Biophysical Environment - Zebra and Quagga Mussels - Attached Algae - Fish - Ice - Sediment	• Water systems o Condenser circulating water system (including intake structure) o Service water system
Seismicity	• Systems critical to safe plant shutdown o Safety and related systems o Electrical power systems
Climate Change	• Integrity and function of external structures and systems o Electric power systems o Power block o Ancillary facilities • Water systems o Condenser circulating water system o Service water system • Stormwater management system

The conditions included in Table 6.2-1 are based on experience of past effects that have occurred at DNGS, including the effects of zebra and quagga mussels and attached algae. Environmental conditions that may adversely affect the Project, but which have not actually substantially affected DNGS in the past, such as flooding, extreme changes in lake water levels, severe weather, seismic events, and climate change are also considered.

Flooding and severe weather are assumed to primarily affect external structures, systems and buildings. The likely effects of seismic events are considered in relation to systems critical to safe station shutdown following a seismic event, for reasons discussed below. Each natural hazard and potential environmental condition, and likely project interference, is described in the following subsections along with relevant project design features and contingency measures. Considering these, the likely effect on the Project of such conditions, and the need for further mitigation and the significance of residual effects (if any) are assessed.

A more detailed analysis of the potential effects of climate change is provided in Section 6.4.

6.2.1 Flooding

Flooding can potentially affect the integrity and function of external structures and systems, therefore a flood hazard assessment of the DN site was undertaken. OPG commissioned a flood hazard assessment for the DN site (OPG 2009d) meeting the requirements of IAEA Safety Guide NS-G-3.5 *Flood Hazard for Nuclear Power Plants on Coastal and River Sites* and CNSC RD-346, *Site Evaluation for New Nuclear Power Plants*. Three sources of potential flood risk to the DN site were identified as coastal flooding, on-site or near-by watercourse flooding and direct surface runoff. Other potential flooding hazards such as lake ice, river ice/debris jamming, landslides or avalanche, and combined events were also evaluated in the flood hazard assessment.

6.2.1.1 Coastal Flooding

The coastal flood hazard assessment considers potential high water levels combined with other physical effects such as storm surge, seiche (rises and drops in Great Lakes coastal water levels caused by prolonged strong winds that push water toward one side of the lake, causing the water level to rise on the downwind side of the lake and to drop on the upwind side), wind wave, and other lake-related physical causes. However, Lake Ontario water levels are regulated to reduce damage along the shores of the Lake and the St. Lawrence River. This control of water levels (since 1962) reduces the range of occurrence of extreme lake levels.

The mean Lake Ontario water level is 74.2 m IGLD (International Great Lakes Datum). The flood hazard assessment presented in OPG 2009d considered the results from a study by the International Joint Commission (IJC) as well as the historical record (International Lake Ontario - St. Lawrence River Study Board 2006). The IJC study considered different management options for lake level control and includes robust modeling of potential future levels under a range of hydrological and meteorological conditions (including climate change). The flood hazard assessment identifies a 1 in 100 year water level of 75.6 m IGLD and a 1 in 500 year water level of approximately 76.6 m.

Hydrodynamic modelling of Lake Ontario for a range of severe weather conditions was included in the flood hazard assessment to estimate potential wave uprush and wave overtopping along the shoreline. The analysis showed that for a 1 in 100 year water level (75.6 m IGLD) plus an estimated maximum storm surge (0.75 m), depending on the lake infill scenario, wave uprush estimates range from 3.5 m to 11.3 m.

Design and Contingency Measures

The design of the shoreline protection will consider the results of the flood hazard assessment to ensure adequate protection of the nearshore structures over the life of the Project. Considering the mitigation that will be applied there is no residual effect of flooding from coastal flooding of NND.

6.2.1.2 Nearby Watercourse Flooding

The DN site is effectively enclosed by two watersheds; Tooley Creek to the west and Darlington Creek to the east (see Figure 4.3-3). The eastern boundary of the Tooley Creek watershed runs along Solina Rd. (essentially the western boundary of the DN site). The discharge point of the Tooley Creek watershed is approximately 4 km west of the NND site. The flood hazard assessment (OPG 2009d) concluded that the distance, infrastructure and topography between the Tooley Creek watershed and the DN site precludes it as a source of flood hazard for the NND.

The Darlington Creek watershed extends to the north and east of the DN site, traversing the St. Marys Cement site both north and south of the CNR railway tracks. The Darlington Creek watershed is the only riverine system in close proximity to the site. The flood hazard assessment reports that there has been no history of severe flooding on Darlington Creek. The NND site is currently protected from flooding of Darlington Creek due to the height of the land which acts as a natural earthen barrier to separate the site from the creek.

The flood hazard assessment included hydraulic modelling of Darlington Creek to determine whether it could affect the site under a Probable Maximum Flood (PMF) condition. The PMF is*"… the flood that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in a particular drainage area"* (OPG 2009d). The PMF flood is a result of a Probable Maximum Precipitation (PMP) event. The PMP is defined as *"the greatest depth of precipitation for a given duration meteorologically possible for a given size storm area at a particular location at a particular time of year, with no allowance made for long-term climatic trends"* (OPG 2009d). The 12-hour PMP precipitation (420 mm rain in 12 hours) was used to analyze the potential impacts of runoff related flood hazards for the NND site.

For all scenarios modelled, the peak PMF flood stage in Darlington Creek is 15.8 m below the height of land separating Darlington Creek from the NND build area, assuming the earthen barrier remains as part of the final design. The flood hazard assessment also evaluated the potential of a debris or ice jam of the CNR culvert. It was determined that during a PMF event with a fully blocked culvert under the CNR railroad crossing there would be no site flood hazard.

It is concluded that there is no flood hazard associated with Darlington Creek, even under peak PMF conditions.

6.2.1.3 Direct Surface Runoff

The flood hazard assessment included a modelling assessment of the flood potential of the model plant layouts presented in Chapter 2. The analysis illustrated that for the PMF, there is a flood hazard potential for the site.

Design and Contingency Measures

Potential flood hazard will be mitigated by engineered features incorporated into the Project as it is constructed. These features will be identified during the Project detailed design phase. Mitigation such as a perimeter berm/ditch system can be designed to redirect flow from the site to a storm water management pond, and ultimately to Lake Ontario. The stormwater management system will be designed to meet the requirements of the National Building Code applicable at the time of construction. This will mitigate the potential effects of flooding due to direct surface runoff. As mitigation is available, there is no residual effect of flooding from direct surface runoff for NND.

6.2.1.4 Other Flooding Hazards

The flood hazard assessment also provides an evaluation of other potential flood hazards such as lake ice, landslides or avalanche, and tsunami. The findings of the assessment in this respect are as follows:

- The Darlington region of Lake Ontario is on average, ice-free year round. While ice can occasionally form in the vicinity of the DN site, it was determined that it does not create or worsen any coastal flooding hazards. Therefore there is no risk of flooding or effects to the water intake systems due to lake ice for NND; and

- There are no man-made water retaining structures within the Darlington Creek watershed or local site watersheds. Therefore, there are no flood hazards associated with the failure of man-made water retaining structures;

The flood threat due to either a landslide or avalanche at the site is minimal, and there is no potential for distant or local tsunamis effects at the DN site.

6.2.2 Severe Weather

Severe weather can potentially affect the integrity and function of external structures and systems at NND. OPG commissioned an evaluation of meteorological events (OPG 2009e) meeting the requirements of IAEA Safety Guide NS-G-3.4 *Meteorological Events in Site Evaluation for Nuclear Power Plants*. This evaluation provides a discussion of the local climate influences at the DN site, a meteorological hazard assessment, extreme value analysis, and a discussion of the modification of meteorological events with time, primarily related to climate change.

The following discussion provides an overview of the results of the discussion of rare meteorological hazards including tornadoes, tropical cyclones, thunderstorms and hailstorms, and freezing rain, and the potential effects of these hazards to NND.

6.2.2.1 Meteorological Hazard Assessment - Extreme Value Analysis

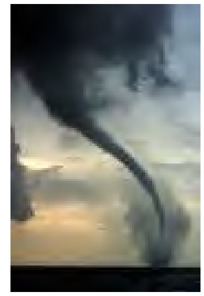
Table 6.2-2 provides a summary of the results of the meteorological events evaluation – Extreme Value Analysis. These data will be used by the facility designers.

TABLE 6.2-2
Meteorological Hazard Assessment – Extreme Value Analysis

Parameter	Return Period (years)				
	10	25	50	100	200
Temperature (°C)[1]					
Min	-25.2	-27.6	-29.4	-31.2	-33.0
Max	36.3	38.1	39.5	40.9	42.3
Wind Speed (km/h)[2]	55	58	61	64	67
Precipitation (mm)[1]	64	73.9	81.3	88.6	95.8
Snow Pack (cm)[3]	40	49	56	62	69

[1] Based on Oshawa data (maximum in one day)
[2] Based on DN site data – 10 m tower
[3] Based on Toronto Pearson data

6.2.2.2 Tornadoes



The distribution of tornadoes, particularly in Ontario, appears to be random and extremely localized. A tornado usually affects a limited area and only for a short period of time; however, serious property damage and injury, including fatalities, may occur along its path. A few tornadoes or funnel clouds (tornadoes that do not reach the ground) are confirmed each year in southern Ontario. In the RSA, one tornado per 10,000 km^2 can be expected annually (Environment Canada 2008). The area of the RSA is approximately 850 km^2; therefore, approximately one tornado every 12 years may be expected. The DN site is approximately 4.85 km^2; therefore, one tornado in approximately 2,000 years may be expected.

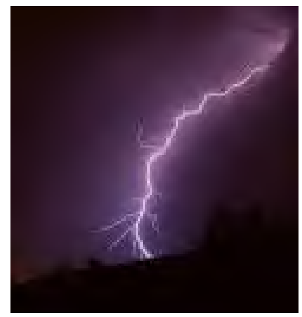
The meteorological events evaluation (OPG 2009e) includes a conservative estimate of the probability of tornado damage to the DN site for the purpose of developing a design basis tornado. Tornadoes in Canada are ranked using the Fujita scale which is a measure of both wind speed and damage (an F0 event involves wind speeds of 64-116 km/hr; an F5 event involves wind speeds of 418-509 km/hr). The probability was estimated based on the tornado frequency within a 180 km radius of the DN site. There have not been any F5 tornados within 180 km of the DN site.

In the event of a tornado, damage to the NND reactor buildings is unlikely due to the robust construction. The reactor buildings are built to withstand winds in excess of 360 km/h. Damage to other buildings on the DN site, including the used fuel dry storage facilities, might occur as a result of strong winds, rapid pressure change, tornado-generated projectiles and/or the collapse of other structures or buildings. Various operational and safety systems could be compromised by building damage and/or power outages. Although on-site road systems might be damaged or obstructed, neither tornadoes nor missiles generated by them can cause significant damage to the used fuel storage containers or the used fuel within them.

6.2.2.3 Tropical Cyclones

The meteorological events evaluation (OPG 2009e) provides a discussion of the potential risk at the DN site due to tropical cyclones (i.e. hurricanes). Tropical cyclone activity at the DN site is rare due to the large distance from the Atlantic Ocean. Approximately one storm of tropical origin passes within 400 km of the site every 3 to 4 years. Typically, tropical cyclones tracking toward Ontario weaken in intensity, but can still result in high rainfalls and gusty winds. In the case of Hurricane Hazel in 1954, the tropical storm re-intensified before tracking over Southern Ontario, resulting in high winds and exceptionally high rainfall. The meteorological events evaluation indicates that a Hurricane Hazel-like storm would approximate a worst case scenario from systems of tropical origin. The maximum rainfall recorded for Hurricane Hazel was approximately 178 mm over 24 hours, and the National Building Code specifies the appropriate design requirement for such an event. The stormwater management system will be designed to meet the National Building Code applicable at the time of construction. Therefore, the design and contingency measures identified in Section 6.2.1.3 for direct surface run-off would also accommodate the worst case storm from tropical origins.

6.2.2.4 Thunderstorms and Hail Storms



Thunderstorms and hail storms are more frequent occurrences than tornadoes; however, they are less damaging. Thunderstorms are more common during the warmer months of the year (May to September). They usually occur as a result of convective instability in a humid atmosphere or as a result of the passage of warm or cold fronts. Typically, thunderstorms are of short duration (e.g., 30 minutes), but during this time they can briefly produce very strong winds (50 km/hour or more) and torrential rain (5-10 cm/hour or more). Damaging hail can sometimes accompany severe thunderstorms.

For the period 1971-2000, the data from Pearson International Airport in Toronto and Trenton Airport indicates that there are, on average, 28-30 thunderstorms per year and 1 hail storm per year along the north shore of Lake Ontario (Environment Canada 2008). Lightning is a common characteristic of thunderstorms that can cause serious damage to structures. The meteorological events evaluation (OPG 2009e) estimates that in the vicinity of the DN site there are two to three cloud to ground flashes per year per km^2.

Thunderstorms and hail storms can result in damage to external structures, buildings and systems directly through high winds, heavy rain and lightning. Operational and safety systems can be affected by power outages. However, as noted above, the structures associated with NND will be designed and constructed so as to resist damage resulting from even extreme weather-related events; and emergency power systems will be included in the Project to consider power outages.

6.2.2.5 Freezing Rain

Ice storms are caused when the atmosphere is layered, with a layer of warm air above the denser cold air near the surface. As precipitation falls in the warm layer, rain forms. The rain then falls into the shallow cold layer and freezes on contact with the surface. Ice storms can damage light structures such as power transmission lines because of the weight of accumulated ice.

Ice storms are known to occur in Eastern Ontario and Quebec, and may occur in Southern Ontario around the DN site. On average, Ottawa and Montreal receive freezing precipitation 12 to 17 days a year. However, this type of precipitation generally lasts only a few hours. In January 1998, a severe ice storm occurred in Eastern Ontario and Quebec; over 90 mm of freezing drizzle fell during the five-day storm. The January 1998 ice storm caused significant damage to transmission lines and sub-transmission systems. The NND safety systems will be designed to withstand a storm-induced loss of grid. It has been estimated that an event involving up to 20 mm of freezing rain may be expected over the operating life of the Project, with a possibility of an event of up to 40 mm of freezing rain (Ontario Hydro 1998b).

6.2.2.6 Design and Contingency Measures

Structures at DNGS have been exposed to various weather conditions for approximately 20 years and no significant damage to the station structures has occurred during this period. It is particularly noted that the January 1998 ice storm did not damage any of the components necessary for generating power. The design of NND external structures will be similarly robust. In addition, equipment redundancy and diversity will reduce any potential effects. Therefore, if severe weather occurred at NND, no significant damage would be anticipated.

No further contingency measures are required to supplement the existing design and mitigation features that will be in place to withstand severe weather. The potential for severe weather requires no further consideration since no effects on the Project are likely.

6.2.3 Biophysical Effects

6.2.3.1 Zebra and Quagga Mussels

At many sites on the Great Lakes, nuisance mussels now include the zebra mussel, *Dreissena polymorpha*, and the quagga mussel, *Dreissena bugensis*. Both species are similar in size but differ primarily in how they attach to substrate, and the temperatures at which reproduction occurs (Claudi and Leach 2000).

Without appropriate control in raw water systems, these mussels generally lead to fouling of virtually all solid substrates. Within a growing season, densities of adult mussels may reach a few thousand to several hundred thousand per square meter of surface area. If uncontrolled, mussels may lead to restricted flow or blockage in piping and strainers, reduced heat transfer, failure of critical equipment, and potential outages. Such problems are more likely to occur in areas of low water flow most common in service water systems. Experimental and casual field observations indicate that settlement of mussels is precluded only when continuous flow rates are in excess of about 1 to 2 m/s.

Zebra mussels are a non-native species that was inadvertently introduced to North America during the mid-1980s in the ballast water of ocean-going ships (Nelepa and Schloesser 1993). In 1989 (former) Ontario Hydro recognized that zebra mussels could interfere with operation of their generating stations located on the Great Lakes and began studies in 1990 (Wiancko 1999). Since then, zebra mussels have rapidly colonized Lake Ontario, their huge population profoundly affecting some fish and invertebrate species and the nutrient distribution and food-web patterns of the lake. Unlike native freshwater mussels, adult zebra and quagga mussels are not free-moving, but live attached to rocks and other solid substrates, including built structures.

During their reproductive season, typically in the spring, summer and/or autumn, large numbers of zebra and quagga mussel larvae are present in Lake Ontario. The free-floating, planktonic larvae are drawn in with lake water and can attach themselves to water intake structures and the inside of pipes and other equipment through which lake water is circulated. Attachment is a function of several parameters which include flow rate, light levels, and food supply. Their establishment and growth within NND systems could, if unchecked, eventually restrict or block water flow and may interfere with mechanical operation of equipment such as valves.

DNGS began monitoring for zebra mussels in 1999 and has identified mussel growth on portions of the water intake structures. Consequently, a semi-continuous chlorination program is in place to reduce infestation into the station. Inspection and cleaning strategies of the DNGS existing intake structure are currently in place to control mussel colonization. The intake structure is inspected on an annual basis and 1/3 of the porous modules are cleaned each year in a 3-year cycle. Cleaning typically occurs between April and July.

Design and Contingency Measures

OPG stations currently use continuous or intermittent sodium hypochlorite injection strategies to control mussel growth within pipes and other equipment through which lake water circulates. This will likely continue to be a control strategy for the NND. The mussel control system will likely be located at the NND screenhouse. At PNGS and DNGS, injection usually takes place from June to November. The sodium hypochlorite solution is injected continuously in the pumpwells of the service water pumps. The total chlorine residual in the station outfall at the property limit is maintained at or below 0.01 ppm, as required by the MOE. In the screenhouse, the problem of zebra and quagga mussels and/or empty shells accumulating in sumps can be adequately addressed by monitoring and periodic removal using vacuum trucks.

Mussels can also attach to the intake structures, which can ultimately block the structure. This can be mitigated by periodically scraping the mussels off the structure. Alternatively, biofouling resistant coated inserts on intake structure/forebay walls could be installed to mitigate biofouling associated with mussel attachment. These coatings may have to be reapplied periodically. Another potential option is to extend the intake into much deeper water, where light penetration is reduced, limiting the plankton food source and therefore the mussel populations. However there are practical limitations to the depth of the intake structure.

It is reasonably expected that mussel management strategies currently in place at other OPG facilities (e.g., PNGS, DNGS) or similar, will also be applied for NND operations, and that these can be configured as necessary to consider either once-through lakewater or cooling tower options. No further contingency measures are required to supplement the existing design and mitigation features that will be in place to resist fouling, as no other effects on the Project are expected from zebra or quagga mussels.

6.2.3.2 Attached Algae

Filamentous attached algae grow in great abundance on rocks and other hard surfaces along the Lake Ontario shoreline and on rocky substrates on the bottom of the lake. The most relevant species to NND is *Cladophora* which is a filamentous green algae that grows attached to hard surfaces within the littoral zone.

The Lake Ontario shoreline in the vicinity of the DN site provides an excellent growth environment for *Cladophora*. Local watercourses and storm drains are also sources of nutrients. The anticipated urban growth will result in increased runoff in the local watersheds over the next 30 years. This in turn will increase the relative contribution of runoff nutrients and warm water to the effluent pathways to Lake Ontario.

Due to the location of the lake infill adjacent to the St. Marys Cement property, current patterns in the nearshore may be altered. These changes may result in reduced water circulation and increased water temperature at the eastern end of the proposed lake infill. This area also receives inflow from Darlington Creek that has been previously noted to contain relatively high concentrations of nutrients. These conditions may be conducive to enhanced algal growth, possibly to nuisance levels locally.

During mid-summer and fall, *Cladophora* senesces, sloughs off their substrate and drifts with waves and currents before washing ashore (Harris 2004). When detached, these algae form "balls" which can travel long distances. While there have been issues with algae at PNGS, because of the design of the intake structure at DNGS, the algae problem is infrequent. There is attached algae growing on the intake cap at DNGS along with zebra mussels. In addition, depending on wind and current conditions, shoreline algae can move offshore and become entrained within the DNGS intake structure. Water supply problems due to plugging of screening equipment and strainers are infrequent due to the design of the DNGS intake structure. The design of the NND intake structure for once-through cooling will be similar to DNGS, so a similar effect is expected. If the screens are operated and maintained properly, entrainment of a small amount of algae is unlikely to affect the Project.

Design and Contingency Measures

To prevent blockage of water flow, routine cleaning of the intake structure ports is required similar to that described above for zebra mussels. Other measures which can be implemented include cleaning bar racks with automatic mechanical rakes and / or high-pressure water to wash the travelling screens of accumulated plant and other material. Similar to zebra mussel control, a coated insert could also be placed over the intake structure ports to reduce attachment.

Considering the contingency measures, the potential for effects from attached algae on the Project requires no further consideration.

6.2.3.3 Fish

DNGS was the first OPG station where fish protection issues were considered in the decision-making process for both design and shoreline location of the intake. Consequently, fish impingement at DNGS is quite small relative to similar sized stations with conventional intakes due to the design of the intake structure. The NND will utilize a similar intake structure for once-through cooling water. For the cooling tower intake, the structure may be different; however the impingement of fish would be no worse than for once-through cooling. The current fish impingement at DNGS does not adversely affect the station. For the NND Project fish impingement is not expected to affect the operation of the NND station.

6.2.3.4 Ice

The flood hazard assessment (OPG 2009d) describes the ice regime in Lake Ontario near NND. On average, Lake Ontario in the vicinity of the DN site is ice-free year round. The 30-year median of ice near NND is new lake ice which has a thickness of less than 5 cm. Since the NND intake would be in approximately 10 m of water, it is not expected that ice will affect water intake for the station.

Frazil ice can occur when the water temperature is below its freezing temperature (i.e. supercooled). This condition is associated with open water, low air temperatures and clear nights. It is also associated with strong winds, which increase the rate of heat loss at the water surface and may provide the turbulence that can mix the supercooled water to the depth of the intake. DNGS has a frazil ice protection system which prevents the formation of frazil ice on the bar screens and on the travelling water screens. This system is capable of maintaining the temperature in the forebay to a minimum water temperature of 1^{o}C during the winter. There are several mitigation measures available to minimize the occurrence of frazil ice formation, including a system similar to that used at DNGS.

6.2.3.5 Silt

The *Aquatic Environment Existing Environmental Conditions TSD* indicates that fine sediments in nearshore Lake Ontario are patchy and thin such that sandy substrates are limited to sporadic occurrences at the 3 to 4-m depth. This was observed during the EA field studies conducted in 2008. Silty organic sediments are almost absent. The sandy and silty organic sediments are more prevalent in the relatively protected area along the St. Marys Cement wharf.

The *Surface Water Environment Existing Environmental Conditions TSD* reports on studies conducted at the DN site in the early and mid 1990s which suggest that a substantial amount of sediment is deflected offshore into deeper water at the St. Marys wharf and it is unlikely that a substantial amount of these sediments remain in suspension long enough to be transported back to the down-current shore areas. These studies also state that the turbulence created by the DNGS discharge diffuser ports is believed to have resulted in scouring of substrates in the immediate vicinity. Further, there is only a limited supply of these fine substrates from the land, resulting in a sediment-deficient shoreline.

These observations indicate that silt accumulation in the vicinity of the NND intake structure is unlikely to affect the station.

6.3 Seismicity

The following discussion of regional and local seismic hazards and related potential effects on the NND Project has been summarized from a more detailed evaluation of the DN site conducted during 2008-2009 (OPG 2009a). That evaluation includes information related to recent updating of a previous probabilistic seismic hazard assessment (PSHA) (OPG 2009h).

6.3.1 Regional Geological Structure and Tectonic History

The DN site lies within the western Lake Ontario region in the tectonically stable interior of the North American continent, which has been characterized by low rates of seismicity (OPG 2009a). As illustrated in Figure 6.3-1, the entire southern Ontario region is underlain by a broad Precambrian basement rock formation of the middle Proterozoic era (greater than 610 million years old) and overlying shallow-water sedimentary rock strata of the Paleozoic era (greater than 290 million years old). This broad basement rock formation, referred to as the "Grenville Province", extends northeast and south beyond southern Ontario. More locally, the region around the DN site is underlain by the Central Metasedimentary Belt, a zone of heavily metamorphosed sedimentary rock formed less than 1,300 million years ago.

While long-past mountain building in the region is widely attributed to a continental collision, deformation occurred in several episodes of extension and compression. The major past tectonic events affecting areas to the south and east of the southern Ontario region are as follows:

- Rifting during the late Proterozoic/early Paleozoic era to form the Iapetus (pre-Atlantic) Ocean;
- Closure of the Iapetan ocean basin during the middle to late Paleozoic era, accompanied by subduction of Iapetan crust and multiple arc-continent and continent-continent collisional episodes of mountain building in the Appalachian region; and
- Rifting during the Mesozoic era to form the present-day Atlantic Ocean.

The principal tectonic elements of the southern Ontario region which have formed over more than 500 million years include (i) the Appalachian orogen (eroded remains of past mountain building process); (ii) the Appalachian and Michigan basins; and (iii) the Findlay, Algonquin, and Frontenac arches founded in basement rock. Key structural elements that mark the boundaries of various geological provinces are used to define regional seismic source zones that are characterized by similar crustal properties (OPG 2009h).

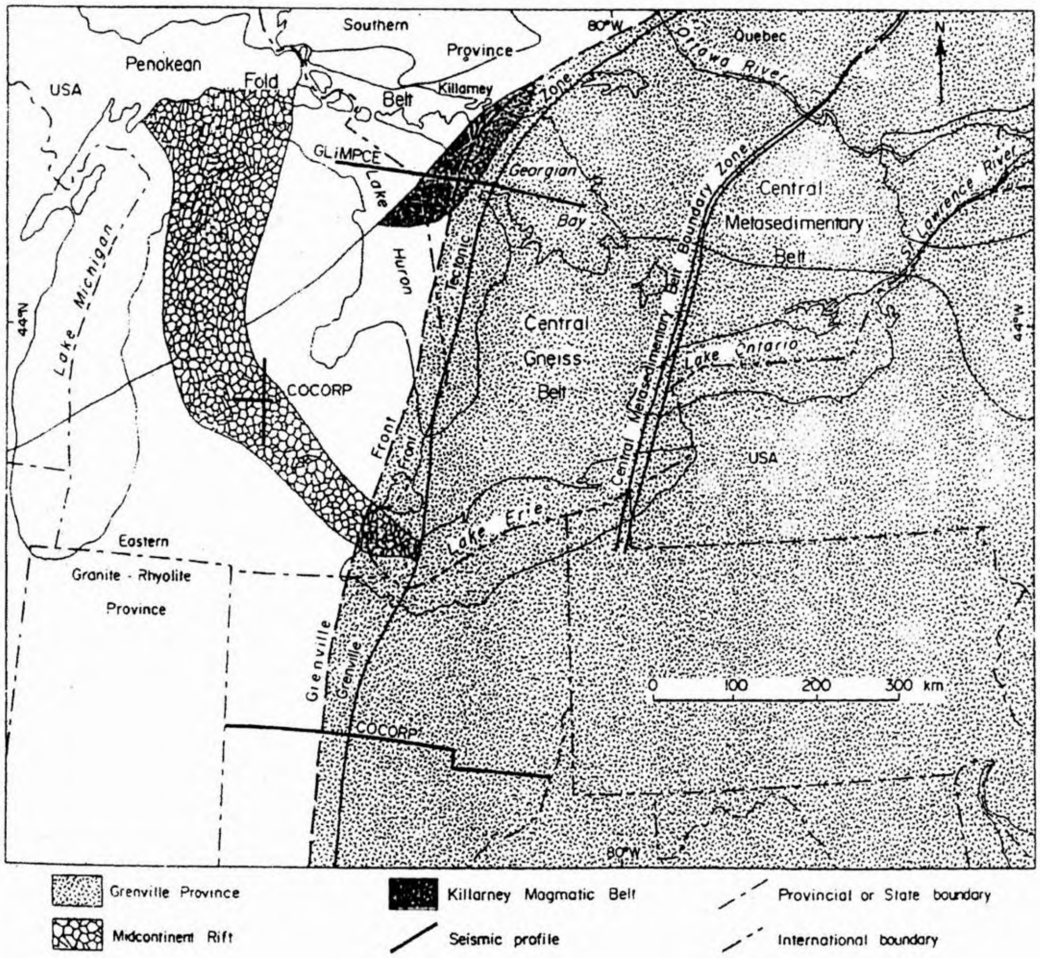
While there is evidence of ongoing tectonic (neotectonic) activity in the broader region (e.g., along the St. Lawrence rift system), this activity is occurring at much lower rates than during the last episode of major tectonic deformation. Most large historical earthquakes in eastern Canada have occurred near Paleozoic or younger rift zones. This is similar to the pattern of earthquakes in stable continental regions elsewhere in the world (OPG 2009a).

The St. Lawrence rift system (early Paleozoic era), which is delineated by a persistent pattern of seismicity, is the postulated source of numerous large, historical earthquakes in southeastern Canada (Adams and Basham 1991 as cited in OPG 2009h). Seismicity along this rift system is concentrated in a number of well-defined clusters, including the Ottawa River, Charlevoix, and lower St. Lawrence River seismic zones, all separated by regions which are relatively free of historical seismic activity.

Overall, as indicated in Figure 6.3-2, the rate of historical seismic activity in this region is low and appears typical of stable crustal rock masses (OPG 2009h). In general, seismic activity and geologic conditions most associated with such activity in the stable continental region of central and eastern North America increase toward the east, away from the large and stable Canadian (Precambrian) Shield rock mass.

Figure 6.3-1

Principal Subdivisions of Precambrian Rocks in the Great Lakes Region



SOURCE:
OPG 2009a

Date: September 2009
Project: 34500

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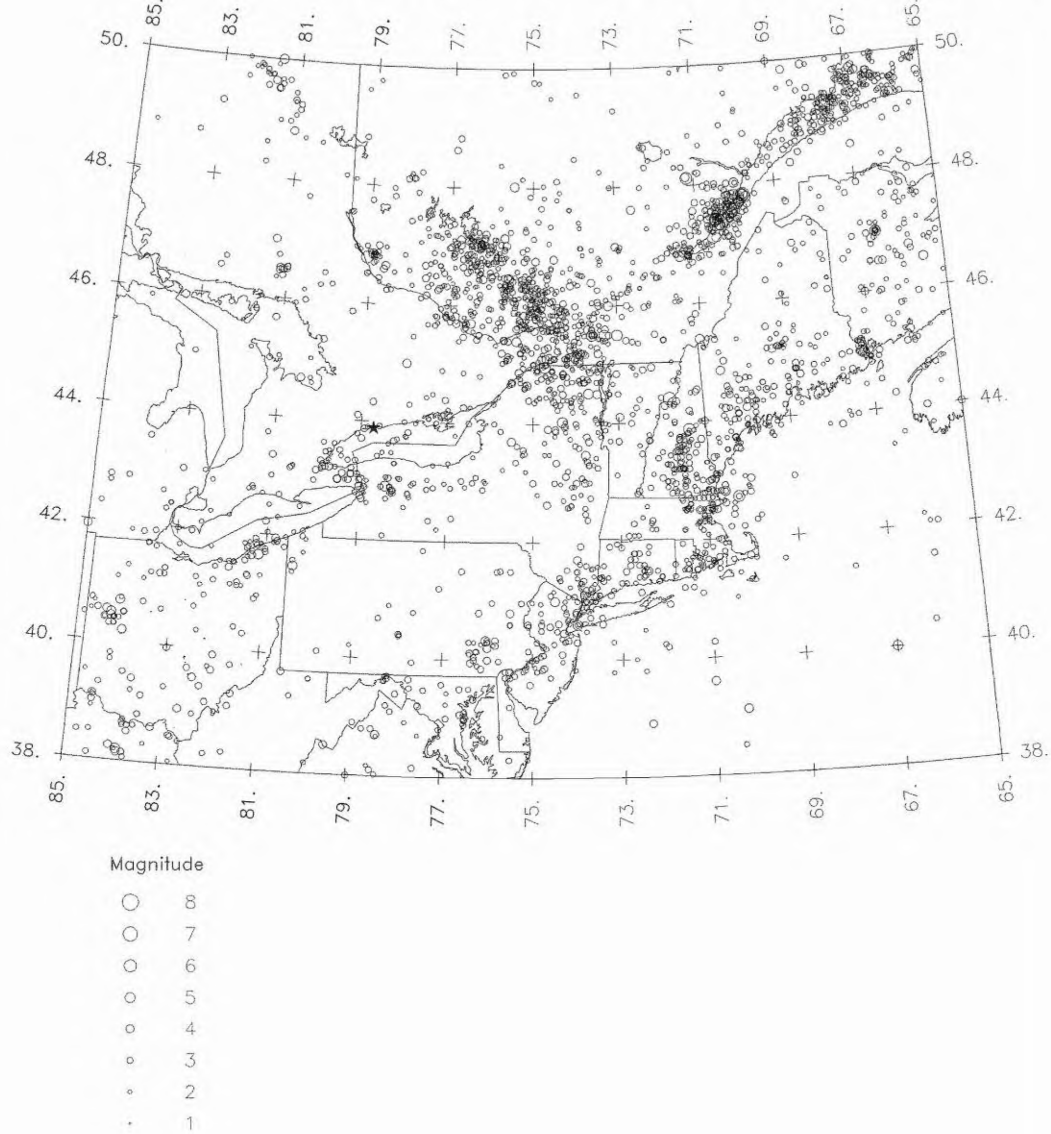
Figure 6.3-2

Regional Seismicity
(showing earthquakes for the period 1534 to 2007)



SOURCE:
OPG 2009a

Date: September 2009
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6.3.2 Assessment of Seismic and Related Hazards at the DN Site

6.3.2.1 Investigation and Assessment Background

The seismic hazard for the DN site (as well as the PN site) was last assessed in 1997 by Geomatrix Consultants Inc. At that time, Geomatrix Consultants performed a probabilistic seismic hazard assessment (PSHA) (Geomatrix 1997) for the two OPG nuclear sites under a contract with the (then) Atomic Energy Control Board (AECB). The 1997 PSHA was used by the AECB as an independent review of OPG's review level earthquake ground motion analysis for seismic assessment of PNGS A. The AECB's peer review panel endorsed recommendations made by Geomatrix Consultants to reduce uncertainties in seismic hazard parameters. These recommendations (with reference to documentation of related follow-up actions) included:

- Enhance regional seismic monitoring capabilities (to record smaller-magnitude earthquakes, identify clusters and trends in activity, and improve ground motion prediction relationships) (Asmis 2001b);
- Evaluate apparent evidence of faulting in the Rouge River valley (OPG 2002c); and
- Evaluate completeness and accuracy of the historical earthquake record in southern Ontario (Evenden and Nelles 2001).

In 1998 OPG initiated a Seismic Hazard Resolution Project (Asmis 2001a) to address these recommendations. OPG also funded Lithoprobe seismic reflection surveys to map geological structures (a) underlying the Oak Ridges Moraine north of the DN and PN sites, (b) north of Belleville and (c) along the north shore of Lake Erie. High-resolution aeromagnetic surveys were flown over southern Ontario and upstate New York to provide consistent mapping of magnetic geological structures (generally located beneath southern Ontario's post-glacial overburden and sedimentary rock cover). The Lithoprobe surveys and aeromagnetic data collection was managed by the Geological Survey of Canada (GSC) and the data collected has been made available on the GSC's website. Lithoprobe seismic reflection survey data and the aeromagnetic survey data, as well as other research findings, were included in the current PSHA update for the NND Project (OPG 2009h).

6.3.2.2 Updated Identification of Regional and Local Seismic Sources

<u>Potential for Surface Faulting</u>

The potential for surface faulting was evaluated at the DN site, site vicinity and regional levels. Historical data from boreholes and excavation mapping at the DN site indicate no evidence of near-surface faulting in bedrock at the site. Furthermore, there is no evidence of post-glacial scarps (steep cliff-like formations) related to seismic action in the overburden or of solution-weathered cavities in the bedrock (OPG 2009a). Regional geologic maps (e.g., Ontario Geological Survey, 1991) show that the Paleozoic rocks are, with few exceptions, relatively flat-lying and laterally continuous, indicating that no major large-scale faulting has occurred in the region since they were deposited. Surface faulting has been accounted for in the definition of regional and local seismic sources (discussed below).

Potential Regional and Local Seismic Sources

Gap analysis performed during these EA studies identified the need to update the 1997 PSHA (Geomatrix 1997) to account for changes in regulatory requirements and to incorporate recent research. The assessment of seismicity and seismic hazard was done in compliance with CNSC Regulatory Document RD-346 *Site Evaluation for New Nuclear Power Plants* (CNSC 2008c) and IAEA Safety Guide NS-G-3.3 *Evaluation of Seismic Hazards for Nuclear Power Plants* (IAEA 2002b).

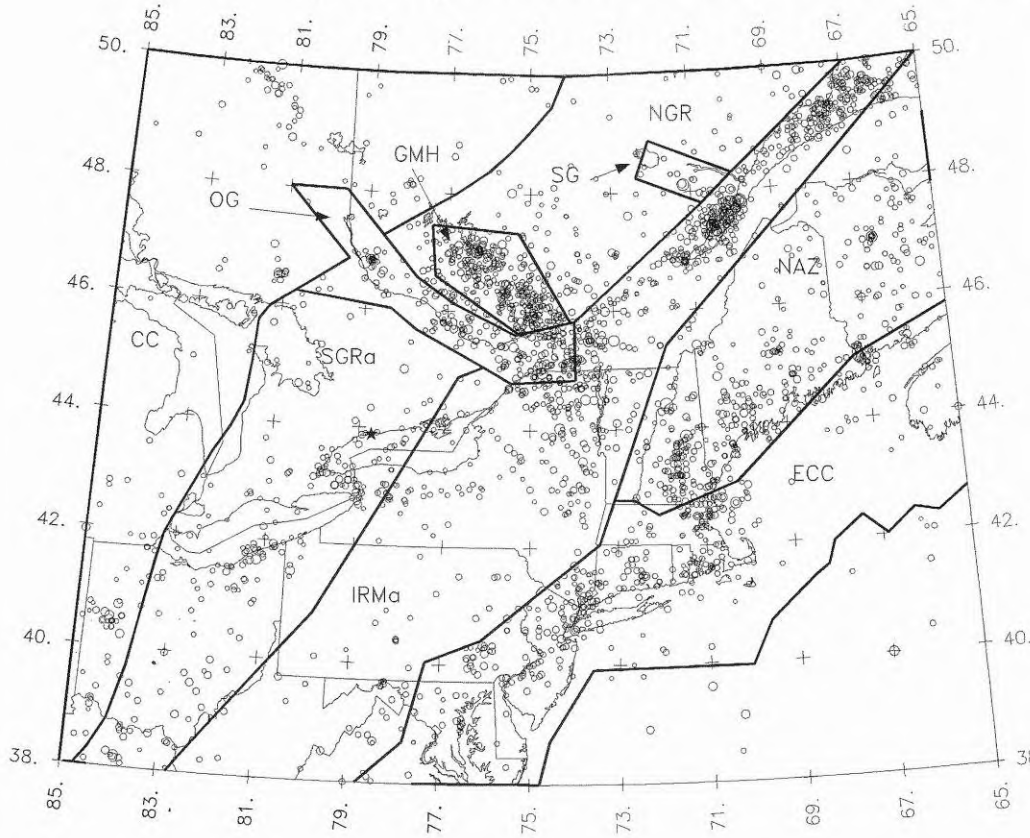
A comprehensive database of geological, geophysical, seismological and geotechnical information relevant to evaluating the ground motion, faulting, and geological hazards at the DN site has been assembled. Information has been assembled at a range of scales, including the site area, site vicinity (5 km radius), near regional (25-km radius), and regional (150-km radius) scales. The site area investigations (OPG 2009b) define geotechnical data necessary for design of plant foundations, shore protection, structures and equipment, as well as identification of any faults and fault displacements. These site area investigations include investigation of the near-shore lakebed. Seismic hazard data for the site vicinity, near region and the region around the DN site are assembled in (OPG 2009h). The approach adopted was to utilize the 1997 study (Geomatrix 1997) as a starting point, update the database assembled for that study, evaluate the effects of recent regulatory guidelines (CNSC 2008c and IAEA 2002b), and incorporate research findings and changes as appropriate. A regional paleoseismology study and an evaluation of the seismogenic potential of deep bedrock structures in southern Ontario have also been performed and the impact of these study findings on the PSHA is being assessed.

The regional seismic source zone models (Figure 6.3-3), originally developed in the 1997 PSHA (Geomatrix 1997), were updated to incorporate information from more recent research (OPG 2009h). Resulting changes in the seismic hazard model for the region include removal of the local Rouge River source from the model, modifications to the boundaries of some regional source zones, and modification of weights assigned to alternative regional seismic source zones and local sources. Previous investigation had determined that the Rouge River faults were not seismically-induced, but were most likely formed by glaciation processes (OPG 2009c). A major revision resulted from the use of updated earthquake catalogues obtained from the GSC and the U.S. Geological Survey covering the period from 1534 to 2007 (Figure 6.3-2). In addition, a set of recently developed ground motion models, representative of the range of scientific opinion, was used in the 2009 PSHA. The models represent the results of extensive research on ground motion modeling for eastern North American earthquakes (OPG 2009h).

Local seismic sources are defined as linear geophysical features postulated to be indicators of past or potential future seismic movement. The seismogenic (earthquake) potential of a number of magnetic lineaments (discussed in Geomatrix 1997) and geophysical features occurring in the Precambrian rock underlying the Lake Ontario region was reassessed using recent research findings and relevant diagnostic criteria (OPG 2009h). The local seismic sources are identified in Figure 6.3-4.

Figure 6.3-3

Regional Source Zones
(showing earthquakes for the period 1534 to 2007)



Magnitude

- 8
- 7
- 6
- 5
- 4
- 3
- 2
- 1

Abbreviations: CC — Central Craton
ECC — Extended Continental Crust
GMH — Great Meteor Hotspot
IRM_a— Iapetan Rifted Margin
NAZ — Northern Appalachians
NGR — Northern Grenville
OG — Ottawa Graben
SG — Saguenay Graben
SGR_a — Southern Grenville

SOURCE:
OPG 2009a

Date: September 2009
Project: 34500

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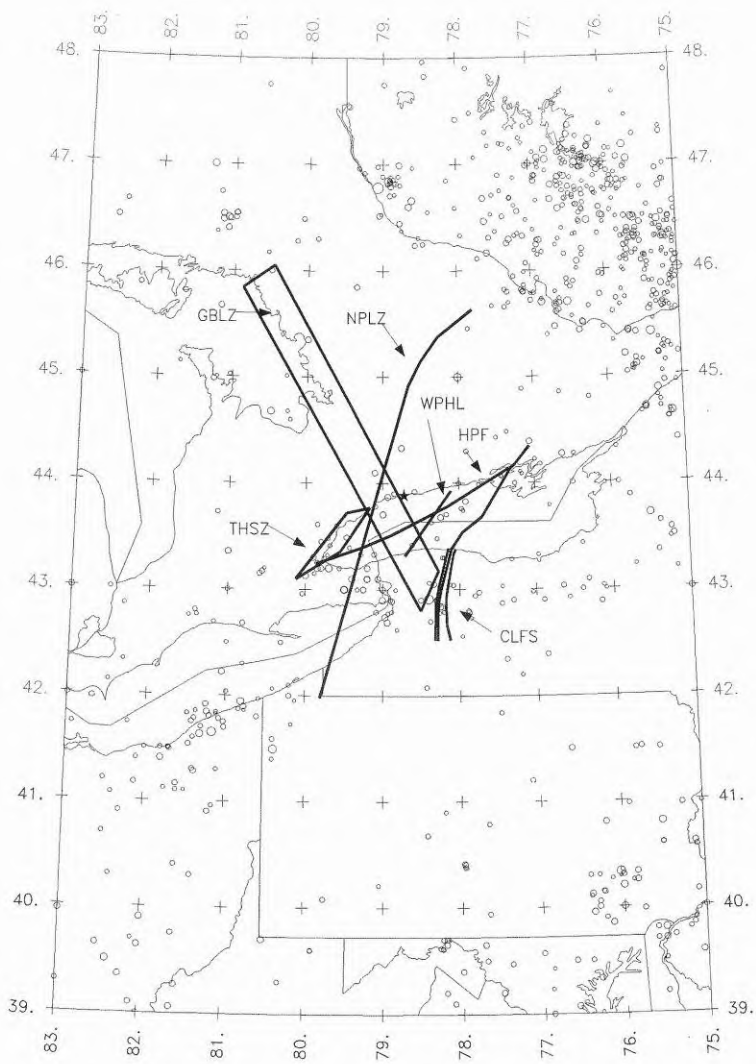

Magnitude
6
5
4
3
2
1

Abbreviations:
CLFS — Clarendon-Linden Fault System
GBLZ — Georgian Bay Linear Zone
HPF — Hamilton-Presqu'ile Fault
NPLZ — Niagara-Pickering Linear Zone
THSZ — Toronto-Hamilton Seismic Zone
WPHL — Wilson–Port Hope Magnetic Lineament

Figure 6.3-4

Local Source Model 1
(showing earthquakes for the period 1534 to 2007)

SOURCE:
OPG 2009a

Date: September 2009
Project: 34500

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6.3.2.3 Assessment of Seismic Hazard at the DN Site

Characterization of Seismicity Parameters

The approaches used to model the key seismicity parameters for this assessment (earthquake occurrence rates and maximum magnitude) have been updated from those used for the 1997 PSHA. A regional paleoseismology study was undertaken to evaluate the liquefaction potential of susceptible materials and to evaluate paleoliquefaction features. The results of this study (evidence of a long return period, about 10,000 years, for large-magnitude earthquakes in the region and no apparent evidence of liquefaction near the DN site) indicate that the regional earthquake occurrence rate that has been used in the updated PSHA is conservative (OPG 2009h).

Changes in ground motion models between 1997 and 2009 have not resulted in significant changes in estimates of ground motion levels at the DN site (OPG 2009h). The effect of the geology at the DN site (sedimentary rock sequence overlying hard basement rocks) on site ground motions was assessed using site response analysis methods that are recommended for the seismic hazard analysis of nuclear facilities (IAEA 2002b).

Updated PSHA Calculation Procedure

The standard PSHA calculation procedure is to consider all earthquakes above a specified minimum size to be able to generate ground motions that are damaging to well-engineered structures. Typically the minimum size has been set at Magnitude 5. The Electric Power Research Institute (EPRI) has developed a PSHA methodology that directly addresses the potential for an earthquake of any size to produce damaging ground motions (EPRI 2006). The parameter used to measure damage potential is the cumulative absolute velocity (CAV) of an acceleration time history produced by an earthquake. The use of this model typically leads to a reduction in the contribution of moderate magnitude earthquakes (those in the Magnitude 5 to 6 range) to the site hazard. This EPRI methodology was employed in the NND PSHA (OPG 2009h).

Results of Updated PSHA for the DN Site

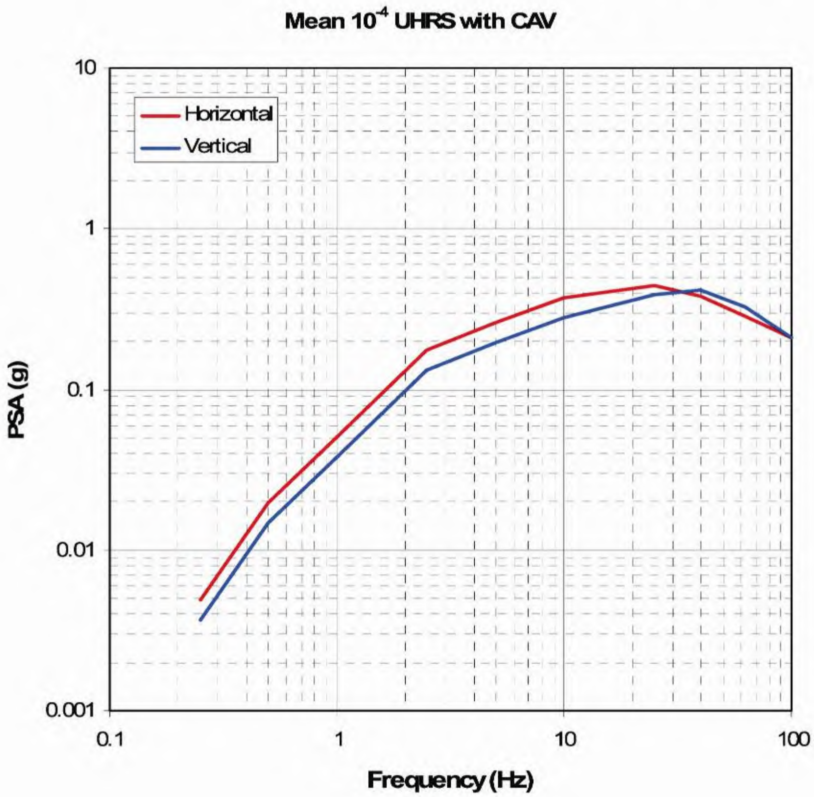
The updated seismic source characterization and ground motion characterization models were used to re-assess the seismic hazard for the DN site (OPG 2009h). The updated PSHA results indicate that both regional and local seismic sources are important contributors to the seismic hazard. The regional sources are the dominant contributors to the hazard at low ground motion levels and the local sources become an equal contributor at high ground motion levels. Of the local sources, the Niagara-Pickering Linear Zone was found to be the largest contributor. The results are typical of seismic hazard estimates in central and eastern North America in that there is a wide confidence band reflecting the large uncertainties in most of the input parameters.

In general, examining the assessed contributions to seismic hazard at the DN site in terms of earthquake magnitude and distance, the major contribution is predicted to come from distant earthquakes for short (100 year) return periods. The magnitudes contributing to the hazard are larger on average for low frequency motions, reflecting the fact that larger earthquakes produce relatively greater low frequency motion than smaller earthquakes. As the return period increases, the hazard contributions shift to closer sources, reflecting the fact that earthquake ground motions increase as the source to site distance decreases.

More specifically, the results of the 2009 PSHA update for the DN site can be summarized in terms of uniform hazard response spectra (UHRS), as presented in Figure 6.3-5. The curves in this figure, representing both horizontal and vertical directions of excitation, were developed for a probability of occurrence of 10^{-4} per year as suggested by current Canadian and international standards. In the figure, PSA, the peak spectral acceleration response (expressed as a fraction of g, the acceleration of gravity) of simple oscillators to ground motions induced by earthquakes occurring in the defined regional and local seismic sources, is plotted on the vertical axis versus natural frequency of the affected medium or structure on the horizontal axis. For example, these curves indicate that an object with a natural frequency of 2 Hz resting on hard rock at the DN site would be subjected to horizontal and vertical acceleration of 0.1 g once in 10,000 years. Most of the key structures and equipment at nuclear power plants have natural frequencies in the 2 to 10 Hz range. These results indicate somewhat higher response accelerations than the 1997 PSHA results, particularly in the high frequency range of the response spectrum. This is attributed primarily to the effects of the earthquake catalogue updating and data conversion process on the earthquake occurrence rates. Nearby moderate earthquakes, occurring within the regional and local sources, tend to produce high accelerations at high frequencies (above 15 Hz approximately). The lower frequency portions of the UHRS curves are associated with larger, more distant earthquakes.

Figure 6.3-5

Horizontal and Vertical UHRS for Annual Exceedance Frequency of 10^{-4} (10,000 year return period)



SOURCE:
OPG 2009a

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Legend to Figure 6.3-5:
UHRS - uniform hazard response spectrum (or spectra)
PSA(g) - peak spectral acceleration expressed as a fraction of g, the acceleration of gravity
CAV - cumulative absolute velocity

In summary, these DN-specific UHRS curves are similar to those for other competent rock sites in eastern North America.

6.3.2.4 Assessment of Hazards due to Seismically-Related Phenomena

In accordance with regulatory guidelines (CNSC 2008c, IAEA 2002b and IAEA 2004b), a number of seismically-related phenomena which could also potentially affect the DN site and NND Project design, such as tsunamis and seiches, were evaluated.

Tsunamis

Tsunamis are long-period gravity waves generated by seismic disturbances or landslides resulting in a sudden displacement of the water surface. The resulting wave energy potentially spreads across the ocean or lake at high speed. Tsunami occurrences in Canada are rare, with the Pacific Coast being at greatest risk due to the higher rate of earthquake occurrence and landslide activity there. The Great Lakes are on the edge of the Canadian Shield, a geologically stable mid-continental region where the rate of occurrence of earthquakes is only about one tenth of that at tectonic plate boundaries.

The Lake Ontario shorelines are not generally susceptible to shore slope failure or landslides. Review of high quality Lake Ontario bathymetric data from the U.S. National Geophysical Data Center (NGDC) gave no evidence of submarine landslides or other surface disturbance in the post-glacial period (OPG 2009d). The Natural Hazards Database at the U.S. NGDC reports only one “tsunami run-up event” in Lake Ontario over 250 years ago (1755). No ground shaking effects were reported and this event is not listed in Canadian earthquake catalogues. While the cause of this event is uncertain, its reported wave runup was less than Natural Resources Canada’s estimate of tsunami wave runup for Lake Ontario.

Natural Resources Canada’s Natural Hazards-Tsunami interactive map indicates a less than low tsunami run-up potential in Lake Ontario, a low ranking being defined as less than 2 m. Based on (a) the absence of reports of tsunami events in the Great Lakes, (b) the lack of shoreline or lakebed evidence of tsunami initiators, and (c) the NRC hazard mapping, tsunamis are considered improbable events with no associated flood hazard potential at the DN site.

Seismic Seiches

Seiches are standing waves which typically occur in closed or partially enclosed bodies of water, such as Lake Ontario. Minor seiches are almost always present on larger lakes, but are not usually noticeable as they are generally caused by common meteorological disturbances (wind and atmospheric pressure variations). More extreme seiches can be caused by infrequent severe wind storms, seismic or related tsunami activity. The reported wave height of historical seismically-induced seiche events in Lake Ontario is less that 2 m, which can be accommodated through shoreline protection at the NND site (OPG 2009d).

Dam Failures and Landslides

There are no human-built water retaining structures within the Darlington Creek watershed or other DN site vicinity watersheds. Hence, there are no flooding hazards associated with seismically-induced failure of such structures. The flooding threat due to potential seismically-induced landslides at the site is considered minimal (OPG 2009d).

Volcanism

Investigation of Natural Resources Canada (NRCan) geological mapping did not identify any evidence of volcanic rocks or volcanism having occurred during the most recent geological era (i.e., during the Cenozoic era or the last 65 million years) within 150 km of the DN site. Hence, based on established methodology, volcanism is not a considered to be a significant contributor to the seismic hazard at the DN site (OPG 2009d).

6.3.2.5 Potential Effects on Project Foundations and Structures

As indicated in the introduction to Section 6.2, seismicity and related effects are examined primarily to confirm that systems which are critical to the safe shutdown of the station will function as planned in the event of a seismic event. Until a reactor technology/vendor has been selected for the NND Project, the potential seismic effects on the Project can only be assessed at a general level. In general, standard nuclear power plant designs are seismically qualified using certified seismic design response spectra. A range of foundation material conditions are generally considered in developing these design response spectra in order that the standard plant designs can be adapted to a variety of potential sites. However, for plant licensing purposes, the design of the selected reactor technology must eventually be assessed and shown to be capable of safely withstanding the effects of the site-specific seismic hazard, as represented by the UHRS.

The dynamic soil/rock properties of the NND site have been documented in detail (OPG 2009h). Stability of the site foundation materials under static, dynamic, and seismic loading has been evaluated (OPG 2009a and 2009b). Investigation results indicate that the NND site can be classified as a "rock and stiff soil site" according to IAEA Safety Guide NS-G-3.6 (IAEA 2004a). No evidence of potential soil or rock instability (collapse, subsidence, surface uplift, or liquefaction) or surface faulting was identified. In summary, no seismicity-related issues were identified that would render the DN site unsuitable for construction of new nuclear facilities.

During implementation of the Project, detailed site geotechnical evaluations will be performed to provide definitive dynamic properties of site rock and soil for plant design purposes. Furthermore, as part of the plant licensing process, the selected vendor will verify that the plant design is capable of safely withstanding the potential effects associated with the site-specific seismic hazard.

6.3.3 Project Design and Contingency Measures

In general, standard nuclear power plant designs are already seismically qualified using certified seismic design response spectra. These design response spectra are generally based on a range of foundation material conditions in order that the standard plant designs can be adapted to a variety of sites. The design approach for the NND Project, regardless of which reactor technology option is selected, includes the defence-in-depth concept to provide a series of barriers (as described in Section 2.6.4). Based on this concept, the plant design would include measures to prevent accidents and measures to provide protection in the event that prevention fails. Fundamental safety functions (control, cool, contain and monitor) are generally provided by redundant systems. For EA purposes, it is reasonable to conclude that this design approach, and the seismic qualification already incorporated in the design, will ensure effective protection of the NND plant against the effects of the assessed site-specific seismic hazard. For later licensing of the NND Project, however, the plant design must be assessed in detail and shown to be capable of safely withstanding the effects of this seismic hazard such that plant systems which are critical to the safe shutdown of the station will function as planned in the event of a seismic event.

Furthermore, as described in Section 2.8, each of OPG's facilities has emergency response plans and capabilities that can be applied to deal with a range of emergency situations which could potentially be initiated by internal or external events, including seismic and related events. The existing response infrastructure is able to draw upon additional support resources and use prioritization techniques if/when required to deal with a major event. NND will be supported by a similar emergency response system.

6.3.4 Summary of Seismic and Related Hazards Assessment

In summary, the seismic hazard assessment and related studies carried out for the NND Project identified no seismicity-related issues that would render the DN site unsuitable for construction of new nuclear facilities. Potential effects of seismicity and related phenomena will be addressed through a rigorous, conservative and regulated design and construction process, such that key systems which are critical to the safe shutdown of the station will function as planned in the event of a seismic or related natural event during operation of the station.

6.4 Climate Change Considerations

In November 2003, the Federal-Provincial-Territorial Committee on Climate Change and Environmental Assessment (FPTCCCEA) released a document entitled *Incorporating Climate Change Considerations in Environmental Assessment: General Guidance for Practitioners*. That Guidance Document outlines a procedure within the EA process for assessing whether:

- A proposed project may contribute to Greenhouse Gas (GHG) emissions; and,
- Climate change may have an impact on a project.

The procedure outlined in the Guidance Document was used to consider the potential effects of climate change on the proposed NND Project.

The use of fossil fuels is the main source of GHG emissions (methane (CH_4), carbon dioxide (CO_2) or nitrous oxide (N_2O)) related to this Project. GHGs will be emitted as a result of fuel combustion associated with the Project-related construction equipment and construction-related traffic. During the Operation and Maintenance phase, GHG emissions will be primarily a result of the testing and operation of backup power equipment and from site-related vehicle traffic. Section 6.4.1 provides an overview of the GHG emissions that are associated with this Project.

As outlined in the Guidance Document (FPTCCCEA 2003), to determine whether the effects of climate and climate change on a project need to be evaluated in detail in the EIS, a determination is required of whether a that project has any sensitivity to potential changes in climate. The proposed NND Project may extend to approximately 2100, and, therefore, may be subject to changes in climate. As such, an evaluation of the effects of climate and climate change on the Project is presented in Section 6.4.2.

6.4.1 Overview of Effects of Greenhouse Gas Emissions

The potential impact of GHG emissions from the Project was assessed through estimation of the GHG emissions during the Site Preparation and Construction and the Operation and Maintenance phases. These emissions were estimated using U.S. EPA AP-42 emission factors (U.S. EPA 1995), and source information detailed in the *Atmospheric Environment – Assessment of Environmental Effects TSD*. The results are considered over-estimates because they assume conservative operating hours for all equipment.

The estimated GHG emissions emitted from the NND Project during the Site Preparation and Construction phase are provided in Table 6.4-1. GHG emissions expected during this phase including emissions from on-site combustion equipment and on-site roads are provided in Table 6.4-2. These emission rates are based on emission factors provided in available U.S. EPA emission factor documents and are considered to be conservative. The construction equipment used will comply with emissions regulations in place at the time the Project proceeds. Similarly, the emergency generators and auxiliary steam boilers will be state-of-the-art equipment and will comply with emissions regulations in place at the time the Project proceeds.

TABLE 6.4-1
Annual Greenhouse Gas Emissions – Site Preparation and Construction Phase

	Source	Emission Rate (tonnes/y) by Construction Year				
		1	2	3	4	5
CO_2	Parking Lot Tailpipe	30.5	30.5	297.3	297.3	289.6
	Haul Truck Tailpipe	855.5	505.2	614.1	614.1	315.7
	Paved Road Tailpipe	137.9	99.5	475.3	475.3	400.0
	Stationary Equipment		1210.5	1733.2	1733.2	522.7
	Non-Road Tailpipe	375.6	400.1	586.2	586.2	301.7
Total		**1399.6**	**2245.7**	**3706.0**	**3706.0**	**1829.7**
CH_4	Parking Lot Tailpipe	0.0036	0.0036	0.0349	0.0349	0.0340
	Haul Truck Tailpipe	0.0152	0.0090	0.0109	0.0109	0.0056
	Paved Road Tailpipe	0.0057	0.0050	0.0397	0.0397	0.0376
	Stationary Equipment		0.0662	0.0948	0.0948	0.0286
	Non-Road Tailpipe	0.0080	0.0086	0.0126	0.0126	0.0065
	Total	**0.032**	**0.092**	**0.193**	**0.193**	**0.112**
Total CO_2 (eq) tonnes		**1400.3**	**2247.6**	**3710.1**	**3710.1**	**1832.1**

TABLE 6.4-2
Annual Greenhouse Gas Emissions – Operation Phase

Source	CO_2 (tonnes/y)	CH_4 (tonnes/y)	Total CO_2 (eq) (tonnes/y)
Emergency Power Generator	893	-	893
Auxiliary Steam Boiler	1315	0.0032	1315
On-Site Roads	52	0.0007	52
Site Total	2260	0.004	2260

Environment Canada (2008b) reported over 200,000,000 tonnes CO_2-eq from Ontario sources in 2005. The Project's GHG emissions in comparison to Ontario's total GHG emissions in any given year are negligible (less than 0.01%) and thus no further consideration is required.

6.4.2 Overview of Potential Climate Change Impacts

Studies reported by EC (2000), the International Panel on Climate Change (IPCC) (2007) and NRCan (2007), indicate that climate change could result in impacts, specifically for Ontario, over the next 100 years. These changes are categorized and described in summary form as follows.

Temperature

- Higher maximum temperatures and a greater frequency of hot days and heat waves, as the number of days exceeding 30^oC is projected to more than double by 2050 in Southern Ontario (Hengeveld and Whitewood, 2005);
- Average seasonal temperatures will increase by 2-4^oC by the 2050s in Southern Ontario (relative to 1961–1990) (Chiotti and Lavender, 2008); and
- Increasing minimum temperatures resulting in fewer cold days, frost days and cold waves. OPG 2008b indicates that winter temperatures in the vicinity of the DN site are predicted to rise by 2^oC by 2040 and by as much as 5^oC by 2100, with similar temperature increases in the summer months.

Precipitation

- Decreases in the total amount of precipitation in Southern Ontario in the Summer and Fall seasons, but an increase during Spring and Winter by the 2050s (relative to 1961–1990) (Chiotti and Lavender, 2008); and
- A greater frequency of higher intensity precipitation events (Kharin et al., 2007).

Lake Ontario Water Surface Temperature

- Increases in Great Lake water temperatures which may result in:
  - Warm-water fish species shifting northward (Environment Canada, 2000); and
  - Cold-water fish species retracting at the southern boundaries of the lakes (Schindler et al, 1996.
- Lake Ontario's surface mixed layers are projected to increase by 4 to 7^oC by the end of the current century. Changes in mean bottom temperatures of the lake are expected to increase by 1 to 3^oC (Lehman, 2002). In an earlier study, as CO_2 levels doubled, mean monthly water temperature was projected to increase by 3-10^oC from the surface to 20 m depth of the lake, whereas deep lake waters would likely see an increase of 1-4^oC (Boyce et al., 1993).

Lake Ontario Water Levels

- Decline in average water levels of the Great Lakes due to a decrease in water supply both from surface and groundwater sources in Southern Ontario, with a concurrent increase in water demand during the summer months (Environment Canada, 2000); and
- A decrease in water levels of the Great Lakes and Lake Ontario would result in an alteration of current distribution and abundance of Great Lake coastal wetland communities (Mortsch *et. al.* 2006). Estimates are included below in the Global Circulation Model discussion.

Groundwater

- Groundwater flows are estimated to decrease for the Great Lakes, although research is mixed (Mortsch et al., 2003).

Soil Moisture

- Along with declining water levels in the Great Lakes, regional models predict decreasing soil moisture in southern Canada (Natural Resources Canada, 2007).

Global Climate Models

General Circulation Models (GCMs) have been used by the IPCC to predict climate change impacts that are likely to occur using the best available data available at that time. Different projection and climate change scenarios are utilized and updated for each version of the IPCC Assessment Report. In order to best assess climate impacts from these models, the IPCC Task Group on Data and Scenario Support for Impact and Climate Assessment (TGICA) published a report outlining the general guidelines to be used when incorporating data on GCM scenarios (IPCC-TGICA, 2007). The report highlights some intrinsic challenges in the modeling process, including the uncertainties present in the developed methodologies and the limitations of downscaling approaches. It also recommends the use of more than just one model or emission scenario prediction when considering specific regions and time periods. For the Canadian context, data and modeling results are available from the Canadian Climate Change Scenarios Network - National Node (EC 2007).

The major challenges with the GCMs remain that the models use equations that govern a set of theoretical concepts and methods, and that the grids used by the models to provide estimated projections are often very coarse. While regional projections can be estimated, large grid cells make it difficult to estimate projections for local areas that have specific weather or precipitation factors that can affect climate (such as the Great Lakes) that will not be accurately assessed within the grid cells used by the GCMs. One of the solutions is to select models/scenarios that 'bound' the maximum or minimum of reasonable model projections, as has been done by Canadian researchers to assess the impacts of the Great Lakes on regional climate change projections.

Projected changes specific to Lake Ontario due to climate change are of particular interest for the NND Project. The best available research documentation on this issue are the studies prepared and conducted by Canadian researchers for the International Joint Commission. Mortsch *et al.*, 2005 described the development of four GCM climate change scenarios for the Great Lakes – St. Lawrence Basin that are bounded by the following conditions:

- Most warming and wettest conditions (warm & wet);
- Most warming and driest conditions (warm & dry);
- Least warming and wettest conditions (not as warm & wet); and
- Least warming and driest conditions (not as warm & dry).

Mortsch *et al.*, 2006, summarized the findings of the GCM-projected scenarios for temperature and precipitation changes in the Great Lakes for 2050 relative to 1961 to 1990 baseline conditions. Average annual air temperature for the Great Lakes area is predicted to increase. Temperature increases ranged from 2.2^{o}C (not as warm & wet) to 4.0^{o}C (warm & wet). Annual precipitation is also predicted to increase, ranging from an increase of 1.4% (warm & dry) to 12.5% (not as warm & wet). Although the precipitation is expected to increase, depending on the scenario, the projected annual mean water levels for Lake Ontario ranges from a decrease of 0.37 m (warm & dry) to an increase of 0.02 m (not as warm & wet). These changes varied by season, with a decrease up to 0.49 m in summer (warm & dry) and even a potential increase of 0.07 m in the winter (not as warm & wet). Higher winter water levels result from warmer winters with more winter rainfall events.

The International Lake Ontario – St. Lawrence River Study Board is studying four options of regulating Lake Ontario water levels (International Lake Ontario – St. Lawrence River Study Board 2006). Their March 2006 report to the IJC identified that the four options could change the range of water levels throughout the year. None of the scenarios result in water levels that exceed the current maximum water level or drop below the currently reported minimum water level.

6.4.2.1 Preliminary Scoping for Consideration of Impacts

The Guidance Document (FPTCCCEA 2003) specifies that the first step in determining whether or not changes to climate need to be evaluated in more detail in an EA study is to determine whether the project has any sensitivity to potential changes in climate.

Activities related to the Site Preparation and Construction phase of the NND Project are relatively short in duration (2012 to approximately 2024). Therefore, climate change impacts related to this phase have not been considered. However, the Operation and Maintenance phase of the Project extends to approximately 2100 and may be subject to changes in climate.

The NND Project is described in Chapter 2. The key physical structures and systems of the NND that have a potential sensitivity to climate change are:

- Power Block – buildings, structures and systems will be constructed based on design weather data (harsh environmental conditions), a design basis earthquake and a site design earthquake. They will be designed to meet the requirements of the National Building Code of Canada;

- Ancillary Facilities - buildings and structures related to the NND on the DN site will be constructed to meet the National Building Code of Canada;

- Marine and Shoreline Works – a reinforced wall or "breakwater" will be constructed to provide a barrier between Lake Ontario and the reactor buildings;

- Condenser Cooling Water Systems – water is drawn from Lake Ontario to be used in the condenser circulating water and service water systems;

- Stormwater Management System – consisting of a series of ditches, drains and storm water management ponds that will be designed for the Regional Storm Event at a minimum;

- Electrical Power Systems – including such equipment as electrical standby generators, emergency power generators and an auxiliary steam boiler.

The climate change parameters that are considered to have a potential interaction with the NND physical structures and systems are:

- Precipitation – overall, average precipitation is expected to decrease, but precipitation occurs in a more intense manner.
  - Total Annual Rainfall – expected to decrease;
  - Total Annual Snowfall – expected to decrease;
  - Frequency and/or Severity of Extremes – precipitation events are expected to be more severe and occur more frequently. In the next 100 years, the frequency of extreme precipitation events will increase and possibly double; therefore, the 1-in-100 year storm may become a 1-in-50 year storm.

- Frequency and Severity of Extreme Weather Events – storms, not exclusively precipitation events (e.g., lightning, tornadoes, hurricanes), are expected to be more severe and occur more frequently. The GCMs estimate that within the next 100 years, storm intensity may increase by 40-50%, and the frequency of extreme weather events in the next 100 years may double; and

- Lake Ontario Effects:
  - Lake Ontario Water Temperature – surface mixed layers expected to increase by approximately 3-5ºC by 2050 due to warmer air temperatures (Lehman 2002).
  - Lake Ontario Water Level – expected to decrease by as much as 0.49m. However, it must be noted that the level of Lake Ontario is controlled for navigation purposes.

Other climate parameters were considered to have little or no interaction with the physical structures and systems associated with the Project, and thus were not included in the assessment. They included the following:

- Wind Velocity – not defined separately because extremes are encompassed within frequency and severity of weather extremes;
- Evaporation – potential changes will not affect NND operation;
- Soil moisture – potential changes will not affect NND operation; and
- Groundwater – potential changes will not affect NND operation.

6.4.2.2 Identification of Impact Considerations

To further assess the potential interaction of climate change parameters with the Project physical structures and systems, a screening exercise was undertaken to evaluate and rank each potential interaction. The Guidance Document (FPTCCCEA 2003) provides a methodology to assist in identifying project sensitivity to changes in climate parameters.

Each of the Project's physical structures and systems has been evaluated against each climate parameter and assessed for potential sensitivity. Table 6.4-3 provides the results of the screening exercise and identifies the sensitivity ranking assigned for each physical structure or system related to the Project. Rank assignment was based on the following:

- Nil rank was assigned if it was determined that the physical structure or system was not sensitive to a change in the climate parameter.

- Low rank was assigned if it was determined that the physical structure or system was unlikely to be sensitive to a change in the climate parameter.

- Medium rank was assigned if it was possible that the physical structure or system would be sensitive to a change in the climate parameter.

- High rank was assigned if it was likely the project physical structure or system would be sensitive to a change in the climate parameter.

TABLE 6.4-3
Potential Interactions Between the NND Project and Climate Change Parameters

Structures and Systems	Climate Parameter					
	Precipitation			Weather other than Temperature or Precipitation	Lake Ontario Effects	
	Total Annual Rainfall	Total Annual Snowfall	Frequency and/or Severity of Extremes (return period)	Frequency and Severity of Extreme Weather Events	Lake Ontario Water Temperature	Lake Ontario Water Level
Power Block	No likely effects since reactor block, structures and systems will be constructed based on design weather data (harsh environmental conditions) and will be designed to meet the National Building Code of Canada. **Nil**			No likely effect since power block, structures and systems will be constructed based on design weather data (harsh environmental conditions), a design basis earthquake and a site design earthquake, as well as being designed to meet the National Building Code of Canada. **Nil**	No effect on power block is anticipated. **Nil**	No effect on power block is anticipated. **Nil**
Ancillary Facilities	No likely effects since buildings, structures and systems will be constructed based on design weather data (harsh environmental conditions) and will be designed to meet the National Building Code of Canada. **Nil**				No effect on buildings is expected. **Nil**	No effect on buildings is expected. **Nil**
Shoreline Works	No effect on the breakwater is anticipated. **Nil**	No effect on the breakwater is anticipated. **Nil**	No effect on the breakwater is anticipated. **Nil**	An increase in the severity of storm levels could potentially result in increased wave levels. This will be mitigated by the design of the breakwater, which will consider wave run-up under extreme conditions. **Low**	No effect on the breakwater is anticipated. **Nil**	No effect on the breakwater is anticipated. **Nil**
Water Systems	No effect on water systems is anticipated. **Nil**	No effect on water systems is anticipated. **Nil**	No effect on water systems is anticipated. **Nil**	Could result in greater disturbance of algae leading to greater quantities of algae becoming detached. Detached algae could potentially affect the intake water flow, however due to the design of the intake structure, potential effects would be minimal. **Low**	Increase in water temperature in Lake Ontario could lead to warmer intake water temperature, increased algal and zebra mussel growth and alteration of fish communities in Lake Ontario. Results could include more frequent algal entrainment and zebra mussel incidents. The deep water intake structure design, minimizes these potential effects. **Low**	Potential for impact on quantity of process cooling water and service water available. Lake Ontario water levels are controlled for navigation. An estimated drop in water levels of less than 0.5 m will not affect NND as it will have a deep water intake. **Nil**
Stormwater Management System	No effect on the stormwater management system is anticipated. **Nil**		Possible overflow of the stormwater management system, causing localized erosion. The stormwater management system will be designed to meet National Building Code requirements, applicable at the time of construction. An adaptive management strategy will be employed to mitigate against the possible effects of a changing climate. **Low**	No effect on the stormwater management system is anticipated. **Nil**	No effect on the stormwater management system is anticipated. **Nil**	No effect on the stormwater management system is anticipated because it is located well above lake level. **Nil**
Electrical Power Systems	No effect on the electrical power systems is anticipated. **Nil**	No effect on the electrical power systems is anticipated. **Nil**	No effect on the electrical power systems is anticipated. **Nil**	Could cause the facility to lose all power including its backup power, which could be an issue if the facility did not have enough power to allow a proper shutdown. Due to the many levels of backup at the facility, it is unlikely that all systems would be non-operational. **Low**	No effect on the electrical power systems is anticipated. **Nil**	No effect on the electrical power systems is anticipated. **Nil**

6.4.2.3 Assess Impact Considerations

Table 6.4-3 contains the results of a screening exercise conducted to identify the potential interactions between climate change and the Project. The Guidance Document (FPTCCCEA 2003) specifies that climate parameter-project component interactions evaluated as being of Medium or High risk should be assessed in more detail. No medium or high risk interactions were identified due to the mitigations that will be incorporated into the design; therefore no further evaluation is required.

6.4.2.4 Results from Assessment of Risks Related to Climate Change

No potential risks related to climate change were identified for the Project using the Guidance Document (FPTCCCEA 2003) methodology. The results show that in spite of possible changes to the climate in the future, there are no climate parameters that would have an effect on a Project physical structure or system resulting in a risk to either the public or the environment.

6.5 Summary of Likely Effects of the Environment on the Project

Sections 6.2 and 6.3 present the assessment of the potential conditions in the environment that could reasonably be anticipated to interfere with the Project. The assessment considered potential physical and biophysical environmental conditions; the Project design and contingency features that will be incorporated into the design to withstand such conditions; the need for any additional mitigation measures; and the effects on the Project that are considered likely to result from such conditions. This assessment concluded that no significant effects of the environment on the Project are anticipated once design and contingency features are considered.

NND will be designed such that systems important to nuclear safety would continue to operate if any of the environmental conditions discussed in the previous Sections were to occur. On the basis of the design and contingency features that will be incorporated into the design to withstand the potential environmental conditions, no additional mitigation measures are required. It is determined that adverse effects on the Project as a result of the environment are unlikely, given that OPG will develop an adaptive management strategy to manage any variability in the environment that could adversely affect NND. Adaptive management is the integration of design, management, and monitoring to systematically test assumptions in order to adapt and learn. This approach is particularly applicable to the potential effects of climate change, given the uncertainty in future climate patterns (i.e. greater frequency of more severe storms).

7. MALFUNCTIONS, ACCIDENTS AND MALEVOLENT ACTS

7.1 Objective and Approach

The *CEAA* requires that every screening or comprehensive study of a project include consideration of the environmental effects of malfunctions or accidents that may occur in connection with the Project. Furthermore, the *CEAA* also requires consideration of measures provided or intended to mitigate such effects.

The objective of the assessment of possible environmental effects of malfunctions, accidents and malevolent acts is to ensure that abnormal events and operational upset conditions relating to the NND Project are considered; credible events are identified; available means to prevent the occurrence or mitigate the possible effects of credible events are included in the Project; and the significance of any residual effects (i.e., after mitigation) of such events is determined.

The focus of the assessment is on those events that are considered credible[7] in the context of the specific project. It is not the intent of the EA to address all conceivable abnormal occurrences, but rather, to address only those that have a reasonable probability of occurring considering the specific aspects of site conditions and Project design.

For the purposes of this assessment six categories of malfunctions and accidents for the NND Project were addressed:

- **Conventional (Non-Radiological) Malfunctions and Accidents,** which are events that involve only non-radiological substances with no potential for a release of radioactivity or other events that could result in injury to workers;

- **Radiological Malfunctions and Accidents,** which are events that involve radioactive substances and components within nuclear power plant facilities other than those directly associated with the reactor and its auxiliaries, such as the radioactive waste and used fuel storage facilities;

- **Transportation Accidents**, which are those malfunctions and accidents related to the off-site transportation of L&ILW;

[7] For conventional malfunctions and accidents, a "credible event" is defined as one that has a reasonable probability of occurrence based on professional judgment in a context of project-specific conditions. For nuclear malfunctions and accidents, the threshold for determining credibility has generally been accepted to be a frequency of occurrence of $1x10^{-6}$ per year or greater.

- **Nuclear Accidents,** which are those malfunctions and accidents that are assumed to involve the operation of the reactor and associated systems and may involve damage to the fuel bundles and/or the reactor core and which could result in an acute release of radioactivity to the environment;

- **Out of Core Criticality,** which are those malfunctions and accidents that involve criticality events outside of the reactor core resulting from the improper spacing or moderation of nuclear fuel enriched in uranium, which may result in an acute release of radioactivity to the environment; and

- **Malevolent Acts,** which are those events where the initiating cause for a malfunction or accident was an intentional attempt to cause damage to the facility.

Malfunctions and accidents (i.e., upset conditions outside of those arising from normal operation) may be precipitated by various “initiating events” which fall into the following three categories: natural events (e.g., lightning strikes, extreme weather, earthquakes), technological causes (e.g., power outage, equipment failure) and human error. The assessments in this EIS are, for the most part, independent of the initiating event and mainly address the potential effects that would result from an accident or malfunction scenario.

Malfunctions, accidents and malevolent acts are considered at a somewhat conceptual level for three main reasons. First, although OPG maintains detailed records of past incidents, past performance does not reliably indicate future performance since, following any accident, OPG evaluates the cause of the accident and changes systems and procedures to prevent its re-occurrence. In addition, such specific information may not be applicable to the NND reactors under consideration. Second, the sequence and temporal details (i.e., date of occurrence) of future events cannot be accurately predicted and moreover, if an accident is capable of being predicted with any certainty, OPG would take the necessary steps to prevent it from occurring. Lastly, the NND Project design is preliminary in nature to the extent that there is no pre-existing facility. Thus, vendor documentation, operating experience and other relevant information from existing OPG nuclear stations was used to support the development of malfunction and accident scenarios for EA purposes.

Out of core criticality events are not considered credible scenarios. Criticality safety considerations as well as design based mitigation measures are discussed qualitatively, and a discussion of the potential environmental effects of a hypothetical out of core criticality event is undertaken. Due to the sensitive nature of postulated malevolent act event sequences, for reasons of station security these events were addressed in a high level qualitative assessment.

7.2 Conventional Malfunctions and Accidents

7.2.1 Assessment Methodology

A multi-step process was used for environmental effects of conventional malfunctions and accidents. A qualitative screening assessment was used to screen out the scenarios that were not expected to result in measurable environmental effects. The scenarios that had measurable environmental effects were considered in detail with a focus on the potential environmental pathways and modes of environmental interaction. Preventive and mitigation measures that would be in place and the magnitudes of potential releases were considered, and bounding scenarios were developed. Using comparisons with previous analyses completed at OPG facilities, professional judgement and an evaluation of credibility, the potential environmental effects of the bounding accident scenarios were identified and discussed, and residual effects were discussed where applicable.

The assessment of conventional malfunctions and accidents was done using the following steps:

- Setting the assessment basis, spatial boundaries, methods, and criteria;
- Identification of the Project phases and works and activities;
- Identification of the potential malfunction and accident scenarios considering each Project phase and work and activity;
- Consideration of mitigation measures;
- Screening of the potential malfunction and accident scenarios;
- Selection of scenarios for further assessment;
- Identification of the bounding malfunction and accident scenarios;
- Assessment of the environmental effects resulting from the bounding malfunction and accident scenarios; and
- Identification of any residual effects and forwarding of these effects to Ecological Risk Assessment (ERA) and Human Health for assessment and for an assessment of significance in Chapter 9.

Each of the Project works and activities was considered individually to determine if there was a plausible malfunction or accident scenario that would have the potential to interact with the environment. It should be noted that conventional malfunction and accident scenarios are generally common to all of the reactor technologies. It is expected that the conventional plant construction and operations are similar in nature, as indicated in the *Scope of the Project for EA Purposes TSD*, and therefore, the associated hazards would also be similar.

Malfunction and accident scenarios were identified using the following sources:

- Safety and spills assessments completed at DNGS, PNGS A and PNGS B;
- Experience from similar past EAs (PNGS A Return to Service EA, Refurbishment and Continued Operation of PNGS B EA, Darlington Used Fuel Dry Storage Facility EA, and Pickering Waste Management Facility EA);
- Experience from other nuclear generating stations in Canada, the US and abroad; and
- Vendor documentation.

A list of potential conventional malfunction and accident scenarios is given in the *Malfunctions, Accidents and Malevolent Acts Technical Support Document (TSD).* The conventional malfunction and accident scenarios identified were categorized based on the nature of the scenario. This categorized list can be found in Table 7.2-1. The table presents a brief description of each postulated conventional scenario, associated preventative and mitigation measures, and the decision regarding the initial screening of the scenario. Several factors were considered in screening the scenarios. These factors include:

- The likelihood of the malfunction and accident scenarios;
- The potential environmental effect of the scenario; and
- The preventive and mitigation measures considered for the scenarios.

The screening process determines the credibility of the postulated scenarios by identifying the inherent limitations in the available mitigation measures and the variability which may be associated with each accident category. An accident category in which many potential accident mechanisms are identified is more likely to result in an environmental interaction than one that is limited in scope due to the breadth of mitigation measures that would need to be in place to prevent the interaction.

Preventative and mitigation measures were considered for each potential malfunction and accident scenario. Primarily, mitigation measures inherent to the operation of nuclear generating stations and to the administration of construction sites (e.g. Policies, Procedures, Health and Safety Programs) are considered in the determination of the likelihood, and hence the credibility of a malfunction or accident scenario.

For the Site Preparation and Construction phase, specific measures may include but are not limited to:

- **Preparation of and compliance with conventional Environmental Impact Management Provisions** such as environmental management plans (EMPs), spill prevention and response procedures, waste management plans and occupational health and safety plans and procedures to mitigate against personnel injury; and

- **Compliance with Construction and Operation Permits** including approvals from the federal Department of Fisheries and Oceans.

For the Operation and Maintenance phase, specific measures may include but are not limited to:

- **Project Design Safety Features** – Safety features that have been incorporated into the project design, including secondary containment where applicable and appropriate instrumentation and process control;
- **Administrative Controls** – Administrative controls are applied through operating procedures, employee training, and control of work activities;
- **Environmental Management System** – conformance with ISO 14001 principles requires development of an Environmental Management System;
- **Regulatory requirements** – regulatory requirements are applied through measures such as Operating Licences;
- **Containment Structures** including dykes and double-walled storage tanks;
- **Field Monitoring and Alarm Systems;**
- **Preventive Maintenance Program; and**
- **Emergency Response Provisions** – Medical aid, fire prevention and response, spill response, and hazardous materials response. Site emergency response procedures can help to minimize or prevent environmental consequences from initiating events.

TABLE 7.2-1
Screening of Potential Conventional Malfunction and Accident Scenarios

Potential Malfunction or Accident Scenario	Preventative and Mitigation Measures/ Screening Evaluation	Project Phase/ Works & Activities	Screening Decision
Accidents involving release of fuel into the lake			
Boat or barge accident resulting in release of oil or fuel into the lake	It is expected that small personnel watercraft and barges will be used to carry out Project works and activities. All use of boats and waterways will be performed within a regulatory environment, in compliance with site safety procedures and conforming to good industry, navigation, and operational practice.	Site Preparation and Construction Operation and Maintenance	Due to the quantity of fuel that could be spilled in this scenario, a boating accident is carried forward for consideration of bounding scenarios.
Accidents involving release of fuel or oil onto land			
Transportation or vehicle accident resulting in a spill of fuel, oil, transmission fluid, hydraulic fluid, coolant or lubricant to land	The typical accident scenario could occur as a result of a leak or release of diesel fuel from a tanker trunk or a storage tank due to a traffic accident. The following mitigation measures are in place to reduce the effect of such a spill: • Safety programs for contractors and operation staff will include safe driving procedures and expectations. • All applicable transportation regulations will be followed in the movement of vehicles on the NND site. • Traffic control and speed limits will be in place. • Spill contingency and prevention plans will ensure prompt spill containment and clean-up. Likely effect after clean-up activities would be minor or negligible.	Operation and Maintenance Site Preparation and Construction	Vehicle accidents have in the past been one of the largest contributors to spills at OPG facilities. Therefore, a spill of fluid to land is carried forward for consideration of bounding scenarios.

TABLE 7.2-1 (Cont'd)
Screening of Potential Conventional Malfunction and Accident Scenarios

Potential Malfunction or Accident Scenario	Preventative and Mitigation Measures/ Screening Evaluation	Project Phase/ Works & Activities	Screening Decision
Fire event at transformer with associated release of oil due to operation of deluge system	Transformers have secondary containment to contain oil in the case of an oil spill, however, during a fire or explosion, the deluge system will release water to extinguish the fire and the oil may overflow from the containment system as a result.	Operation and Maintenance Site Preparation and Construction	Due to prior operating experience with this spill scenario and the magnitude of the resultant spill, a release of oil is carried forward for consideration of bounding scenarios.
Fuel spill from standby power generator fuel storage tank.	The following mitigation measures will be put in place for such a scenario: • The generator fuel storage tank will have secondary containment. • Regular maintenance and visual inspection will be in place to detect any structural problems with fuel storage tanks. • Spill contingency and prevention plans will be in place to ensure prompt spill containment and clean-up.	Site Preparation and Construction Operation and Maintenance	Likely effect would be minor or negligible after the clean-up. However, a spill may still have a measurable environmental effect. Therefore, this scenario is carried forward for consideration of bounding scenarios.
Spill of oil or lubricant from fuelling equipment	The typical accident scenario that could occur is human error or failure of refuelling hose or tanker truck. The following mitigation measures will be put in place to reduce the effect of such a spill: • Refuelling will be conducted by trained staff. • Spill contingency and prevention plans will be in place to ensure prompt spill containment and clean-up.	Site Preparation and Construction Operation and Maintenance	Likely effect would be minor or negligible after the clean-up. The volume of spill is not expected to result in a measurable environmental effect. No further assessment required.

TABLE 7.2-1 (Cont'd)
Screening of Potential Conventional Malfunction and Accident Scenarios

Potential Malfunction or Accident Scenario	Preventative and Mitigation Measures/ Screening Evaluation	Project Phase/ Works & Activities	Screening Decision
Accidents involving a release of chemicals			
Leak or release of chemicals from blowdown ponds for cooling towers	Specially designed ponds may be used for the treatment and retention of blowdown from the cooling towers, if they are used. This blowdown will contain concentrated chemicals used in the cooling tower process stream. The blowdown ponds will be inspected as required. Likely effect would be minor or negligible.	Operation and Maintenance	No further assessment required.
Spill of hazardous waste during handling, processing, or transport	Procedures will be in place to handle hazardous waste according to regulations and standards. Hazardous materials during waste management would be small quantities with lesser toxicity than the chemicals identified under the spill scenario for handling or process systems. Therefore, this scenario is bounded by the spill scenario for handling or process systems.	Site Preparation and Construction Operation and Maintenance	No further assessment required
Spill of sewage during tie-in to site services and utilities	Procedures will be in place to ensure that precautions are taken during tie-ins to municipal services such as sewage, and grid power. These are activities carried out routinely in the construction of new facilities and any spill would result in a local effect that will be cleaned up as quickly as possible. No effect is anticipated from this activity.	Site Preparation and Construction	No further assessment required

TABLE 7.2-1 (Cont'd)
Screening of Potential Conventional Malfunction and Accident Scenarios

Potential Malfunction or Accident Scenario	Preventative and Mitigation Measures/ Screening Evaluation	Project Phase/ Works & Activities	Screening Decision
Spill of chemicals used for construction such as cement, paints, solvents or sealants	Spill contingency and prevention plans will ensure prompt spill containment and clean-up. Likely effects would be minor or negligible after clean-up. Any effect would also be small because of the limited amounts and types of chemicals and hazardous materials used; and the Environmental Management Plan that will be in place.	Site Preparation and Construction	No further assessment required
Spill of process chemicals or fluids, lubricants or oils during maintenance and operation activities, or during transport of chemicals for addition to process systems	Process chemicals are used at nuclear power plants for maintenance of water quality, the prevention of corrosion, and other reasons. The following mitigation measures are in place to handle spills of these chemicals: • Staff training, handling procedures; • Spill contingency and prevention plans to ensure prompt spill containment and clean-up. Process chemicals typically used at nuclear power plants include: • boron or borated water • chemicals for cooling towers • hydrazine and morpholine • water treatment chemicals • lubricants and oil for pumps, turbines, and generators	Operation and Maintenance	Spills of process fluids may be attributed to equipment failure or procedural issues. Due to the variety of chemicals used at nuclear power plants, and the volumes of chemicals that could potentially spill to land or water, a spill of process chemicals is carried forward for consideration of bounding scenarios.

TABLE 7.2-1 (Cont'd)
Screening of Potential Conventional Malfunction and Accident Scenarios

Potential Malfunction or Accident Scenario	Preventative and Mitigation Measures/ Screening Evaluation	Project Phase/ Works & Activities	Screening Decision
Accidents involving fall of heavy equipment			
Crane failure resulting in damage to existing structures and facilities	Cranes will have to meet stringent safety requirements, and will have a significant safety factor in terms of lifting capability. All applicable regulatory requirements related to safe rigging and hoisting will be met. An experienced contractor with a proven safety record in undertaking heavy lifts will be used, where applicable. All of these factors provide a high level of confidence that lifts will be carried out safely.	Site Preparation and Construction Operation and Maintenance	No further assessment required
Accident involving moving heavy equipment from barge or rail	Large modular components will be moved from barges or rail cars during the construction of facilities and structures for NND. Movement will be done using cranes or lifts as required. Additionally, large pieces of equipment will be moved during refurbishment activities, such as the removal and replacement of steam generators. On-site rail spurs will be operated by trained personnel, using appropriate transportation regulations. Scheduling restrictions may be put in place to ensure the safety of other trains during deliveries of large components, if applicable. Cranes will have to meet stringent safety requirements, and will have a significant safety factor in terms of lifting capability. All applicable regulatory requirements related to safe rigging and hoisting will be met. An experienced contractor with proven safety record in undertaking heavy lifts will be used, where applicable. All of these factors provide a high level of confidence that the lifts will be carried out safely.	Site Preparation and Construction Operation and Maintenance	No further assessment required

TABLE 7.2-1 (Cont'd)
Screening of Potential Conventional Malfunction and Accident Scenarios

Potential Malfunction or Accident Scenario	Preventative and Mitigation Measures/ Screening Evaluation	Project Phase/ Works & Activities	Screening Decision
Fire and Explosion Accidents			
Fire involving hazardous waste packaging or shipment	Protocols will be in place to minimize the potential for fire during the transport and storage of hazardous waste. A fire of hazardous waste would involve small quantities and emergency and fire response plans would be put in place to mitigate against the release of chemicals to the environment. Likely effect of occurrence would be minor or negligible. .	Operation and Maintenance	No further assessment required
Blasting accidents resulting in chemical release, personnel injury, or damage to existing structures and processes	Blasting at the NND site will be done in compliance with stringent regulatory and procedural requirements, including consideration of worker safety and limitations imposed by surrounding structures. Design and construction protocols will be followed at all times, and the work will be done according to the Environmental Management Plan that will be in place. Work will be conducted such that existing DN site facilities are not unacceptably affected.	Site Preparation and Construction	No further assessment required

TABLE 7.2-1 (Cont'd)
Screening of Potential Conventional Malfunction and Accident Scenarios

Potential Malfunction or Accident Scenario	Preventative and Mitigation Measures/ Screening Evaluation	Project Phase/ Works & Activities	Screening Decision
Release of hydrogen resulting in fire or explosion	Hydrogen may be used onsite at NND as a coolant, and may be stored in a storage facility outside of the primary reactor facilities. A release of hydrogen due to an impact scenario or leakage may result in a fire or explosion in the presence of a spark. The hydrogen storage facility will be designed and located in such a way that the likelihood of external impact, such as that from a vehicle, is minimal. Regular inspection will be in place to ensure the structural integrity of the storage vessels and associated piping and accessories.	Operation and Maintenance	Due to the worker safety risk associated with a hydrogen fire, this scenario is carried forward for consideration of bounding scenarios.
Fire or explosion of transformer.	OPG has extensive policies, procedures and programs in place for fire prevention and response. Regular maintenance and visual inspection is in place to detect any structural/functional problem with the transformers.	Operation and Maintenance	Due to the potential environmental effects from a transformer fire, this scenario is carried forward for consideration of bounding scenarios.
Fire from fuel or oil	OPG has extensive policies, procedures and programs in place for fire prevention and response. During the Operation and Maintenance phase, fuel or oil may be stored in tanks, potentially resulting in a large fire. Due to the limited quantities of fuel or lubricants that would be stored on-site during construction, and construction protocols developed to minimize the potential for fire, the risk from a fire is considered minimal during this phase.	Site Preparation and Construction Operation and Maintenance	Due to the potential environmental effect of a fire during the Operation and Maintenance phase, this scenario is carried forward for consideration of bounding scenarios.

TABLE 7.2-1 (Cont'd)
Screening of Potential Conventional Malfunction and Accident Scenarios

Potential Malfunction or Accident Scenario	Preventative and Mitigation Measures/ Screening Evaluation	Project Phase/ Works & Activities	Screening Decision
Accidents involving release of gases			
Accidents involving compressed gas cylinders	All operations will be performed within a regulatory environment and conforming to design and construction protocols that will minimize the potential for personal injury, equipment damage and chemical leakage as a result of the use of compressed gas cylinders.	Site Preparation and Construction Operation and Maintenance	No further assessment required
Accidents involving occupational health and personal injuries			
Dry storage container (DSC) accident resulting in non-radiological consequence and personnel injuries (Note: Potential radiological consequences are addressed in Section 7.3.1)	An accident involving the Transporter dropping a DSC or striking another DSC in storage is unlikely. However, even if this were to occur, the low lift height and the emergency stop features would prevent any non-radiological consequence of significance.	Operation and Maintenance	No further assessment required
Personnel injury during the performance of maintenance or operation activities	Personal injuries such as pinching, electrocution, tripping, falls, overexertion injuries, impact injuries or exposure to sources of heat or steam could result during the performance of general maintenance and operating activities. OPG has extensive programs, policies and procedures in place to prevent and mitigate such health and safety events. All activities will be performed within a regulatory environment and safety culture that will minimize the potential for personal injury accidents. Having a good safety culture means that sources of hazards will be controlled or minimized through the use of PPE, barriers, hazard identification and controlled or restricted access.	Operation and Maintenance	Despite adherence to strict policies and procedures to minimize the potential for personnel injury during operation and maintenance activities, this event is still considered credible and is carried forward for consideration of bounding scenarios.

TABLE 7.2-1 (Cont'd)
Screening of Potential Conventional Malfunction and Accident Scenarios

Potential Malfunction or Accident Scenario	Preventative and Mitigation Measures/ Screening Evaluation	Project Phase/ Works & Activities	Screening Decision
Water-related accident resulting in personnel injuries and drowning	All use of boats and waterways will be performed within a regulatory environment, in compliance with site safety procedures, minimizing the potential for personal injury accidents. Personnel training and use of personal protection equipment will reduce the probability and extent of injuries.	Site Preparation and Construction Operation and Maintenance	No further assessment required
Potential personnel injury due to construction activities.	Personal injury could result from a construction accident such as a failure of temporary platforms, heavy equipment crashes, slope failures or trench collapse, etc. during creation of parking and laydown areas, movement of heavy equipment, construction of structures or buildings, and provision of NND site services. Contractors will have extensive programs, policies and procedures in place to prevent such health and safety events. All activities will be performed within a regulatory environment and conforming to design and construction protocols that will minimize the potential for personnel injury accidents.	Site Preparation and Construction	Despite adherence to strict policies and procedures to minimize the potential for personnel injury or fatality during construction activities, this event is still considered credible and is carried forward for consideration of bounding scenarios.

TABLE 7.2-1 (Cont'd)
Screening of Potential Conventional Malfunction and Accident Scenarios

Potential Malfunction or Accident Scenario	Preventative and Mitigation Measures/ Screening Evaluation	Project Phase/ Works & Activities	Screening Decision
Accidents involving sediment release during dredging			
Sediment release during water related activities (i.e. dredging, building cofferdam).	Sediment control techniques such as a silt or turbidity curtain will be used during dredging operations to prevent sediment disturbed in the dredged area from entering the area outside of that immediately surrounding where dredging is occurring. This will prevent silt or sediment from entering the surrounding water and affecting the aquatic environment. If it is determined to be necessary, a filtration system or similar mitigation measure will be used to prevent unintentional sediment release during water related activities such as dewatering. Procedures and protocols will be put in place to ensure safe dredging practices and work will not proceed should the silt curtain be damaged. Additionally, all applicable regulations with respect to dredging will be followed at all times. Likely effect of occurrence would be minor or negligible.	Site Preparation and Construction	No further assessment required

7.2.2 Identification of Conventional Malfunctions and Accidents for Further Assessment

The conventional malfunction and accident scenarios that were forwarded for further assessment following the initial screening process shown in Table 7.2-1 were categorized based on potential environmental effect and pathway. Table 7.2-2 summarizes the resultant malfunction and accident categories and the scenarios developed within each category in order to select the bounding accident scenarios for assessment.

TABLE 7.2-2
Conventional Malfunction and Accident Scenario Categories for Further Assessment

Conventional Accident and Malfunction Category	Phase of Project	Description of Developed Scenarios	Selected Bounding Scenario
Spill of oil or fuel on to land	Site Preparation and Construction, Operation and Maintenance	Leak or release of fuel oil from a tanker trunk or a storage tank during a transportation accident or a leak of fuel from a vehicle. Release of transformer oil along with deluge water during a fire scenario. Spill of fuel from standby power generator or fuel storage tank. Spill would occur either over the existing ground within the construction island or within the storage tank containment.	Release of 200,000 L of transformer oil to finished ground surface along with deluge water following a transformer fire
Spill of oil or fuel into the lake	Site Preparation and Construction, Operation and Maintenance	Boat or barge accident resulting in release of oil or fuel into the lake. Spill would occur directly to Lake Ontario.	Boating accident during marine activities that could result in a release of 40,000 L of fuel to Lake Ontario.
Spill of chemicals, oils or lubricants	Operation and Maintenance	Spill of chemicals, oils or lubricants used in process systems during storage, handling, and transportation, or spill of process fluids during operation.	Spill of 410 L of 35wt% hydrazine solution during transport
Fire and explosion incidents	Operation and Maintenance	Release of hydrogen due to an impact scenario or leakage may result in a fire or explosion in the presence of a spark. Fire or explosion of transformers or fuel oil resulting in the creation of a smoky plume.	Fire in a fuel storage tank containing approximately 900,000 L of fuel.
Personnel injury – pinching, crushing, or fall	Site Preparation and Construction, Operation and Maintenance	Injury during Project activities using heavy equipment, working at heights, working with sharp objects, etc.	Personnel injury or fatality during Site Preparation and Construction

7.2.3 Bounding Scenarios for Conventional Malfunctions and Accidents

For each category of screened scenarios one or more conventional malfunction and accident scenarios were selected as the bounding scenario. The criterion for the selection of the bounding scenario was the extent of environmental interaction resulting from the event. The bounding scenario is expected to have a greater potential environmental effect than the other scenarios within the category.

The bounding scenarios were screened for potential environmental interactions with the components identified in Chapters 4 and 5 of this EIS. Table 7.2-3 shows the results of this initial screening. The following sections provide a detailed assessment of each potential interaction to identify effects that could occur as a result of the bounding conventional malfunction and accident scenarios. Professional judgement and review of the scenario descriptions (including mitigation measures) were used in the development of the preliminary interactions.

TABLE 7.2-3
NND Interactions Matrix – Conventional Malfunctions and Accidents

Bounding Conventional Malfunction and Accident Scenario	Atmospheric Environment	Surface Water Resources	Aquatic Environment		Terrestrial Environment	Geology and Hydrogeology		Land Use		Transportation		Socio-Economic Conditions				Physical and Cultural Heritage Resources			Aboriginal Interests			Human Health	
	Air Quality	Site Discharges and Water Quality	Aquatic Biota	Aquatic Habitat	Communities and Species	Soil Quality	Groundwater Quality	Land Use	Landscape and Visual Setting	Transportation System Operations (Road, Rail, Marine)	Transportation System Safety (Road, Rail, Marine)	Human Assets	Financial Assests	Physical Assets	Social Assests	Aboriginal Heritage Resources	Euro-Canadian Built Heritage Resources	Euro-Canadian Cultural Landscape Resources	Aboriginal Communities	Traditional Land and Resource Use	Ceremonial Sites and Significant Features	Health and Well-Being of the General Public	Health and Safety of Workers
Spill of Oil to Land during Transformer Fire		◆	◆	◆	◆	◆	◆																
Spill of Fuel to Lake Ontario		◆	◆	◆																		◆	
Spill of Chemicals during Operations (Hydrazine)	◆	◆	◆	◆																		◆	◆
Fire in Fuel Storage Tank	◆																					◆	◆
Personnel Injury during Construction Activities																							◆

7.2.3.1 Spill of Oil to Land During Transformer Fire

The bounding scenario for a spill of oil to land involves a potential transformer fire scenario where the deluge water and majority of the oil (i.e. 200,000 L) would be released outside of the secondary containment onto an outdoor finished or unfinished ground surface. Atmospheric effects of the initiating fire scenario are expected to be minimal due to the rapid extinguishing of the fire by the deluge system, and are bounded by the fire in a fuel storage tank discussed in Section 7.2.3.4.

Inherent Mitigation Measures

Some large transformers at nuclear facilities contain large quantities of oil. NND will have spill prevention and contingency plans for all sources of potential chemical spills at the facility. The spill prevention and contingency plans ensure that NND will establish spill control measures to reduce the probability of spills occurring or to reduce the probability of the spilled material reaching the environment. These measures include the following:

- Constructing or installing containment structures;
- Field monitoring of fuel storage; and
- Instituting preventive maintenance programs.

As can be seen in Table 7.2-3, no interaction is expected with this scenario and the human health environmental component as the spill would be to an outdoor surface and no harmful vapours are expected from a release of oil. Therefore, potential effects on human health as a result of this scenario are not assessed further.

Surface Water Environment

It was assumed in this scenario that very little of the oil and water mixture reaches Lake Ontario directly due to the location of the spill. All of the oil in this case would be spilled to the ground. Some of the spilled oil may reach water bodies via the stormwater management ponds. The water and oil mixture could also reach water pathways through catch basins in the vicinity of the fire. These catch basins and drains would be covered immediately following the incident and absorbent material would be used to isolate the spill to prevent oil from reaching nearby catch basins.

It was anticipated that overflow of the secondary containment system would be collected by stormwater management systems. During the Site Preparation and Construction phase, provisions will be made to manage stormwater and runoff. Upon completion, this system will serve as the permanent stormwater management system for the Operation and Maintenance phase.

Appropriate sampling of the stormwater management ponds will be conducted during and following the event. Storm water will not be released to surface water bodies if the quality of water stored in the ponds does not meet the applicable quality standards. With the provisions of the storm water management system, release of water contaminated with oil to the lake is unlikely. Additionally, booms and spill control measures would be rapidly implemented by the on-site ERT to reduce the volume of oil that may reach the surface water bodies.

Consequently, it was determined that there would be no effects from this scenario on the Surface Water Environment.

Aquatic Environment

Due to the potential environmental interaction of this scenario with the Surface Water Environment, effects of this scenario on the Aquatic Environment were advanced for further assessment.

Very little of the spilled oil in this scenario was expected to reach Lake Ontario or site water bodies. Therefore, no lasting effects on the Aquatic Environment were identified as a result of this scenario.

Terrestrial Environment

The spill scenario being assessed in this case will occur on paved or gravel surface near the NND facilities. This area will be one of previously disturbed terrestrial habitat, with a primarily industrial and heavily used character. Spill management procedures, plans and protocols will be put in place to mitigate the spread of such a spill beyond the immediate area surrounding the source. The spill was expected to be rapidly contained and remediated to prevent the spread of the spill boundary. An assessment of the potential effects of this bounding scenario on non-human biota in the terrestrial environment is given in Section 7.2.5.2.

Geological and Hydrogeological Environment

In the case of a spill of this magnitude onto a gravel surface, it is possible that the spilled oil could enter the groundwater through absorption. Once the incident has been brought under control, NND will initiate activities relating to repair and restoration of the site. As this would be a spill scenario following a fire, response is expected to be rapid and containment measures would be taken to ensure the spill does not spread and to minimize contact with groundwater.

Clean-up of impacted soil and shallow sub-surface groundwater would be done and groundwater monitoring would be implemented to ensure that groundwater quality has not been impacted as a result of the spill. It is assumed additional remediation would take place if there is a change in groundwater quality. After clean-up, all chemically contaminated materials will be stored, classified and disposed of safely in accordance with Provincial HAZMAT regulations (Province of Ontario 2008). Due to the quick cleanup response anticipated by the NND spill response organization, no measurable effects on groundwater or soil quality were expected as a result of this accident scenario.

7.2.3.2 Spill of Fuel to Lake Ontario

The bounding scenario for a spill of fuel to Lake Ontario involves a potential boating accident during marine activities that could result in a release of 40,000 L of fuel to the lake.

Inherent Mitigation Measures

It is anticipated that the spatial scale of nearshore marine activities during site preparation and construction will be small and the area in which work is being done would be closed to general navigation. Marine traffic will be limited to those vessels involved in the specific activity being undertaken. Traffic and scheduling restrictions will be imposed where applicable to minimize potential accident scenarios that could occur during marine activities.

Surface Water Environment

A spill of fuel to water may result in a change in surface water quality. Following a fuel spill, steps will be taken to reduce and mitigate the local impact of the spill by containing the plume with floating containment booms and collecting the fuel from the surface of the water. Lake water sampling will also be conducted to monitor the movement of the spilled fuel and its potential to cause an adverse effect on the environment. After clean-up, collected fuel will be stored, or disposed of safely in accordance with applicable regulations.

The bounding spill was expected to be relatively small temporally and spatially, and no lasting residual effect was expected from this accident scenario. However, as a result of this fuel spill, potential environmental effects were identified via the surface water pathway as: i) local effects on the Aquatic Environment; and ii) potential for contamination of nearby drinking water supplies. These are discussed in more detail below.

Aquatic Environment

The marine activities that would initiate this accident scenario would take place during heavy construction activities and when the surrounding areas would already have been disturbed. This would minimize the number of aquatic species within the immediate vicinity of the malfunction or accident event. Additionally, marine activities would not be undertaken during inclement weather, such as high winds, when the spread of contaminants in the water may be more rapid. As the area would be quickly isolated using booms and cleanup would begin as quickly as possible following the accident, the scope of the possible effects is expected to be limited. It is anticipated that a fuel spill would have very limited local impacts on the Aquatic Environment and a residual effect on the Aquatic Environment is not anticipated. Nonetheless, an assessment of the potential effects of this bounding scenario on non-human biota in the aquatic environment is given in Section 7.2.5.1.

Human Health

If the spill can not be contained locally, the plume of spilled fuel may move toward the intake of a municipal water treatment plant. Protection of the drinking water system against a potential fuel spill will involve a multiple-barrier approach that includes:

- Preventive measures to reduce the likelihood of a fuel spill from occurring;
- Mitigation measures to contain the spilled fuel; and
- Notification to the operators of nearby drinking water systems for appropriate action.

Advanced notification procedures will be in place to inform applicable drinking water supply plant operators of any spill where there is potential for the contamination of the drinking water supply. The notification will ensure that the operator has adequate time to take precautions and appropriate actions before the plume of spilled fuel reaches the intake of the drinking water supply plant system. The limited nature of the spill that would result from this scenario would add an additional level of protection against contamination concerns.

Adverse effects resulting from a fuel spill on the quality of a neighbouring community's drinking water are very unlikely and any effects would be mitigated prior to reaching the water supply of those in the community. There were no residual effects anticipated as a result of this scenario.

7.2.3.3 Spill of Hydrazine During Operation

Hydrazine is used in relatively small quantities as a chemical conditioning agent and to control the oxygen in the plant water systems. Drum-stored hydrazine is stored and handled as 35wt% solution in 205-L drums. The bounding chemical scenario postulated that the content of two drums would be released outdoors to a finished surface, during drum movement from storage. This scenario was evaluated by the PNGS A Return to Service EA (OPG 2000a) and the Refurbishment and Continued Operation of PNGS B EA (OPG 2007c).

Inherent Mitigation Measures

Spill prevention and contingency plans will be in place and include spill control measures to reduce the probability of spills occurring and to reduce the potential effect of a spill on the environment. All personnel working with chemicals will receive training related to their job descriptions, including the proper handling of chemicals to prevent their release. Stored drums would be located at a safe distance from any potential sources of external impact.

Following a release, steps will be taken to contain and clean up the spill. Once the incident has been brought under control, NND will undertake the activities necessary in order to repair and restore the site. After clean-up, all chemically contaminated materials will be stored, classified and disposed of safely in accordance with NND procedures and applicable regulations.

Atmospheric Environment

This spill scenario was assessed in the PNGS B EA, where it was assumed that the spilled hydrazine solution would form a pool of approximately 2 m^2 and release vapours to the atmosphere. This pool size was used to calculate the concentrations of hydrazine in the atmosphere at varying distances from the source of the spill. The U.S. National Oceanic and Atmospheric Administration defines Emergency Response Planning Guidelines (ERPGs) in order to estimate the atmospheric concentrations at which most people will begin to experience health effects if they are exposed to a toxic chemical for a 1-hour period. The following three levels of ERPGs are defined for a specific chemical:

- **ERPG 1:** the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing other than mild transient health effects or perceiving a clearly defined, objectionable odour;

- **ERPG 2:** the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms which could impair the individuals ability to take protective actions; and

- **ERPG 3:** the maximum airborne concentrations below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing life threatening health effects.

For the bounding hydrazine spill, the ERPG levels and the corresponding distances at which these levels would be reached are given in Table 7.2-4. The distances are given for two scenarios: one scenario with typical meteorological characteristics (wind speed, temperature) and a second scenario with calm (low windspeed) meteorological characteristics, which would represent the conservative case.

TABLE 7.2-4
Extent of Effects from Bounding Spill of Hydrazine for Typical and Conservative Meteorological Conditions

EPRG Level	Concentration	Distance from Source	
		Typical	Conservative
1	0.5 ppm	75 m	439 m
2	5 ppm	23 m	132 m
3	30 ppm	Less than 10 m	52 m

As indicated by the values in Table 7.2-4, no perceivable effects would occur more than 439 m from NND according to the ERPG definitions for hydrazine, even when using conservative weather assumptions. It is not expected that members of the public will reside within this area.

Workers involved in the cleanup of the hydrazine spill will be exposed to higher concentrations of hydrazine in the atmosphere. These workers would wear appropriate personal protective equipment such as respirators, gloves and goggles while located within the vicinity of the spill. Workers not involved in the cleanup activities would not remain in the area.

Surface Water Environment

The postulated bounding spill scenario would result in a release of 410 L of hydrazine onto a finished paved or gravel surface at NND. It is expected that this spill would be cleaned up as quickly as possible according to the NND spill response plans and procedures; however, some of the hydrazine may enter the yard drainage system through catch basins in the vicinity of the spill. Immediately following the spill, actions will be taken to cover applicable catch basins to reduce the amount of hydrazine entering the yard drainage system. From the yard drainage system, the spilled hydrazine would enter the stormwater management system where the system would be isolated to prevent the contaminated liquid from being released into Lake Ontario. Monitoring and cleanup activities would be undertaken and the water would not be released to the lake until it was determined that there would be no risk to humans or non-human biota as a result of the spill.

Aquatic Environment

As noted above, water containing hydrazine at levels that would result in adverse effects to aquatic species in the lake would not be released via the stormwater management system. Cleanup and monitoring activities would be undertaken to ensure that there was no measurable effect on the aquatic environment as a result of this spill.

Human Health

As discussed above, no atmospheric health effects would be experienced by members of the public as a result of the bounding spill of hydrazine. Additionally, the hydrazine from the spill that is not contained at the site will drain into the stormwater management system and/or by the Emergency Response Team where it will be prevented from entering Lake Ontario until mitigation measures have been undertaken. Therefore, no effect on the public as a result of hydrazine entering the municipal drinking water supply is expected.

Workers may be exposed to higher concentrations of hydrazine during cleanup activities for the spill; however, the use of proper personal protective equipment and hazardous material cleanup procedures will provide adequate protection against adverse health effects.

Consequently, no residual effects are expected on the human health environmental component as a result of the bounding spill of hydrazine.

7.2.3.4 Fire in Fuel Storage Tank During Operation and Maintenance

This scenario involves a fire in a fuel storage tank, which contains approximately 900,000 L of fuel.

Inherent Mitigation Measures

Fire response plans will be developed at NND to prevent and mitigate fire scenarios. These will include that an Emergency Response Team be in place to provide immediate onsite assistance in minimizing the effects of a fuel storage tank fire.

Design features would also contribute to mitigating the effects of this fire scenario. A fire extinguishing system using a chemical fire suppression agent may be activated to douse the flames. Adequate material is used to ensure that the fire does not spread and to minimize the resultant smoke plume. Providing the storage tank fire was extinguished as rapidly as expected due to the suppression system and/or rapid response by the Emergency Response Team, it is reasonable to assume that only a small portion of the fuel would burn prior to the fire being put out.

Atmospheric Environment

The fire suppression system that may be activated automatically to extinguish the fire as soon as the fire is detected will help to minimize the effects of this accident scenario on the Atmospheric Environment component. Additionally, an Emergency Response Team would be deployed immediately to extinguish the fire. Though it is possible that some of the fuel could burn off prior to the fire being extinguished, effects resulting from this scenario would be limited in scope and magnitude and are therefore not anticipated to result in a lasting change to the environment.

For comparison, in August of 2008, a number of propane tanks at a handling facility in Toronto, Ontario exploded resulting in a fire involving approximately 16,300 L of propane and a large, smoky plume. Fire fighters collected and analysed air quality samples within the two to four weeks following the fire and determined that there was no air quality hazard as a result of the fire (City of Toronto 2008). The control of dust and continued monitoring of air quality parameters was undertaken to ensure that there were no long term effects. Environmental clean-up and disposal crews were employed to remediate the area while minimizing environmental interactions. Similarly stringent measures will be put in place following a fire at NND if applicable.

Environment Canada (EC) cites *in situ* burning of oil spills to water as an effective clean-up method, despite the visible smoke plume. Tests for air and water quality during oil burns were completed and it was found that levels of most of the substances that were released through the in-situ burning of crude oil were below human health limits within 500 meters downwind of the source. According to EC, an international group of scientists and spill response specialists have been carrying out laboratory tests and more than 45 large-scale burns over the past decade to study various aspects of diesel and crude-oil burning (EC 2001).

The burning of fuel oil is largely accepted to result in minimal effect to the Atmospheric Environment provided that measures are put in place to stop the fire as rapidly as possible in order to minimize the extent of the smoke plume.

<u>Human Health</u>

For the bounding fire scenario, effects on the Human Health environmental component could potentially include effects on members of the public and on workers.

Workers near to the fire would be exposed to the smoke or heat resulting from the event. However, due to the rapid extinguishing of the flames with the suppression system and/or by the Emergency Response Team, no significant spread in flames or smoke is anticipated. Appropriate fire training will be given to personnel, and station emergency response plans and protocols will be put in place including considerations for evacuations of specific plant areas. Fire prevention methods, such as the performance of maintenance procedures and inspections, will reduce the probability of such a scenario occurring and, as a result, the probability of a worker experiencing effects as a result of the accident.

The limited scope of this event would minimize effects on members of the public through the atmospheric pathway as a result of a fire in a fuel storage tank.

7.2.3.5 Personnel Injury During Construction Activities

This scenario involved a lost-time injury to, or fatality of, a tradesperson as a result of an accident during the Site Preparation and Construction phase of the Project.

<u>Inherent Mitigation Measures</u>

Health and Safety Plans will be put in place during the construction of NND facilities and structures. Trades employed for site preparation and construction activities will be qualified to perform their duties, properly trained in job safety procedures, and certified where applicable. The contractor will be required to prepare a Site-specific Safety Plan that will be reviewed by OPG for acceptability before undertaking work on the NND site. OPG is committed to maintaining low numbers of accidents and injuries at the Darlington and Pickering Nuclear Generating Stations and this philosophy will be carried forward to NND.

Human Health

Despite the emphasis put on safety by OPG, it is likely that some lost-time injuries will occur, and it is possible that some injuries may result in worker fatalities during the Site Preparation and Construction phase at NND. The statistics for construction accidents indicate that injuries are generally a fairly common part of working in construction due to the physical nature of the work, regardless of the programs and policies put in place to prevent and mitigate injury. The quantity and magnitude of these incidents will be minimized where possible using safe work practices. Procedures and programs will be in place to ensure safe working conditions and compliance with provincial health and safety regulations.

Construction activities carried out within the Province of Ontario are subject to the *Occupational Health and Safety Act (OHSA)*. The purpose of the *OHSA* is to protect workers against health and safety hazards on the job. The *OHSA* imposes duties on employers and workers, and affords workers the right to refuse work that they feel is unsafe.

As per the *OHSA*, a Health and Safety Committee and representatives will be put in place at the NND site. Equipment inspection programs, requirements for personal protective equipment, and the hiring of appropriately certified workers will help to minimize accident incidents during construction activities. OPG, as the owner of the construction project, will be responsible for ensuring that the requirements to meet the *OHSA* will be included in contracts.

Historically, injury rates at OPG facilities compare favourably with those reported for the Province of Ontario. (OPG 2009c) For the year 2007, the Construction Safety Association of Ontario (CSAO) reported 1.96 lost time injuries per 200,000 hours worked in the construction industry. For the same period, OPG reported no lost time injuries for construction contractors at OPG facilities. In 2007, the all-injury rate reported by the CSAO was 6.64 injuries per 200,000 hours worked, which was more than triple the OPG reported rate of 2.08 injuries per 200,000 hours worked by construction contractors. The common injury modes for OPG construction contractors are the same as those for all of Ontario, and include falls and impact accidents (being struck by or against an object).

The lower injury rates for construction contractors employed by OPG are the result of the specific measures put in place to ensure the health and safety of workers at OPG facilities and the emphasis put on safety by OPG. In order to ensure that the site preparation and construction activities at NND are carried out safely, OPG will pre-qualify contractors prior to engaging them in contracted work. This pre-qualification process includes safety as one of the evaluation criteria. The contractor will be required to prepare a Site-specific Safety Plan that will be reviewed by OPG for acceptability before undertaking work on the NND site.

It is expected that the rates of injury or fatality for employees working on the construction of NND facilities will be equal to or less than those at other construction sites for jobs of similar duration and complexity within Ontario. Therefore, if the workers were not employed at the NND site, they would be exposed to similar risk at another construction site within the Province.

7.2.4 Mental and Social Health Effects from Conventional Malfunctions and Accidents

Mental and social health effects could result from a conventional malfunction or accident if members of the public have concern over the effects that the accident may have on their well-being and community. OPG has specific procedures that govern communications with the public regarding on-site accidents and malfunctions. It is anticipated that similar programs and policies will be put in place at NND. Notification of an accident scenario and frequent follow-up communication with members of the public and workers on the progress of mitigation activities will help to minimize potential concerns about the accident. Additionally, frequent communication on regular station activities, as well as the implemented emergency response programs and policies, will help to provide a sense of safety and security with NND.

No residual human health effects were determined to result from credible conventional malfunction and accident scenarios associated with the Project.

7.2.5 Effects of Conventional Malfunctions and Accidents on Non-Human Biota

The bounding spill scenario of a spill of fuel to Lake Ontario could have a potential adverse effect on the Aquatic Environment. The bounding spill scenario of a spill of oil to land following a transformer fire could have a potential adverse effect on the Terrestrial Environment. In the following sections, a high level assessment of the effects of these bounding spills on the aquatic and terrestrial environment is provided. The assessments assume that a potential spill will be responded to and contained immediately, the spilled chemical will be removed to the extent possible, and the site will be cleaned and restored to the original conditions within a reasonable timeframe. It was also assumed that during these remediation activities, the access of wildlife to the spill site (terrestrial only) will be prevented in order to minimize the exposure.

7.2.5.1 Effects of Spill of Fuel to Lake Ontario on the Aquatic Environment

Immediately following a spill of fuel to the lake, spill response will be initiated and activities to contain and clean up the spill will begin. It is anticipated that a small fraction of the spilled fuel may be left following clean up activities. Natural processes will reduce the severity of the residual fuel contamination and accelerate the recovery of an affected area. Some of these processes include:

- Weathering and wave action resulting in natural dispersion;
- Evaporation of lighter or more volatile substances within the fuel mixture;
- Oxidation;
- Biodegradation; and
- Emulsification.

Refined products, such as kerosene, gasoline and No. 2 diesel fuel contain a high proportion of volatile components with relatively high vapour pressure. These may evaporate within a few hours after a spill event and, therefore, some toxic substances in the spilled fuel may evaporate quickly from the surface of the water. Consequently, exposure of aquatic biota to the most toxic substances in the spilled fuel will be reduced with time, and in the case of small spills or spills which are cleaned up effectively, the exposure is usually limited to biota within the initial spill area.

Lake Ontario aquatic environments are made up of complex interrelations between phytoplankton and zooplankton communities, aquatic invertebrates, fish, waterfowl, a limited number of other species, and the physical environment in which they live. The potential adverse effects of a spill scenario vary among the locations of the spill in the lake.

In open water, most fish will swim away from a spill by going deeper in the water or further out to the lake, reducing the likelihood that they will be exposed to the spilled fuel. Some fish mortality would be expected, but it expected that these species would repopulate the area quickly and no population level effects are expected. The exposure to benthic invertebrates is minimal in these areas.

In shallow waters or near shorelines, aquatic animals that generally live closer to the shore, such as turtles and waterfowl, are more exposed to the spilled fuel. Aquatic invertebrates are also more exposed to the spills in these areas. The effect of the spill on zebra mussels could be greater since they are attached to substrate rocks near the shore. Attached algae growing on the near shore rocks will also be impacted. If there is mortality in the invertebrate population, it is expected that they will re-colonize the area relatively quickly, particularly the zebra mussels and attached algae.

Exposed sand or gravel around the shorelines will be remediated after the spill event. Although fuel oil can soak into the sand and gravel, few organisms use this habitat, so the risk to animal life or the food chain is less in this area. In addition, the fuel mixture does not have large portions of non-volatile components and is very unlikely to leave residual non-volatile components in the shorelines. As with the invertebrate population, a small effect on the populations of aquatic animals and waterfowl may occur, however it is expected that there will be no population level or lasting effects.

As a result of the mitigation measures that will be put in place and the characteristics of the environment that is expected to be affected by the spill, no residual effects on the aquatic environment are expected as a result of the bounding spill of fuel to Lake Ontario.

7.2.5.2 Effect of an Oil Spill to Land during Transformer Fire on the Terrestrial Environment

An oil spill can harm birds and mammals in several ways: direct physical contact, toxic contamination, destruction of food sources and habitats, and reproductive problems. The areas that could potentially be affected by the identified bounding spill scenario are unlikely to provide permanent habitat and food source for birds and mammals.

Shortly after a spill, the Emergency Response Team will begin to engage in cleanup activities. There will be personnel and emergency response equipment and the area will be heavily disrupted. In the spill of oil to land as a result of a transformer fire, fire fighting personnel and fire engines will also be present. The areas affected by the spill will be secured immediately following a spill and this will limit the access of wildlife to the affected area. However, some bird mortality may be expected as a result of the spill. Physical contact of non-human biota with the spilled oil and the resultant potential toxic contamination of birds and mammals are not expected to have a measurable effect on species within the region of the spill.

Soil invertebrates such as earthworms living at the site affected by a potential spill will likely experience adverse effects. However, the affected population will repopulate the area shortly after the clean-up operations and remediation of the site of the spill.

As a result of the mitigation measures that will be put in place and the characteristics of the environment that is expected to be affected by the spill, no residual effects on the terrestrial environment are expected as a result of the bounding spill of oil to the ground as a result of a transformer fire.

7.2.6 Summary of Residual Effects

The results of the conventional malfunctions and accidents assessment carried out in the, *Malfunctions, Accidents and Malevolent Acts TSD* are summarized in Table 7.2-5 below.

TABLE 7.2-5
Results of Conventional Malfunction and Accident Assessment

Scenario	Potential Environmental Effects	Mitigation Measures	Residual Effects
Release of 200,000 L of transformer oil to finished or gravel ground surface along with deluge water following a transformer fire	Surface water effects due to oil draining into catch basins or stormwater management system	• Cover catch basins immediately following the event • Testing of stormwater in ponds prior to release to Lake Ontario	Limited local effects are anticipated from this scenario; however, no long term or residual effects are expected.
	Terrestrial and hydrogeological effects due to spill on land	• Rapid response and cleanup of the spill • Remediation of effected land areas	
Boating accident during marine activities that could result in a release of 40,000 L of fuel to Lake Ontario.	Surface water and aquatic effects due to spill of fuel directly to water	• Rapid containment and clean-up of the spill	Local changes in water quality are expected immediately following the accident, but it is anticipated that mitigation measures will contain potential effects to within a limited area. This accident is expected to occur in an area where extensive construction activities are occurring and any aquatic habitat or species would already be disturbed. No residual effects are expected from this scenario.
	Human health effect due to contamination of the drinking water supply	• Notification plan for nearby water supply plants to ensure contaminated water does not enter drinking water supply	
Spill of 410 L of 35wt% hydrazine solution during transport	Air quality effect from evaporation of hydrazine spill	• Rapid containment and cleanup would be undertaken • Workers would wear proper personal protective equipment to prevent exposure to hydrazine vapours	The potential effects of this scenario were considered by comparison to the assessments completed for a similar spill for the Pickering B EA and PARTS EA and it was determined that no residual effects are anticipated as a result of this accident scenario.

TABLE 7.2-5 (Cont'd)
Results of Conventional Malfunction and Accident Assessment

Scenario	Potential Environmental Effects	Mitigation Measures	Residual Effects
(cont'd) Spill of 410 L of 35wt% hydrazine solution during transport	Surface water effect from release of hydrazine into lake	• Covering of catch basins in the vicinity of the spill to reduce the magnitude of the release to water	
	Human health effect on workers from exposure to hydrazine.	• Use of proper personal protective equipment to mitigate worker health risks	
Fire in a fuel storage tank containing approximately 900,000 L of fuel.	Air quality effect from smoke plume resulting from the fire	• Possible fire suppression system to rapidly extinguish flames and limit the size of the smoky plume • Rapid Emergency Response to fire	A fire involving a fuel storage tank is expected to be rapidly extinguished and therefore atmospheric effects are expected to be short term and local in scope. Workers in the vicinity of the fire will be required to leave the area immediately, and those remaining will wear appropriate personal protective equipment. Limited local effects are anticipated from this scenario; however, no long term or residual effects are expected.
	Human health effect to workers from exposure to smoke and heat from the fire and to members of the public through atmospheric effects	• Possible fire suppression system to rapidly extinguish flames • Rapid response to fire scenarios to limit the number of people within the vicinity of the fire • Worker training on fire safety and response	
Lost time accident to, or fatality of, personnel during Site Preparation and Construction Phase	Human health effect to the health and safety of workers	• Use of proper personal protective equipment to prevent injuries to workers • Procedures and programs to ensure safe working conditions and compliance with provincial health and safety regulations	The effects of this scenario are not expected to be distinguishable from the effects of working on any other construction project. Therefore, no residual effects are anticipated for this accident scenario.

7.3 Nuclear Malfunctions and Accidents

Nuclear accidents are defined in the EIS Guidelines (Section 12.2) as: " *…all accidents and malfunctions with radiological consequences. These accidents may be further subdivided into nuclear accidents directly involving the reactor core (such as serious damage to the reactor core), nuclear accidents involving other on-site nuclear power plant facilities that contain radiological substances (including the storage of spent fuel waste and radioactive waste handling facilities) and nuclear accidents related to the off-site transportation of low and intermediate-level radioactive waste. Accidents that do not directly involve the reactor core include criticality events associated with the nuclear fuel"*.

Nuclear malfunctions and accidents, as defined in the EIS Guidelines noted above, have been divided into four sub-categories for the purposes of this assessment:

- **Radiological Malfunctions and Accidents -** events that involve radioactive substances and components within nuclear power plant facilities other than those directly associated with the reactor and its auxiliaries, such as the radioactive waste and used fuel storage facilities;
- **Transportation Accidents** - those malfunctions and accidents related to the off-site transportation of low and intermediate-level radioactive wastes;
- **Nuclear Accidents -** those malfunctions and accidents that are assumed to involve the operation of the reactor and associated systems and may involve damage to the fuel bundles and/or the reactor core and which could result in an acute release of radioactivity to the environment; and
- **Out of Core Criticality -** malfunctions and accidents that involve criticality events outside of the reactor core resulting from the improper spacing or moderation of nuclear fuel enriched in uranium.

7.3.1 Radiological and Transportation Malfunctions and Accidents

Radiological malfunctions and accidents, as defined in the *Malfunctions, Accidents and Malevolent Acts TSD*, are events that involve radioactive substances and components within nuclear power plant facilities other than those directly associated with the reactor and its auxiliaries, such as the radioactive waste and used fuel storage facilities. These accidents are addressed in the *Nuclear Waste Management TSD* where nuclear waste and used fuel transportation, processing and storage are discussed in detail.

Transportation Accidents are defined as those malfunctions and accidents related to the off-site transportation of low and intermediate-level radioactive wastes. These accidents are addressed in the *Nuclear Waste Management TSD* and the *Malfunctions, Accidents and Malevolent Acts TSD.*

7.3.1.1 Bounding Scenarios for Radiological Malfunctions and Accidents

In the determination of bounding radiological malfunction and accident scenarios, waste management activities (processing, storage and transportation) where a potential for an accident scenario existed were identified for the following waste categories:

1) L&ILW;
2) Refurbishment Waste;
3) Used Fuel Processing and Dry Storage.

Accident scenarios were developed through a consideration of potential internal and external initiating events that could result in an abnormal release of radioactivity to the environment during waste management activities. These scenarios were evaluated qualitatively to select a bounding scenario and the bounding scenarios were assessed for potential effects to the environment.

It should be noted that the regulatory dose limit for members of the public is 1 mSv/yr (1,000 µSv/yr) and the regulatory dose limit for NEWs is 100 mSv over 5 years (i.e. an average of 20 mSv/yr) with a maximum of 50 mSv in a single year. These regulatory limits were used for comparison with the doses resulting from the bounding radiological malfunction or accident scenarios. As accident scenarios are a one time occurrence, the 50 mSv maximum annual dose is used as the regulatory dose limit for comparison to the worker dose resulting from the accident.

<u>L&ILW</u>

The bounding malfunction or accident scenario for LLW is a pool fire (spill of gasoline or diesel fuel from a material handling vehicle that catches fire beside a stack of waste containers) during the placement of a waste container on the top row in a Low Level Storage Building (LLSB). The hypothetical radiation dose to a member of the public from this fire was calculated to be 14 µSv which is less than 2% of the regulatory limit for a member of the public. The hypothetical radiation dose to the NEW in this fire scenario is 14.2 mSv which is about 28% of the regulatory maximum annual dose to a worker.

The bounding malfunction or accident scenario for ILW is a pool fire (spill of gasoline or diesel fuel from a material handling vehicle that impacts on the waste) involving transfer of an intermediate level waste form such as a 3 m^3 resin liner. Intermediate waste packaging is assumed to be robust enough and response time is assumed to be rapid enough that only a "confined" burn occurs. In a confined burn, waste is not ejected from the container, however gaskets may fail and internal gases would be allowed to escape from the container. The hypothetical radiation dose to a member of the public was calculated to be 83 µSv for a pool fire involving intermediate level waste which is about 8% of the regulatory limit to a member of the public. The hypothetical dose to a NEW is 1.43 mSv which is about 3% of the regulatory maximum annual dose to a worker.

Refurbishment Waste

Two bounding scenarios were developed for refurbishment waste. The first scenario is the drop of a refurbishment waste container containing intermediate level waste during material handling or storage. It is assumed that the container is a robust container similar to the retube waste containers being stored at the WWMF. It was determined that the maximum hypothetical radiation dose from the drop of a waste container is 0.7 µSv to a member of the public which is less than 1% of the regulatory annual limit for radiation dose to a member of the public. The dose to a NEW due to this postulated scenario is 4.1 mSv which is about 8% of the regulatory maximum annual radiation dose limit for radiation dose to a worker.

The second bounding scenario for refurbishment waste is the drop of a steam generator. Any openings in a steam generator would either be bolted or welded shut prior to transfer to storage. During waste moving and loading into a storage building, any potential drop would be quite short in distance. Because the steam generator is a heavy pressure vessel, any damage would be limited to rupture of the bolted or welded cover. A hypothetical public radiation dose of <0.1 µSv to a member of the public (less than 0.01% of regulatory annual radiation dose limit to a member of the public) was determined from the bounding scenario. The dose for a NEW was determined to be 609 µSv (about 1% of the regulatory maximum annual radiation dose limit to a worker) from this bounding scenario.

Used Fuel Processing and Dry Storage

All of the three reactor technologies considered were assessed to determine a bounding malfunction and accident scenario for used fuel processing and dry storage. For all of the three reactor technologies, the bounding case is postulated to be a drop of a loaded fuel dry storage canister causing damage to 30% of the fuel elements. For the EPR and AP1000 reactors, two cask sizes were included in the assessment (24 assembly and 40 assembly capacity) but the 40 assembly cask was assumed to provide the bounding doses for the accident scenario.

For the ACR-1000, the acute off-site dose consequence resulting from this stylized scenario for a member of the public at the DN site fenced boundary is estimated to be 21.6 µSv. This is approximately 2% of the regulatory dose limit for members of the public. The estimated acute maximum dose to a worker in the vicinity of the event scenario is 3.2 mSv, which is approximately 7% of the regulatory maximum annual radiation dose limit to a NEW. For the EPR and AP1000, the hypothetical maximum radiation dose from the bounding accident scenario is 240 µSv for a member of the public. The dose estimate is about 24% percent of the regulatory dose limit for members of the public. The estimated acute maximum hypothetical radiation dose to a worker in the vicinity is 33.9 mSv. This is approximately 68% of the maximum annual one year radiation dose limit for a NEW. Given the robust container designs, these consequent doses are considered to be very conservative.

7.3.1.2 Human Health Effects from Radiological Malfunctions and Accidents

As evidenced by the doses noted above, the doses to members of the public and to NEWs resulting from each of the bounding radiological accidents associated with L&ILW, refurbishment waste and used fuel waste management activities are all less than the regulatory dose limits. If a radiological malfunction or accident scenario were to occur, procedural measures would be taken to monitor worker dose so that dose remained below the cumulative dose criteria of 100 mSv in 5 years.

It is possible that some mental and social effects on workers and members of the public could occur as a result of a radiological accident scenario. The implementation of emergency response procedures and programs to ensure appropriate clean up and remediation measures are taken where applicable will assist in restoring feelings of safety and security for NEWs and members of the public. OPG has specific procedures that govern communications with the public regarding on-site accidents and malfunctions. It is anticipated that similar programs and policies be put in place at NND. Notification of an accident scenario and frequent follow-up communication with members of the public and workers on the progress of mitigation activities will help to minimize potential concerns about the accident. Additionally, frequent communication on regular station activities, as well as the implemented emergency response programs and policies, will help to provide a sense of safety and security with NND.

Consequently, no residual human health effects are expected from radiological malfunctions and accidents as a result of the NND Project.

7.3.1.3 Effects of Radiological Malfunctions and Accidents on Non-Human Biota

The largest potential dose resulting from a radiological malfunction or accident scenario would be from the drop of a 40 assembly cask. This scenario is the bounding scenario for the EPR and AP1000 reactors and assumes that following the drop of a cask that 30% of the fuel elements fail. In this situation, the maximum dose to a worker was estimated to be about 33.9 mSv (which for beta and gamma emitters is equivalent to 33.9 mGy), primarily from immersion in the plume of noble gas assumed to be released at the time of the accident. This is a conservative estimate of dose to non-human biota as none are expected to be as close to the plume source as workers at the time of the accident. The United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR 1996) concluded that for acute exposures, significant effects to non-human biota are unlikely below a dose of about 1,000 mGy. Thus, no potentially significant effects to populations of non-human biota would be expected.

7.3.1.4 Transportation Accidents

The Nuclear Waste Management Division (NWMD) of OPG has the overall accountability for the transportation of radioactive material. It operates a Radioactive Material Transportation (RMT) program, authorized under the *NSCA,* that includes a fleet of tractors, trailers and specialized packaging, a maintenance facility, operational staff and comprehensive procedures governing its activities. The RMT program also transports non-radioactive material (e.g., work clothing to and from the Bruce Power laundry facility) and new used fuel dry storage containers from the manufacturing facilities. The RMT program will be expanded as required to meet the needs of NND.

OPG has an excellent radioactive materials transportation safety record. In an average year for the overall OPG RMT program, over 900 shipments of radioactive materials are consigned, and/or carried by OPG, traveling approximately 500,000 km. Materials shipped include contaminated tools and equipment, low and intermediate level radioactive waste, solid and liquid samples, used fuel, and tritiated heavy water which is currently transported from PNGS and the Bruce Power NGS for processing at the Tritium Removal Facility located on the DN site. In the more than 35 years that OPG has been transporting radioactive materials, involving in excess of 11.5 million km travelled, only five shipments have been involved in traffic accidents. Three accidents involved trucks transporting low-level waste; and two involved the transportation of heavy water. There were no releases of radioactivity to the environment as a result of these accidents.

The RMT program is supported by the following elements:

- Packaging designed, fabricated, and tested in accordance with applicable regulations and standards;
- Regular audits and reviews of transportation procedures;
- An on-going Transportation of Dangerous Goods Class 7 (radioactive materials) training program;
- A rigourous transportation package inspection and maintenance program; long service-life packages are also subject to an aging management program;
- Over-sight of high-hazard and non-routine shipments;
- Procurement and engineering support for transport and work equipment; and
- A Transportation Emergency Response Plan that is audited both internally and externally by authorities like Transport Canada.

All radioactive material shipments are logged into a computerized database that compiles information regarding the type of material being transported, point of origin, destination, shipper, and carrier.

The Packaging and Transport of Nuclear Substances Regulations under the *NSCA* identify four categories of packaging for use in the transport of nuclear substances, specifically: excepted packaging, industrial packaging, Type A and Type B. These packaging types provide increasing levels of protection from radiological releases depending on the activity and quantity of the contents. The performance of the packages is assessed during routine conditions of transport, normal conditions of transport (which include minor transport related incidents such as rough handling) and accident conditions. To verify the performance and integrity of each packaging type, the containers are also subjected to tests including a drop from heights, stacking tests and penetration tests. If additional transportation packages are required for the transport of specific radioactive wastes from NND, these packages would be designed, certified as necessary, and procured according to OPG's existing processes. All radioactive materials transportation packages will comply with Canadian Packaging and Transport of Nuclear Substances Regulations.

Future transportation of L&IL radioactive materials for NND to an off-site licensed facility will be conducted under the RMT program as outlined above. The timing of shipments will depend on the final decision on whether the L&IL waste will be stored on-site versus off-site, the waste forms, and the availability of an alternate off-site licensed facility for either interim storage or disposal. The bounding volume of LLW that would require shipment to an offsite facility for processing and storage is estimated at approximately 38,700 m^3 which would result in approximately 1,935 truck shipments of 20 m^3 each, or two to three truck shipments per month during the 60-year operating life of NND. The bounding volume of ILW that would require shipment to an offsite facility is approximately 688 m^3 per unit, which would require two to three truck shipments per month during the operating period. During the refurbishment year for a reactor, approximately two additional shipments per day would be required for refurbishment waste shipment.

OPG has the capability of responding to a transportation malfunction or accident involving radioactive material through its Radioactive Material Transportation Emergency Response Plan (TERP). The TERP identifies OPG's responsibilities during a transportation malfunction or accident involving a shipment of radioactive material, and identifies the liaison and potential interface with external emergency response organizations. The TERP also includes requirements for personnel training, procedures and equipment, a mutual aid agreement (Mutual Initial Response Assistance Agreement) with other nuclear facilities and a service agreement with an external spills contractor.

Under the *Transportation of Dangerous Goods Act (TDG)* and its Regulations, the Shipper is required to have emergency response capability, and to file an emergency response plan with the Director General, Transport Canada, when transporting quantities which exceed a threshold value. Transport Canada assesses the acceptability of the identified response capability and confirms the feasibility of the outlined emergency response plan. The TERP program is tested annually using drills and exercises to practice emergency response capability, and to provide the means to test the effectiveness of different aspects of emergency response capability and identify areas for improvement.

As evidenced above, comprehensive control and mitigation measures are in place to prevent a release of radioactivity resulting from a transportation accident involving a shipment of L&ILW. Though transportation accidents may be possible, based on the extensive operational history and considering the robustness of the packaging and the other precautions taken to ensure the safety of workers and members of the public, any such accident is not likely to result in an effect on the environment or on human health. Consequently, transportation-related accidents are not considered further.

7.3.2 Nuclear Accidents

Nuclear accidents, for the purposes of this assessment, are those malfunctions and accidents that are assumed to involve the operation of the reactor and associated systems and may involve damage to the fuel bundles and/or the reactor core and which could result in an acute release of radioactivity to the environment. The fundamental causes of nuclear accidents are well understood and an extensive body of knowledge and expertise exists in Canada and internationally. Common principles of reactor safety have been developed and implemented in order to ensure the risk to workers, the public and the environment is controlled to acceptable levels.

The underlying principles of reactor safety are to ensure that measures are in place to control the nuclear chain reaction, cool the fuel, and ultimately, to contain any radioactivity that may be released from the reactor should the first two functions prove unsuccessful.

A major nuclear accident at a NND reactor could occur only if there were an imbalance between heat produced in the fuel and heat removed by the engineered cooling systems. The severity of the accident depends on the amount of fuel that overheats and the magnitude of the temperature excursion until cooling can be restored. In general, the more severe the accident, the more equipment failures and human errors that are necessary for it to occur; and therefore, the less likely the event is to occur.

Whatever the nature of the accident inside the containment structure, these events can pose a potential threat to the environment only if radioactivity escapes from NND in an uncontrolled manner. This would require an accident causing major damage to fuel in the reactor core, an opening in the containment structure and an internal driving force sufficient to expel the radioactivity into the environment.

The reactors being assessed for NND are enhancements of designs currently operating and have a variety of characteristics that make them safer to operate. These Generation III+ reactors incorporate a number of passive safety features that are reliant on natural forces such as gravity or convection, which are designed to work in the case of a loss of power.

Regardless of the reactor design selected, administrative means such as procedures, training and practice drills will be used to ensure the safety of the public and NND workers in the case of an emergency. Off-site emergency preparedness and response is described in the *Emergency Planning and Preparedness TSD.* On-site measures such as assembly and accounting programs, on-site emergency preparedness groups, procedures and protective equipment will be used to provide confidence that appropriate worker actions will be taken for the safety of the public and NND workers.

7.3.2.1 Safety Goals

CNSC Regulatory Document RD-337, *Design of New Nuclear Power Plants*, (CNSC 2008b) identifies qualitative and quantitative safety goals for new nuclear reactors. The NND reactors will meet these goals, which are further described below.

The following two qualitative safety goals are established in Regulatory Document RD-337:

- Individual members of the public are provided a level of protection from the consequences of nuclear power plant operation such that there is no significant additional risk to the life and health of individuals; and

- Societal risks to life and health from nuclear power plant operation are comparable to or less than the risks of generating electricity by viable competing technologies, and should not significantly add to other societal risks.

The following quantitative safety goals are established in Regulatory Document RD-337:

- Core Damage Frequency (CDF) – The sum of frequencies of all event sequences that can lead to significant core degradation is less than 10^{-5} per reactor year;

- Small Release Frequency (SRF) – The sum of frequencies of all event sequences that can lead to the release to the environment of more than 10^{15} Bq of I-131 is less than 10^{-5} per reactor year. A greater release may require temporary evacuation of the local population; and

- Large Release Frequency (LRF) – The sum of frequencies of all event sequences that can lead to release to the environment of more than 10^{14} Bq of Cs-137 is less than 10^{-6} per reactor year. A greater release may require long term relocation of the local population.

7.3.2.2 Expected Reactor Performance

Before discussing the assessment results related to a specific nuclear release scenario, it is useful to summarize the expected performance of the three reactor technologies with respect to their expected event frequencies and consequences for severe nuclear accidents. More detailed explanations and references are provided in the *Malfunctions, Accidents and Malevolent Acts TSD.*

<u>ACR-1000:</u>

- The design target for core damage frequency (from internal events) is between $8x10^{-8}$ and $8x10^{-7}$ per reactor year and has been calculated to be $1.8x10^{-7}$ per reactor year, significantly better than the Regulatory Document RD-337 (CNSC 2008b) requirement for core damage frequency of less than $1x10^{-5}$ per reactor year. This is also better than the RD-337 LRF safety goal frequency. (Note that in order for a large release of radioactivity to occur, there must be a failure of containment function in addition to core damage. Therefore, the large release frequency will be lower than the frequency of core damage alone, as the core damage must occur in conjunction with a loss of containment in order for a release of radioactivity to the environment to occur.)

- Beyond Design Basis Accidents (BDBA) are characterized by CNSC Regulatory Document RD-310 *Safety Analysis for Nuclear Power Plants* (CNSC 2008a) to have a frequency of less than $1x10^{-5}$ per year, which is also the Regulatory Document RD-337 SRF maximum frequency limit. The ACR-1000 analysis of two significant BDBAs has shown that the release of I-131 from containment in these BDBA events is well below $1x10^{15}$ Bq, the SRF I-131 threshold release limit.

<u>*EPR:*</u>

- The calculated core damage frequency (from internal events) is approximately $5.9x10^{-7}$ per reactor year. This is significantly better than the Regulatory Document RD-337 requirement for core damage frequency of less than $1x10^{-5}$ per reactor year, and also better than the Regulatory Document RD-337 LRF safety goal frequency. (Note that a large release requires failure of containment in addition to core damage.)

<u>*AP1000:*</u>

- The calculated core damage frequency (from internal events) is approximately $5.1x10^{-7}$ per reactor year. Again, this is significantly better than the Regulatory Document RD-337 requirement for core damage frequency of less than $1x10^{-5}$ per reactor year, and also better than the Regulatory Document RD-337 LRF safety goal frequency. (Note that a large release requires failure of containment in addition to core damage.)

This provides confidence that the Regulatory Document RD-337 safety goals will be met with sufficient margin on frequency and consequence, as required by the EIS guidelines. These safety goals were specified by the CNSC to ensure that the risk posed by a nuclear power plant to members of the public living near the plant is small compared with the risks to which they are normally exposed.

7.3.2.3 Emergency Response Measures

Emergency Response Planning for nuclear emergencies has been described in Chapter 2 of the EIS and in more detail in Chapter 3 of the *Emergency Planning and Preparedness TSD*. In brief, the aim of the Federal Nuclear Emergency Plan (FNEP) is to minimize the impact of a nuclear emergency on the health, safety, property and environment of Canadians. FNEP provides a framework for emergency planning, while recognizing that the responsibility to deal with emergencies lies first with the organization responsible for the facility, then on successive orders of government as the resources, expertise, or mandates of each are required or affected. It is also recognized that a nuclear emergency that is expected to extend beyond provincial or federal boundaries will require a coordinated federal and provincial response. The extent and focus of federal involvement will depend on the scale and nature of the emergency situation, the level of support required by the province, and the nature of the interventions required. FNEP contains an Ontario Annex, which provides for liaison with Ontario, the provision of federal assistance, and provisions for obtaining international assistance, should any be requested by Ontario.

The Provincial Nuclear Emergency Plan (PNEP), now referred to as the Provincial Nuclear Emergency Response Plan (PNERP)) specifies the overall principles, policies, basic concepts, organizational structures and responsibilities. Under the PNEP, EMO is responsible for assisting municipalities with emergency training, developing emergency plans, and assisting or advising on the set-up of emergency preparedness programs. EMO takes the lead management role in nuclear emergencies and provincial nuclear exercises in Ontario. Part IV of the PNEP is specific to Darlington. The principal characteristics of the basic off-site effect, as stated in the Provincial Nuclear Emergency Plan, Part IV (PNEP Part IV 1998), are the following:

- *(a) A warning period would usually exist before the off-site effects occur;*
- *(b) The main hazard to people would be from external exposure to and inhalation of radionuclides;*
- *(c) Doses would be low (for planning purposes, it is assumed that the individual dose to the most exposed person at the station boundary will not exceed 250 mSv);*
- *(d) Environmental contamination would be limited;*
- *(e) Low-level radioactive emissions to the environment could continue for some time (i.e., days or even weeks);*
- *(f) The impact would be mainly confined to the Primary Zone around the station.*

In addition, the Province of Ontario (Province of Ontario 1999) has established various protective measures, including sheltering, evacuation and thyroid blocking. Protective Action Levels (PALs), which are based on projected dose, are used as guidance for when to consider implementing various protective actions in the event of a nuclear emergency as shown in Table 7.3-1. The implementation of protective measures corresponds with a PAL, which is either projected dose (Exposure Control Measures) or radionuclide concentration level (Ingestion Control Measures). PALs represent levels of risk from potential exposure that would justify the initiation of various protective measures. The PALs for exposure control measures are prescribed as a range for each protective measure because the decision on applying protective measures is based not only on technical factors, but also on operational and public policy considerations. The lower end of the range indicates when a protective measure should be considered, and the higher end of the range when it becomes necessary unless implementation clearly entails greater risks for the people involved than those from the projected radiation dose. The doses given provide a representation of the dose that could be averted through the implementation of the protective action.

The lower and upper levels of projected whole body dose to an individual for the Province to implement sheltering are 1 mSv and 10 mSv respectively. Similarly, the lower and upper levels of projected whole body dose to an individual for the Province to implement evacuation are 10 mSv and 100 mSv respectively. The lower and upper levels of projected thyroid dose to an individual for the Province to implement sheltering are 10 mSv and 100 mSv respectively. Similarly, the lower and upper levels of projected thyroid dose to an individual for the Province to implement evacuation are 100 mSv and 1000 mSv respectively. Above projected thyroid doses of 100 mSv and 1000 mSv, lower and upper levels respectively, thyroid blocking would be initiated via the distribution of potassium iodide pills to those potentially affected.

It is useful to note that the doses associated with the PALs are considered to be quite protective of human health. To illustrate, consider that the average dose from natural background in the Durham Region is approximately 2 mSv per year and that the regulatory dose limit for a NEW in Canada and throughout the world is typically 100 mSv over 5 years with no one year exceeding 50 mSv. Thus while it is preferable to avoid such doses and they are much greater than the doses typically associated with the normal operation of a nuclear reactor, the doses associated with the Provincial PALs can reasonably be considered safe.

TABLE 7.3-1
Protective Action Levels (PALs)

Protective Measure	Lower Level		Upper Level	
	Effective Dose (mSv)	Thyroid Dose (mSv)	Effective Dose (mSv)	Thyroid Dose (mSv)
Sheltering	1	10	10	100
Evacuation	10	100	100	1,000
Thyroid Blocking	-	100	-	1,000

The IAEA (IAEA 2002a) and Health Canada (HC 2003) also provide guidance on the need to shelter as a result of a nuclear accident. Their guidance is consistent with the range of PALs for sheltering established by Emergency Management Ontario (Province of Ontario 1999).

Relocation may be required for residents who were expected to receive a dose of 20 mSv or greater in the first year (Province of Ontario, 1999). The Province of Ontario (1999) also indicates the potential for ingestion control measures to protect the food chain from radioactive contamination, and prevent the ingestion of contaminated food and water. This category of protective actions may include the clearing of milk storages from local dairy farms, banning the consumption of food or drink that may have been exposed outdoors, or preventing milk- and meat-producing animals from accessing outside pastures and exposed water sources. PALs for ingestion control measures are given for determining when they should be implemented.

In the case of a nuclear malfunction or accident occurring, established emergency response notifications, actions and protective measures would be implemented as required for the safety and protection of the public.

Evacuation Study

Several agencies at all levels of government are responsible for aspects of emergency planning and response, particularly with respect to a nuclear emergency. These agencies, in conjunction with OPG, have developed detailed plans and procedures to ensure an organized, orderly response to an emergency which could potentially put the public at risk. Details of emergency planning and preparedness at the federal, provincial and municipal levels, as well as at the DN site, are provided in the *Emergency Planning and Preparedness TSD*.

Evacuation time estimates (ETEs) are important for emergency response planning, however, due to the large number of variables that affect evacuation time (e.g., the number of people affected, capacity of the roadways, weather conditions, time and day of the event) the actual time that an evacuation would take is variable. Nonetheless, ETEs provide important information to decision-makers that indicate whether or not an evacuation would be a feasible protective measure.

An ETE study was undertaken for the NND Project to establish that a safe evacuation could take place if a nuclear emergency were to occur. Details of the study are included in the *Emergency Planning and Preparedness TSD.* ETEs were determined for the Emergency Planning Zone around the DN site. This zone includes two evacuation regions of 3-km and 10-km radii from the DN site, each of which is further divided into Protective Zones. A total of 12 scenarios representing different seasons, time of day, day of the week, and weather were considered. The scenarios also considered two points in time; 2006 and 2025.

Populations in the planning zones were estimated for the two time periods based on Canadian Census data for the 2006 base year; with projections to year 2025 based on growth rates provided by Durham Region.

The “Advisory to Evacuate” applies only to those people occupying the specific Evacuation Region. Conservatively for the ETE study, it was assumed that 100% of the people within that area will evacuate in response to this advisory. If the selected Evacuation Region is the 3-km area, then the people occupying the remainder of the Emergency Planning Zone may be advised to take shelter. The ETE computation assumes that a portion of the population occupying the remainder of the Emergency Planning Zone will elect to “voluntarily” evacuate. In addition, a portion of the population in the Shadow Region beyond the Emergency Planning Zone (i.e. out to a 15-km radius from the DN site) will also elect to evacuate. The impedances that could be caused by the voluntary and shadow evacuees are explicitly considered in the ETE computation for the smaller Evacuation Region. It was also assumed that no special traffic control within the Emergency Planning Zones would be used to expedite evacuation travel.

ETEs are presented in the evacuation study for the evacuation of each Protective Zone, and for each scenario. The ETE is defined as the elapsed time from the issue of an “Advisory to Evacuate” by the Province to persons within a specific evacuation region, to the time that region is clear. Both voluntary and shadow evacuations are assumed to take place over the same time frame as the evacuation from within the evacuation region.

Table 7.3-2 shows the ETEs determined from the evacuation study for the years 2006 and 2025, for a full 100% evacuation based on a 3-km and a 10-km evacuation radius. The study showed that in all scenarios considered, the full population (year 2025 projection) within 10 km of NND can be evacuated in less than 9 hours.

TABLE 7.3-2
ETEs for 3 km and 10 km Evacuation Radii in 2006 and 2025

Year	Time Ranges to Evacuate Specified Evacuation Zone Radius (hr:min)	
	3 km	10 km
2006	3:25 – 4:40	4:35 – 6:25
2025	2:55 – 5:25	6:00 – 8:50

7.3.2.4 Nuclear Release Assessment Methodology

For previous EAs completed for operating nuclear power plants, the selection of a bounding nuclear accident scenario was completed through a review of event frequencies in the Probabilistic Risk Assessment (PRA) for the station being assessed. For consideration in an EA, the threshold identified by the CNSC for credibility of a nuclear accident scenario is that it has a one in one million ($1x10^{-6}$) or greater chance of occurring in any year.

The *Malfunctions, Accidents and Malevolent Acts TSD* gives an overview of the safety systems of each of the reactors and the results of preliminary safety assessments for each technology. Final versions of the PRAs have not been completed for the reactors, taking into consideration Canadian regulatory requirements and specific site characteristics, but the behaviour of the three reactor designs at event frequencies in the $1x10^{-6}$/yr range is not expected to result in substantial off-site releases. Nevertheless, an assessment was done to evaluate scenarios corresponding to the RD-337 safety goal release thresholds, which demonstrated that the reactor designs under consideration meet the intent of the Regulatory Document RD-337 safety goals with respect to the impact of protective measures (i.e., temporary evacuation, long term relocation) on the local population. For this, Regulatory Document RD-337 Safety Goal Based (SGB) Releases to the environment were identified and used in dose calculations.

The new reactors will comply with the Regulatory Document RD-337 safety goals. This sets limits on the performance of the reactors with respect to accident frequency and consequences of off-site releases. The LRF is specified in Regulatory Document RD-337 as having a frequency of less than $1x10^{-6}$ per year, and thus these events can be considered to be at or below the credible limit for EA purposes. The SRF is specified in Regulatory Document RD-337 as less than $1x10^{-5}$ per year, so some events within this category may be considered credible for EA purposes. As indicated in Regulatory Document RD-337, the consequences of such an event may require temporary evacuation of the local population. It should be noted, however, that the SGB Releases and the associated off-site protective actions will not form the basis of the event upon which the Emergency Preparedness Program will be designed. The design basis event for

Emergency Preparedness planning will be identified later in the licensing process through established emergency planning protocols, design basis event analysis and stakeholder communications and involvement.

A stylized accident radioactive release scenario was created, using actual reactor design information (core radionuclide inventory, accident radionuclide release fractions). The isotope amounts in this calculated reactor accident release were adjusted by two scaling factors to create two release scenarios for use in the EA, with I-131 and Cs-137 amounts aligned to the RD-337 small release and large release Safety Goal threshold values, respectively. These releases, the SGB Small Release and the SGB Large Release respectively, were used to determine dose to the public that may occur, should an event in these categories, at the release thresholds, occur. Dose was calculated for various distances from the plant, over various time frames, to the whole body and to the thyroid gland of potentially affected members of the public, and the predicted doses at various distances were compared to the PALs for evacuation and relocation to determine whether the effects are within the intent of Regulatory Document RD-337. The results of the assessment were used to assess the potential effects of such releases on human health (physical, mental and social effects) and the potential effects on non-human biota.

7.3.2.5 Determining the Safety Goal Based Releases

Regulatory Document RD-337 safety goals refer to threshold release values for I-131 and Cs-137 only. These isotopes are only two of many radioactive isotopes contained within used nuclear fuel that may be released to the environment in the event of a nuclear accident resulting in core damage and an impairment of containment. For the assessment, a source term with a full set of potential radionuclides was needed and was derived to reflect the design of the reactors (NSS 2009).

A core radionuclide inventory was selected from the three reactor technologies based on factors such as maximum reactor core size, maximum fuel burnup rate, and use of (relatively) high enrichment fuel. The core inventory defines the radionuclide mix within the core at the time of the accident. The portion of each isotope in the core that would be released from the damaged fuel (and then from the reactor vessel or coolant system) during the accident is dependent on the accident scenario. For EA purposes, safety analyses for the three reactor technologies were reviewed, and an accident scenario was identified, a severe accident involving damage to the nuclear fuel, that was a high contributor to the large release frequency. This scenario (specifically the radionuclide mix) was selected as the starting point for determining the source terms for EA purposes, the SGB Small Release and the SGB Large Release.

The amounts of each radioisotope released from the reactor in the selected accident scenario, the baseline release, were identified. Two source terms, adjusted using scaling factors to reflect the RD-337 SRF and LRF threshold release values, were then calculated as described below:

- Case 1: The I-131 in the baseline release was scaled to the RD-337 SRF threshold value of $1x10^{15}$ Bq. The same scaling factor was then applied to each radionuclide in the baseline release. This is the SGB Small Release; and

- Case 2: The Cs-137 in the baseline release was scaled to the RD-337 LRF threshold value of $1x10^{14}$ Bq. The same scaling factor was then applied to each radionuclide in the baseline release. This is the SGB Large Release.

Regulatory Document RD-337 requires that containment should prevent releases to the environment, even in the case of a severe accident, for a period of time allowing protective actions to be implemented. For the purposes of the EA, this time was taken to be 24 hours, immediately followed by the start of the release. This effect was taken into account in the SGB Release determination process.[8]

The SGB Releases were modelled as single plume releases, with durations of 72 hours. This was meant to provide a representative scenario for evaluation of potential emergency response scenarios and doses but is not necessarily characteristic of all potential releases for the reactor technologies.

7.3.2.6 Doses Resulting from Safety Goal Based Releases

The goal of the assessment of the SGB Small and Large Releases was to evaluate the potential dose to the public over several time periods to assess compliance with the intent of the Regulatory Document RD-337 safety goals with respect to the impact of protective measures (i.e., temporary evacuation, long term relocation) on the local population.

The assessment was done in two parts. Firstly, the RD-337 Small Release criterion identifies that a release to the environmental of more than 10^{15} Bq of I-131 may require temporary evacuation of the local population. Therefore, for the SGB Small Release, the assessment focussed on the projected dose for the Early Phase, which comprises the first week following the start of the release, and the consequent short term emergency response. A 7-day evacuation duration was selected because the plume length was modelled to be 3 days in length, and a further 4 additional

[8] This 24 hour delay period results in decay of the radionuclides within containment for a 24 hour period. This effect was taken into account in the SGB Release determination process. It did not result in a reduction in I-131 and Cs-137 amounts in the SGB Small and Large Releases, respectively, due to the scaling process (scaling to fixed RD-337 threshold release values).

days was assumed to be a reasonable length of time for appropriate surveying work to be completed prior to residents returning to their homes. Secondly, the RD-337 Large Release criterion identifies that a release to the environment of more than 10^{14} Bq of Cs-137 may require long term relocation of the local population. Therefore, for the SGB Large Release, the assessment focussed on the projected dose for the Late Phase and the long term emergency response. The Late Phase of the release comprises the time period starting after the return from an evacuation period (i.e., one week for the purposes of this evaluation) until 50 years following the release.

Assessment of Whole Body Dose from SGB Small Release during Early Phase

In order to determine the extent over which a one week duration evacuation might be initiated as a result of the SGB Small Release, the whole body dose resulting from the SGB Small Release was assessed over the first week following the release. Table 7.3-3 shows the dose to an individual present at the given location during the Early Phase of the postulated release.

TABLE 7.3-3
Whole Body Dose Projected for SGB Small Release (Early Phase)

	Distance		
	1 km	3 km	10 km
Dose over 1 week	25 mSv	4.1 mSv	0.97 mSv

The evacuation lower and upper PALs for whole body dose are 10 mSv and 100 mSv of projected dose, respectively. The PALs for exposure control measures are prescribed as a range for each protective measure because the decision on applying a protective measure is based not only on technical factors but also on operational and public policy considerations. In the case of evacuation, 10 mSv represents the projected dose at which evacuation should be considered and 100 mSv represents the projected dose where evacuation becomes necessary. For the SGB Small Release, the lower dose limit for evacuation, when evacuation would be considered, is met for people within approximately 2 km of the release point. For a projected whole body dose of greater than 100 mSv, evacuation would be required. For the SGB Small Release, this occurs at approximately 400 m, close to the NND site boundary where there are no permanent residences. According to the safety goals set out by in Regulatory Document RD-337, a Small Release, a release of more than 10^{15} Bq of I-131, may require temporary evacuation of the local population. Accordingly, as other radionuclides are also included in the SGB Small Release, this temporary evacuation of the local population is within the expectations for a release with these characteristics.

Assessment of Thyroid Dose from SGB Small Release

In addition to the whole body dose discussed above, the dose to the thyroid during the Early Phase resulting from the SGB Small Release was also assessed. This was to determine the extent over which a one week duration evacuation might be initiated as a result of the SGB Small Release, as a result of projected thyroid dose.

Table 7.3-4 shows the thyroid dose at several representative distances that will result from the SGB Small Release during the Early Phase.

TABLE 7.3-4
Thyroid Dose Projected for SGB Small Release (Early Phase)

	Distance		
	1 km	3 km	10 km
Dose over 1 week	160 mSv	25 mSv	5.9 mSv

The evacuation lower and upper PALs for thyroid dose are 100 mSv and 1000 mSv of projected dose, respectively. In the case of evacuation due to thyroid dose, 100 mSv represents the projected dose at which evacuation should be considered and 1000 mSv represents the projected dose where evacuation becomes necessary. For the SGB Small Release, the lower thyroid PAL dose limit for evacuation is met for people within approximately 1.5 km of the release point. For a projected thyroid dose of greater than 1000 mSv, evacuation would be required. For the SGB Small Release, this occurs at approximately 300 m, close to the NND site boundary where there are no permanent residences. The potential evacuation distances resulting from projected thyroid doses resulting from the SGB Small Release are bounded by the evacuation distances determined for whole body dose.

Assessment of Dose from the SGB Large Release during Late Phase

In order to determine the extent over which long term relocation might be initiated as a result of the SGB Large Release, the whole body dose resulting from the SGB Large Release was assessed as a function of distance for two time periods in the Late Phase (following the return from a one week long evacuation): 1 year of exposure and 50 years of exposure. Table 7.3-5 shows the dose to an individual present at several representative distances from the release point that will result from this postulated release.

TABLE 7.3-5
Whole Body Dose Projected for SGB Large Release (Late Phase)

	Distance		
	1 km	3 km	10 km
Dose over 1 year	17 mSv	2.6 mSv	0.6 mSv
Dose over 50 years	55 mSv	8.8 mSv	2.0 mSv

From the values given above, it can be seen that the dose to a person living at 10 km from the release point would be less than the natural background level of 1.84 mSv over a 1 year period (OPG 2008b) (the dose would be in addition to the natural background).

The dose from radionuclides deposited on the ground during the passage of the plume, notably Cs-134 and Cs-137, accumulates over time due to the long half life and the persistence of caesium in the environment. The doses are assessed against relocation standards set out by the Province of Ontario (Province of Ontario 1999) to ensure that residents will receive a late phase dose of no more than 20 mSv in the first year.

The dose to people as a result of the SGB Large Release drops rapidly with distance from the release point. The relocation limit for dose over 1 year is met within 1 km of the NND reactors. This is expected to be close to the NND site boundary and would affect few, if any, residents. It is possible that temporary relocation measures will be required within this area for a time immediately following the release and for as long as 1 year. This relocation would only apply to permanent residents within this area and not to workers or businesses. According to the safety goals set out in Regulatory Document RD-337, a Large Release, a release of more than 10^{14} Bq of Cs-137, may require long term relocation of the local population. Accordingly, as other radionuclides are also included in the SGB Large Release, this relocation of the local population within 1 km of the NND reactors is within the expectations for a release with these characteristics.

In addition to temporary relocation, the Province of Ontario (1999) also indicates the potential for ingestion control measures to protect the food chain from radioactive contamination, and prevent the ingestion of contaminated food and water. This category of protective actions may include the clearing of milk storages from local dairy farms, banning the consumption of food or drink that may have been exposed outdoors, or preventing milk- and meat-producing animals from outside pasture and exposed water sources. PALs for ingestion control measures are given for determining when they should be implemented.

At a natural background dose rate of 1.84 mSv/year, the dose that is expected to be received by a typical member of the public from natural background sources over a 50 year period is 92 mSv.

For comparison purposes, this is more than the dose that would be received in the Late Phase by a person living 1 km from the reactor over a 50 year period following an accident that released radioactivity equivalent to the SGB Large Release. As near as 10 km from the reactor, the dose received over 50 years following such a release would be nearly indistinguishable from the fluctuations in the dose attributed to natural background radiation. For additional information on human health impacts from radiological exposure, see the *Human Health TSD*.

7.3.2.7 Human Health Effects of Nuclear Accidents

Physical Health Effects of the SGB Large Release

In this section, potential collective dose to the population surrounding the NND site is calculated to provide an illustration of the potential health effect of a release that meets the Regulatory Document RD-337 LRF threshold value for Cs-137.

In Section 7.3.2.6, the total whole body dose resulting from the SGB Large Release was assessed as a function of distance for two time periods beginning at the time of the event: 1 year of exposure and 50 years of exposure. The resultant whole body doses at distances within 100 km of the release point were multiplied by the populations in 2006 (actual), 2031 (predicted) and 2084 (predicted) to determine the collective dose resulting from the SGB Large Release. These populations, given by ring sector (distance from release point), are shown in Table 7.3-6. More information on the derivation of these population values can be found in Appendix A of the *Land Use Assessment of Environmental Effects TSD.*

TABLE 7.3-6
Projected Populations by Ring Sector

Ring (km)	Population		
	2006	2031	2084
0-1	0	0	0
1-2	44	31	0
2-4	7,961	10,363	17,941
4-8	51,213	77,587	120,832
8-16	174,471	251,267	399,988
16-24	136,013	228,372	355,767
24-32	141,672	267,611	448,509
32-40	188,048	273,671	391,368
40-60	2,185,327	2,809,962	3,729,773
60-80	1,878,896	2,448,809	3,388,366
80-100	2,317,863	3,096,326	5,361,864
Total	**7,081,508**	**9,463,999**	**14,214,408**

Reference: *Land Use TSD*

Table 7.3-7 below gives the collective dose to the population within 100 km of NND for various time periods following the SGB Large Release. The dose given does not account for any protective measures that may be taken in portions of this area, such as evacuation or ingestion controls on potentially contaminated food or drinking water. In other words, the dose in Table 7.3-7 is the dose that would be received by the population who continue to reside at their residences within 100 km of NND for the entire period (1 year or 50 years) following the release.

TABLE 7.3-7
Collective Doses from SGB Large Release to Population within 100 km of NND

	Dose (person-Sv)		
	2006	2031	2084
Dose over first year	2,595	3,549	5,301
Dose over first 50 years	4,975	6,816	10,190

For comparative purposes, the collective natural background dose to the population within 100 km of NND was determined and is shown in Table 7.3-8. For the purposes of determining background dose, the effective dose rate from natural background radiation in Canada (taken to be 1.84 mSv/yr) was used (OPG 2008b).

TABLE 7.3-8
Collective Effective Dose from Natural Background Radiation to Population within 100 km of NND

	Dose (person-Sv)		
	2006	2031	2084
Dose over 1 year	13,030	17,414	26,155
Dose over 50 years	651,500	870,688	1,307,726

As can be seen from Table 7.3-7, much of the collective dose to the population in the area surrounding NND as a result of a radiological release will be received shortly after the release. The dose rate will decrease substantially with time. Over a 1 year period following the release, the dose received by the population within 100 km of NND from a release such as the SGB Large Release will be approximately one fifth of the natural background dose this population would receive during that year. The dose from a nuclear malfunction or accident would be in addition to dose received from natural background sources.

The collective dose received over 50 years following a release with characteristics similar to the SGB Large Release is approximately 1 % of the dose received from natural background radiation over the same time period and would be almost indistinguishable from the natural background dose.

Currently in Ontario, approximately four out of 10 people (40%) will develop cancer and approximately one in four (25%) will die from cancer in their lifetime (NCIC 2008). On this basis, it can be statistically determined that about 25% of the 7,081,508 people in the 2006 population within 100 km of NND are predicted to eventually die from cancer from natural causes (1,770,377 people) over their lifetime. ICRP 103 (ICRP 2007) indicates a risk of 5.5 x 10^{-5} per mSv of developing cancer after exposure to radiation at low doses. Should a nuclear accident occur with a release similar to the SGB Large Release, it can be statistically estimated that the number of individuals who live within 100 km of NND, and who may eventually develop cancer, would be 1,770,626, an increase of about 0.01%. This same very small percent increase would be expected if the dose consequences of the SGB Large Release were applied to the population distribution predicted in 2084, taking into account the larger population. Such a small statistical increment in cancer risk would not be measurable in the overall population due to natural variation in cancer deaths on an annual basis.

Social, Mental and Economic Health Effects of Nuclear Accidents

If a nuclear incident were to occur, resulting in sheltering and / or temporary evacuation, it is highly likely that some effects would occur at both the individual and community level that could be deemed psychosocial. The severity and duration of these effects would likely be related to the length of time the protective actions were in place, and the amount of radiation released from the plant. Effects to some individuals could include fear, anxiety, a sense of loss of control, and a feeling of hopelessness (Sorensen *et al.* 1987). Disruption of lifestyles could occur, especially to the elderly (e.g. temporary loss of social support networks, or suspension of cultural and recreational activities). Emergency responders (e.g. police, fire) and health care workers could experience increased stress and fatigue. Manifestations of individual stress could include health problems, lack of sleep, and lethargy. Some individuals may find it difficult to cope with normal activities, thus affecting their job performance. Community well-being could be compromised through loss of neighbourhood vitality, loss of community cohesion, and social stigma of living near the plant where the accident occurred. These potential effects would be felt most strongly in the area immediately adjacent to the NND.

A variety of measures could be implemented after the incident to assist in mitigating some of these anticipated effects, and to maintain OPG's credibility with the public. Such measures could include regular publication of radiation monitoring results, a central information centre where both the media and the public could obtain credible information regarding issues such as decontamination activities, repairs to the reactor, or any anticipated changes to emergency response and alerting procedures. These measures would likely enable the community to return to normalcy and lessen the likelihood of long-lasting effects.

In addition to the potential mental and social effects described above, there would be economic costs associated with emergency response to a nuclear malfunction or accident. The magnitude of these costs would be proportional to both the geographic extent and the duration of the evacuation. At a general level, as determined from the Mississauga train derailment in 1979, the economic costs of an evacuation consist of the value of lost opportunities for production and consumption resulting from the evacuation (IES 1981). An overview of the range of economic effects of the Mississauga evacuation in 1979 (IES 1981) and the TMI accident in Pennsylvania in 1979 (Sorensen *et al.* 1987) is helpful in assessing the potential economic effects of an evacuation near the NND. Production losses consist of the reductions in output of business and the public sector that are not made up later. Increased expenditures on food, accommodation, and travel related to evacuation are examples of consumptive losses.

Further discussion of potential human health effects arising from a nuclear accident is provided in the *Human Health TSD*.

7.3.2.8 Effects of the Safety Goal Based Large Release on Non-Human Biota

In this section, the (illustrative) doses from the SGB Large Release were used to determine the potential effects on non-human biota from a release that meets the Regulatory Document RD-337 LRF threshold value for Cs-137.

Determination of Dose to Non-Human Biota from SGB Large Release

The approach to assessing the radiation exposure to non-human biota following a nuclear accident involves:

- Describing the characteristics of the SGB Large Release;
- Identifying representative non-human biota for the assessment;
- Describing the consequences of the SGB Large Release sufficiently to facilitate dose estimation for non-human biota and estimating the dose or dose-rate to which non-human biota might be exposed; and
- Comparing the estimated dose or dose-rate to reference dose or dose-rate criteria below which effects on population or non-human biota are unlikely.

Characteristics of the Postulated Nuclear Release

The SGB Large Release involves emissions to the air only. The doses to non-human biota are estimated for the following three time phases:

- The 72 hour period (“release phase”) during which radionuclides are released to the atmosphere and dispersed via atmospheric dispersion with a fraction of the radioactivity depositing on the ground surface beneath the radioactive plume;

- The subsequent 30 days following the release (“interim phase” i.e. 72 hours to 1 month) during which time radioactive decay reduces the inventory of radionuclides on the ground surface; and

- The remainder of the year (“chronic phase” i.e. 1 month to 1 year) during which time radioactive decay continues to reduce the inventory of radioactivity deposited during the passage of the plume. Also during this time, the radioactivity originally deposited ground surface is gradually mixed through deep soil layers through leaching and downward migration of radioactive particles and also, very importantly, through bioturbation (e.g., mixing of the soil by worms).

Identifying Representative Non-Human Biota

For this assessment, five representative non-human biota were selected to represent the variety of terrestrial indicator species (plants and animals) which are present on the site:

- Bird;
- Meadow vole (small mammal);
- White-tailed deer (large mammal);
- Earthworms (soil); and
- Terrestrial vegetation.

As mentioned in the previous section, the SGB Large Release involves emissions to air; therefore there is no direct impact on aquatic biota. Potential effects from radionuclides in water as a result of lake deposition are expected to be negligible as the concentrations would be rapidly diluted due to current and wind movements.

Methodology for Dose Estimation

A conceptual site model was used to estimate the dose to non-human biota via two pathways relevant to the early phase of a nuclear accident, namely cloudshine and groundshine. Cloudshine is the external dose received while immersed in a cloud of radioactive materials, and groundshine is the dose received while standing on contaminated soils or ground surfaces.

The cloudshine dose was calculated by multiplying the ground level air concentrations at 1 km from the point of release (OPG 2009g) by an external dose conversion coefficient for cloudshine. The ground level air concentrations predicted during the release phase (i.e., during the initial release) of the SGB Large Release at 1 km from the point of release are provided in Table 7.3-9.

TABLE 7.3-9
Ground Level Air Concentrations*

Isotope	Centre Ground Level Mean Concentration (Bq/m^3)
I-131	3.9E+03
I-132	2.2E+04
I-133	6.0E+02
I-134	1.3E-25
I-135	1.4E+00
Cs-134	1.4E+03
Cs-136	2.9E+02
Cs-137	5.4E+02
Tc-99	6.2E+02
Sr-90	6.8E+00
Ru-103	1.4E+03

Source: OPG 2009g
*average concentration during release phase

The groundshine dose was calculated by multiplying the mean concentrations of radionuclides deposited on the ground at 1 km from the point of release by a dose coefficient for groundshine. The ground level mean concentrations immediately following the release are provided in Table 7.3-10.

TABLE 7.3-10
Concentrations of Radionuclides Deposited on the Ground

Isotope	Mean Centre Line Concentrations Deposited on the Ground (Bq/m^2)
I-131	2.49E+06
I-132	1.63E+07
I-133	9.78E+05
I-134	8.95E-07
I-135	5.00E+04
Cs-134	8.32E+05
Cs-136	1.81E+05
Cs-137	3.17E+05
Tc-99	4.81E+05
Sr-90	4.02E+03
Ru-103	8.27E+05

Source: OPG 2009g

Release Phase

In the "release phase", the dose received by non-human biota is from cloudshine (i.e. immersion in radioactive plume) and groundshine from radioactivity deposited on the ground surface beneath the radioactive plume. Though dose is received from other pathways during this phase, the primary contributors to dose to non-human biota are typically cloudshine and groundshine. The assessment of dose to non-human biota from the SGB Large Release was done to determine an order of magnitude estimate of the potential effects of a release of this magnitude and characteristics. The contributions of other pathways would not substantially affect the total dose received by non-human biota for this assessment.

For cloudshine, the dose was calculated by multiplying the air concentration in Table 7.3-9 by an external dose coefficient for cloudshine (HC 1999). For groundshine, the dose rate was calculated by multiplying the adjusted ground level concentration by the dose coefficient for groundshine (Health Canada 1999). The "average" ground level concentration for each isotope was adjusted from the value shown in Table 7.3-10 by decaying the concentration for a period of 36 hours. This was done to account for gradual deposition of radioactivity on the ground surface, which also decays over the 72-hour release period.

Interim Phase

In the "interim phase", the dose to non-human biota is only from groundshine. The groundshine dose was calculated by multiplying the adjusted ground level concentration by a dose coefficient for groundshine (on the ground surface) (HC 1999). The ground level concentrations in Table 7.3-10 were reduced to account for the radioactive decay of the radionuclides during this period.

Chronic Phase

In the "chronic phase", the dose to non-human biota is (essentially) only from groundshine. The groundshine dose was calculated by multiplying the adjusted ground level concentration by a dose coefficient for external exposure to radionuclides distributed to a depth of 5 cm in the soil (Eckerman and Leggett 1996). The ground level concentration in Table 7.3-10 (i.e., on the surface) is assumed to be mixed through the deep soil layers and is reduced by radioactive decay of the radionuclides.

Assessment of the Effects of the SGB Large Release on Non-Human Biota

Based on a review of the information available prior to 1996, UNSCEAR 1996 concluded that, for acute exposures to radioactivity, observable effects on populations of non-human biota are unlikely below an acute dose of approximately 1 Gy (i.e., 1,000,000 μGy)) delivered over a short time, such as would occur in an accident scenario. This reference dose of 1 Gy applies to animals, but is also conservatively used for plants for the purposes of this assessment. Additionally, observable effects on populations of non-human biota are not expected below a dose rate of 1 mGy/d during the interim and chronic phases of an accident scenario.

The Health Canada Dose Conversion Coefficients for humans were used to calculate the dose for non-human biota. This was done because coefficients were not available for all of the required radionuclides for non-human biota. A comparison was done between the Health Canada coefficients (Health Canada 1999) and the coefficients given in Framework for Assessment of Environmental Impact (FASSET 2003). This comparison shows that the Health Canada coefficients are more conservative than those specific to small and large non-human biota.

The estimated doses to non-human biota at 1 km from the point of release via the cloudshine and groundshine pathways were calculated based on concentrations in Table 7.3-9 and Table 7.3-10, respectively. The doses at 0.7 and 0.5 km were estimated based on scaling factors calculated from whole body effective dose with distance in OPG 2009g. Doses at distances less than 0.5 km were not estimated because non-human biota are unlikely to be closer than 0.5 km from the point of release given that the dimensions of the buildings are a few hundred meters and the areas adjacent to the buildings are paved.

The estimated doses and dose rates with distance to non-human biota as a result of the SGB Large Release are summarized in Table 7.3-11.

TABLE 7.3-11
Estimated Dose and Dose Rate with Distance to Non-Human Biota from the SGB Large Release

		Distance from Point of Release (km)					
		0.5		0.7		1	
Phase	Pathway	Dose (Gy)	Dose Rate (mGy/d)	Dose (Gy)	Dose Rate (mGy/d)	Dose (Gy)	Dose Rate (mGy/d)
Release	Cloudshine	1.99E-03	-	1.20E-03	-	6.64E-04	-
	Groundshine	2.59E-03	-	1.55E-03	-	8.62E-04	-
Total Dose during Release Phase		4.58E-03	-	2.75E-03	-	1.53E-03	-
Interim	Groundshine	1.76E-02	5.86E-04	1.05E-02	3.52E-04	5.86E-03	1.95E-04
Chronic	Groundshine	1.84E-03	5.50E-06	1.10E-03	3.30E-06	6.25E-04	1.87E-06

In the release phase, the main contributor to dose is I-132 (approximately 67%); however, its contribution decreases in the chronic phase due to its short half-life (2.3 h). In the interim phase, the main contributors to dose are I-131 (approximately 14%) and Cs-134 (approximately 51%), largely as a result of their longer half-lives of 8.04 d and 2.062 y, respectively. This is expected because of the longer half-life of Cs-134 relative to other short-lived radionuclides that have decayed significantly within the first month. In the chronic phase, almost all the dose to non-human biota as a result of the SGB Large Release is from Cs-134 (89%). This is expected because of the longer half-life of Cs-134 relative to other short-lived radionuclides that have decayed significantly within the first month.

It can be seen from Table 7.3-11 that the estimated doses to non-human biota from all phases are far below the 1 Gy reference dose for accidents(less than 2% of the reference dose for all phases). The dose rates are also well below the reference dose rate of 1 mGy/d during the interim and chronic phases of the release scenario (less than 1% of the reference dose rate for both phases). Therefore, no observable effects on populations of non-human biota would be expected.

7.3.2.9 Summary of Effects of Nuclear Malfunctions and Accidents

All of the reactors being assessed for NND are enhancements of designs currently operating and have a variety of characteristics that make them safer to operate. These reactors are designed using the principle of defence in depth, meaning that several systems are in place to prevent and/or mitigate against nuclear accidents.

The new reactors will comply with the RD-337 safety goals. This sets limits on the performance of the reactors with respect to accident frequency and consequences of off-site releases. Review of the preliminary safety analyses for the reactor technologies under consideration provides confidence that the RD-337 safety goals will be met.

SGB Small and Large Releases were developed in order to demonstrate that the reactor designs under consideration meet the intent of the RD-337 safety goals with respect to the impact of protective measures (i.e., temporary evacuation, long term relocation) on the local population. The assessment concluded that the impact of protective measures was consistent with the intent of the safety goals. The potential collective dose to the population within 100 km of the release point was calculated for the SGB Large Release, and the incremental change in cancer risk for a release such as the SGB Large Release was determined not to be measurable.

Additionally, an assessment was undertaken to determine the potential effect of the SGB Large Release on non-human biota. For all phases of the release, the doses to non-human biota were found to be less than 2% of the reference dose, above which observable effects on populations of non-human biota would be expected.

Consequently, no residual adverse effects are expected from nuclear malfunctions and accidents on humans or non-human biota. For comparison purposes, however, should the assessment have concluded that there would have been a residual adverse effect, based on the discussion above, it is apparent that the effect would not be considered significantly adverse. Specifically, the nature and extent of the effect would be of low frequency and highly unlikely to occur; the magnitude of the effect would not alter the current baseline conditions (i.e., emergency plan) approved and in place (the off-site protective measures already in place); in terms of human health effects, the dose in the first year would be an increment of one-fifth of background, and less than 1% of background over 50 years. The estimated doses to non-human biota from all phases would be well below the reference dose for accidents, and no observable effects on populations of non-human biota would be expected.

7.3.3 Out of Core Criticality

The *Malfunctions, Accidents and Malevolent Acts TSD* addresses the potential for criticality events outside of the reactor core at NND, for both new fuel and used fuel. Out of core criticality associated with used fuel dry storage is addressed in the *Nuclear Waste Management TSD*.

7.3.3.1 Criticality

Uranium is a common element and is present in all soils and rocks at low concentrations, typically of a few parts per million. Natural uranium contains various uranium isotopes including uranium-238 (U-238) and U-234 from the U-238 decay chain as well as U-235. Some uranium isotopes, U-235 for example, are fissionable by thermal neutrons (i.e., fissile) which means the nucleus can split upon absorbing a neutron, releasing energy and additional neutrons in the process. It is this property of a controlled nuclear reaction that enables uranium to be used as a fuel in nuclear reactors. This is done by carefully arranging the uranium and other materials in a manner such that a self-sustaining fission chain reaction is maintained by ensuring sufficient numbers of neutrons continue to be generated to keep the reaction, and hence energy production, going.

The fissile component of natural uranium is the U-235 isotope. Natural uranium only contains 0.711% U-235 and requires the very precise conditions of a nuclear reactor to sustain a chain reaction. As the concentration of U-235 in the uranium is increased ("enriched" relative to the other isotopes of natural uranium), it becomes possible to create the conditions for nuclear criticality outside of the reactor core (e.g. storage areas). The uranium fuel for the proposed NND reactors will be enriched to between 1% and 5% (by mass) U-235. Operations that handle fissile material (enriched uranium) must ensure that the conditions for a sustained nuclear chain reaction or criticality are not created inadvertently. The term criticality safety is used to describe the measures that are undertaken to prevent an inadvertent sustained nuclear chain reaction outside of the reactor core.

The focus of this section is criticality safety of fissile materials (i.e., fresh and used fuels) while onsite at NND. The transportation of radioactive materials is addressed through the requirements of the Canadian regulations based in part on guidance from the IAEA (IAEA 2006).

7.3.3.2 Criticality Safety

A comprehensive review of nuclear criticality accidents has been carried out by the Los Alamos National Laboratory (McLaughlin *et al.* 2000). It is important to note that the lowest enrichment level identified for a historical criticality accident was an enrichment of 6.5% U-235 (as uranium oxide slurry which can more readily achieve a critical geometry), which occurred in the former Soviet Union in 1965. This is larger than the enrichment of the NND fuel. It should also be noted that according to McLaughlin, only one accident resulted in measurable exposures (well below allowable worker annual exposures) to members of the public (see discussion of Tokaimura, Japan below). The released heat and radiation from past accidents were found not to be sufficient to damage process equipment (McLaughlin *et al.* 2000). Moreover, McLaughlin *et* *al.* report no out of core criticality incidents at nuclear power stations. The most recent criticality accident occurred at a fuel fabrication facility in Tokaimura, Japan. The accident occurred with a uranium solution at an enrichment level of 18.8% U-235 (IAEA 1999). This is a much higher enrichment level than associated with fuel for any of the potential NND reactor technologies. The accident at the facility in Tokaimura also provides insights and lessons about the potential consequences of a criticality accident. The facility in Japan was not built with any specific shielding designed to mitigate the consequences of a criticality accident. As a result, elevated radiation levels, primarily from neutrons, were measured beyond the plant boundary. As a precautionary measure, there was a temporary evacuation of people within 350 m of the facility.

The framework for criticality safety has been established through more than 60 years of experience in handling enriched fissile materials outside a reactor and in the safe operation of nuclear power plants throughout the world. Lessons learned from historical criticality accidents resulted in significant improvements in criticality safety performance in terms of physical safety systems and management practices. Past experience has been incorporated into the ANSI/ANS series of standards. These guidelines are published as ANSI/ANS Series 8 (e.g., ANSI/ANS 1998, *Nuclear Criticality Safety in Operations with Fissionable Material Outside Reactors*) and provide the basic criteria and limits for operations with fissionable materials outside reactors. Since power reactors in Canada have not until recently used enriched fuel, a Canadian set of criticality standards does not exist. It is expected that adoption of recognized international standards, such as the ANSI/ANS-8 series of standards, will likely be required to meet Canadian regulatory expectations.

Overall, nuclear criticality control factors can be grouped in two broad categories, namely engineered (e.g., geometry controls and volume controls) or administrative (e.g., mass limits and operating procedures). An important principle guiding the design is called the "Double Contingency Principle", which states that the design should have sufficient factors of safety to require at least two unlikely, independent and concurrent changes before a criticality is possible (ANSI/ANS 1998). The U.S. NRC (1977) argues that the application of the double contingency principle has been successful in reducing the probability of an inadvertent criticality to a low value and that the chance of a simultaneous failure of two independent controls is very unlikely. In broad terms, with appropriate design (engineering) and control (administrative) procedures in place, an inadvertent out of core criticality event is considered not credible. For example, compliance with U.S. NRC general design criterion 62 (of Appendix A of 10 CFR Part 50) requires the prevention of criticality in the fuel storage and handling system through the use of engineered controls, with preference given to the application of geometrically safe configurations. This provides assurance that inadvertent criticality will be prevented in fuel storage facilities (U.S. NRC 1987).

ANSI/ANS Series 8 addresses requirements for criticality safety programs, including requirements for engineering controls, safety assessments, training, criticality detection and alarms, and governance. In general terms, nuclear criticality safety as outlined for example in ANSI/ANS 1998 is achieved through application of the administrative and technical practices including, amongst others:

Administrative

- Clearly defining responsibilities;
- Employing appropriately knowledgeable and trained personnel;
- Establishing criteria for nuclear criticality safety controls;
- Implementing written procedures; and
- Use of operational controls, operational reviews, and emergency procedures.

Technical

- Application of Double Contingency principle whereby at least two unlikely, independent and concurrent events must occur before a criticality is possible;
- Identification and establishment of limits for all controlled parameters;
- Establishment of geometry controls;
- Use of neutron absorbers(poisons); and
- Validation of calculational methods.

Engineered safety features are preferred to administrative controls and are used whenever practicable. Critical values upon which criticality safety limits are established are determined by accepted nuclear safety guides, data derived from experiment; or in the absence of directly applicable experimental measures, calculations by a method shown to be valid or conservative in comparison with experimental data, after sufficient allowances have been made for uncertainties in the data. All criticality limits are based on conditions that maximize the theoretical chance of a criticality event occurring, unless other (less conservative) conditions can be positively assured.

The U.S. Department of Energy (U.S. DOE) has also developed guidelines for criticality safety which require that design considerations for establishing criticality controls include consideration of mass, density, geometry, moderation, reflection, interaction, material types, and neutron absorbers (US DOE 1993). The DOE also emphasize the use of passive engineered controls, such as geometry controls, as the preferred method for preventing criticality events.

A key goal of managing fresh and used fuel at a nuclear power plant is to ensure zero accidental criticalities. In other words, criticality management must ensure that subcritical conditions are maintained during both normal operations and abnormal conditions or credible accidents. Simply put, the effective neutron multiplication factor (k_{eff})[9] must be less than 1. In other words, subcritical conditions must be ensured at all times.

Subcritical conditions in the arrays of new and used fuel that are kept in the storage areas are maintained through a combination of administrative and engineered safety controls. Design considerations include factors such as geometry designed to prevent criticality (configuration control), moderation and reflection and the use of neutron absorbing materials. For example, the new fuel and used fuel storage racks will be designed to ensure that geometry unfavourable for criticality is maintained under all credible conditions. Control of moderation is important as a moderated system allows a smaller mass of U-235 to become critical. Similarly, in a reflected system, neutrons leaking from the fissionable material are reflected back into the fissionable material (new or used fuel) also potentially reducing the critical mass. Water, for example, is both a moderator and reflector. On the other hand, the hydrogen in normal water in the used fuel storage bay is effective in absorbing thermal neutrons and helping to maintain subcritical conditions. Moreover, to reduce the available neutrons and hence the potential for a criticality event, an additional strong neutron absorber (a non fissionable material that absorbs neutrons, e.g., boron in the form of boric acid) may be added to the water in the fuel storage bay. Finally, an additional neutron absorber in the form of sheets of neutron absorbing material may be used with sheets placed between the fuel assemblies in the fuel racks as an additional preventative measure.

Nuclear reactor facilities have storage facilities for both fresh and used fuel. Used fuel is stored in a used fuel pool for approximately 10 years following removal from the reactor core. US NRC Regulation 10 CFR 50.68, provides regulatory requirements for used fuel pools in the U.S. to ensure that subcriticality is maintained through a combination of geometric spacing and fixed neutron absorbers. Although PWR spent fuel pools contain soluble boron, 10 CFR 50.68 does not credit the boron for maintaining the subcritical conditions under normal operating conditions. The role of the soluble boron is thus to provide defense-in-depth during accident conditions to ensure that no individual accident will result in an inadvertent criticality.

More information on the design measures implemented to prevent out of core criticality in three reactor technologies under consideration can be found in the *Malfunctions, Accidents and Malevolent Acts TSD.* The TSD also summarizes the results of preliminary criticality

[9] The effective neutron multiplication factor (k_{eff}) is defined as (neutron production rate) / (neutron loss rate). The U.S. NRC Standard Review Plan Section 9.1.2, in discussing storage of new and spent fuel, requires that $k_{eff} < 0.95$ if the storage area is flooded with unborated water and that k_{eff} of 0.98 is required if the storage area is filled with an optimum moderator.

assessments completed for each reactor technology. The *Nuclear Waste Management TSD* (OPG 2008g) provides an assessment of criticality safety in the management of used fuel.

7.3.3.3 Consequences of an Inadvertent Criticality

Although, as previously indicated, with appropriate design (engineering) and control procedures in place, an inadvertent out of core criticality event is considered not credible, the potential consequences of inadvertent criticality are discussed below for illustrative purposes.

A review of criticality accidents by McLaughlin *et al.* (2000) provides a description of 60 criticality accidents none of which are attributed to out of core incidents at power reactors. As noted earlier, the lowest enrichment level, namely 6.5% U-235 in the form of a uranium oxide slurry, in any of these historical criticality accidents was higher than that in fuel (< 5% U-235 and in solid form) which will be used at NND. In general, criticality events in liquid systems exhibit a prompt criticality spike followed by a plateau, the result of quenching by a variety of physical processes (e.g., bubble formation in the liquid system) possibly followed by a series of smaller spikes. As noted by McLaughlin *et. al*, there was only minimal damage to equipment and negligible release of fissionable material in these incidents, although several of the incidents resulted in worker fatalities as a result of the radiation dose accrued. Only one incident resulted in measurable exposure to the general public (well below allowable worker annual dose limits).

From data reported by McLaughlin *et. al*., it is clear that there is a very large range in the number of (prompt) fission events that could occur following criticality accidents with a median of about 1.2×10^{17} fissions and an upper 95th percentile of about 2.5×10^{18} fissions. The criticality accident at the lowest level of enrichment, namely 6.5% U-235, which involved a wet oxide slurry, was a relatively small one with 8×10^{15} fissions. According to a U.S. DOE handbook (U.S. DOE 1994), a value of $1x10^{20}$ fissions bounds the reported values (based on historical evidence) of fission yields for out of core reactor fuel arrays with moderation; however, the OECD (NEA 2005) suggests $5 \text{ x } 10^{18}$ fissions is a reasonable “envelope” scenario. As noted above, the upper 95th percentile of historical criticality accidents resulted in about 2.5×10^{18} fissions. For the purposes of illustration, an out of core criticality event of $5 \text{ x } 10^{18}$ fissions is appropriately conservative and this hypothetical event is described below.

Analysis of criticality experiments and accidents has resulted in empirical formulae that can be used to provide a reasonable upper estimate of the doses arising from a criticality event. (e.g., U.S. NRC 1977, 1987, 1998). The key input to these empirical formulae is the numbers of (prompt) fissions. For solid systems (e.g., large fuel arrays), the total numbers of fissions would be accounted for in the initial burst (i.e., prompt fissions). Table 7.3-12 below shows the gamma and neutron doses estimated in this way for a hypothetical event of $5 \text{ x } 10^{18}$ (prompt) fissions and a number of distances from the location of the criticality. The estimated doses shown in Table 7.3-12 assume no shielding. According to NRC 3.33 (US NRC 1977), an 8" thickness of concrete will reduce the neutron and gamma dose rates by factors of 2.3 and 2.5 respectively.

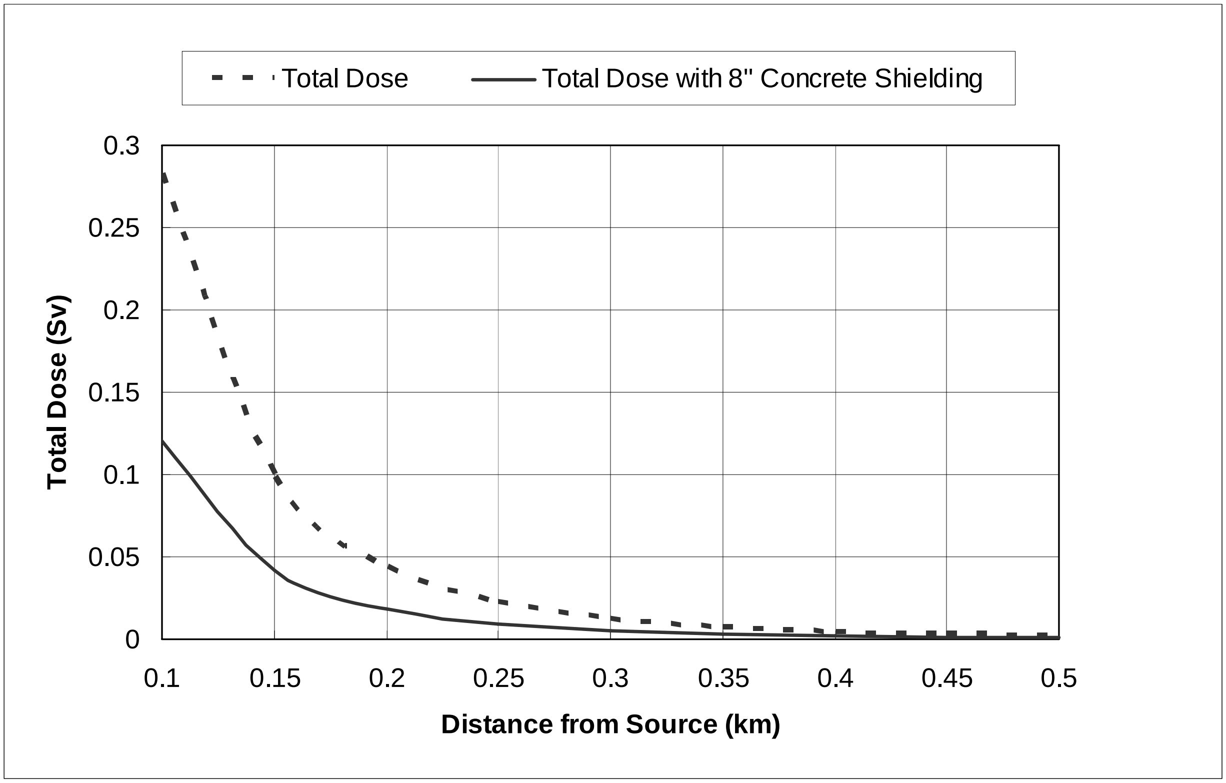
Figure 7.3-1 shows the total dose (neutron plus gamma) from a criticality event of $5x10^{18}$ fissions without shielding and with shielding assumed equivalent to an 8" thickness of (normal) concrete. Doses to persons nearby at the time of this hypothetical criticality event are very high and potentially lethal; however, the doses decrease rapidly with increasing distance, with doses decreasing to below 50 mSv within about 200 m even without taking credit for the shielding provided by the very substantial structures involved.

TABLE 7.3-12
Doses Resulting from Criticality Events for $5x10^{18}$ (Prompt) Fissions

Number of Fissions	Distance from Source (km)	Prompt Gamma Dose (Sv)	Prompt Neutron Dose (Sv)	Total Dose (Sv)
$5x10^{18}$	0.1	$7.5x10^{-2}$	$2.1x10^{-1}$	$2.8x10^{-1}$
	0.5	$7.7x10^{-4}$	$1.0x10^{-3}$	$1.8x10^{-3}$
	1	$4.0x10^{-5}$	$2.0x10^{-5}$	$5.4x10^{-5}$
	2	$2.9x10^{-7}$	$2.7x10^{-8}$	$3.2x10^{-7}$

Reference: US NRC 1977.
Note that NRC equations were in rem, 1 Sv = 100 rem.

FIGURE 7.3-1
Total Dose Arising from the Illustrative Hypothetical Criticality Event*
with and without Shielding



*Illustrative Hypothetical Event: $5x10^{18}$ fissions

As indicated by McLaughlin *et. al.*, the released heat and radiation from past accidents have not been sufficient to damage process equipment. Additionally, it is not expected that the thermal energy resulting from a criticality involving nuclear fuel would be higher than that for which the fuel is designed, and therefore, no damage to the fuel sheath should occur. This would preclude the release of fission product gases as a result of an out of core criticality.

The EIS Guidelines require an indication that consequences of out of core criticality events do not violate criteria established by national guidance (HC 2003) and international standards (IAEA 2002a) as a trigger for public evacuation. These documents address emergency response requirements for managing nuclear or radiological emergencies in Canada and internationally. The intervention value for temporary evacuation set by both the IAEA and Heath Canada is 50 mSv of avertable dose in a period of no more than 1 week. It can be seen from the illustration of dose with distance in Figure 7.3-1 that the trigger level for temporary public evacuation would only be reached within 200 m of the release point for the hypothetical illustrative criticality event. As it is expected that there will be no permanent residents at this distance from NND, no evacuation of members of the public would be required for such a hypothetical out of core criticality event. The intent of the EA Guidelines, with respect to off-site protective actions for out of core criticality, will be met.

7.3.3.4 Conclusions

A criticality accident releases relatively large amounts of radiation in a short period of time. However, with appropriate design (engineering) and control (administrative) procedures in place, an inadvertent out of core criticality event is not considered credible.

A review of past criticality incidents shows that no accident has resulted in significant radiation impacts either to people or to the environment beyond the facility site boundaries (only one incident resulted in measurable exposure to the public) and, moreover, that the released heat and radiation from past accidents have not been sufficient to damage process equipment (McLaughlin *et al.* 2000). Modeling of a hypothetical illustrative out of core criticality event in a nuclear power station has shown that the radiation from a criticality accident does represent a significant potential risk to any workers within the vicinity of the event. The effects of such an event on the public would be greatly reduced due to mitigation provided through distance and shielding.

7.4 Malevolent Acts

Since the events of 11 September 2001, increased attention has been given world-wide to ensuring the safety and security of nuclear power plants.

The IAEA provides an international forum for exchanging information on nuclear security and programs to mitigate against malevolent acts. The IAEA considers that physical protection against malevolent acts should prevent or delay access to a nuclear facility and that physical protection includes design (e.g., layout), the use of physical barriers and procedures. Requirements for physical protection of nuclear power plants suggested by the IAEA include amongst others, limiting access to protected areas, training of all staff, and routine reviews and evaluations of physical protection systems (IAEA 1998).

In addition, the implications of a malevolent event in emergency planning and preparedness are also an important consideration. In this respect, the U.S. NRC reviewed the safety of nuclear installations and concluded that the robust design of nuclear power plants not only protects against external hazards, such as tornadoes and hurricanes, but also that "the same design features also protect against potential acts of terrorism." Furthermore the U.S. NRC also concluded that *"Whether the initiating event is terrorist based or a nuclear accident the EP [emergency preparedness] and planning basis provide reasonable assurance that public health and safety will be protected"* (U.S. NRC 2009).

Following September 2001, the CNSC required that all licensees undertake a variety of measures to enhance security practices and systems, including implementation of various search and screening measures, site hardening and the 24/7 presence of highly trained armed responders. OPG has completed a comprehensive review of the robustness of its existing nuclear assets against credible threats and accidents, up to and including the consequence of aircraft strikes impacting each facility. It was determined that, as unlikely as an accident would be to occur, and as difficult as it would be to perpetrate a malevolent act of this type, the nature of the facility's construction would be sufficiently robust, with defense in depth provided by various safety systems, that it would not cause a significant release of radioactivity to the public. However, following such an event, conventional effects would be expected such as fires and debris, and it is anticipated that an extended shutdown of one or more units would be required to repair any damage to the station.

In considering the potential consequences of malevolent acts, it is important to consider that although malevolent acts are not accidents, the physical consequences of a malevolent act are likely to be bounded by the consequences of an accident. For example, the consequences of a large airplane crashing into a reactor containment structure at NND would be comparable irrespective of whether the event was the result of an accident or an intentional malevolent act. Containment structures designed to protect against accidental releases of radioactivity also provide robust protection from malevolent acts. Nuclear design philosophies employ defense in depth, redundant systems, diversity, separation, fail-safe design and multiple barriers, which all act to mitigate against potential malevolent acts.

As described in Chapter 2, details of security measures around nuclear installations are prescribed information and cannot be disclosed in a public forum as this could compromise the security of the facility. Specific security provisions, including a consideration of design basis threats, will be addressed in separate submissions to the CNSC as part of the licensing process. In general terms however, such measures will include:

- Consideration of physical protection measures early in the design;
- Limiting access to protected or vital areas;
- Security screening of personnel;
- Intrusion detection;
- Record keeping;
- Training of all personnel;
- Routine evaluations of physical protection systems and procedures;
- Emergency response and preparedness planning to establish policies, procedures, and plans to prepare for, train for, respond to, mitigate, and recover from emergencies arising from malevolent acts; and
- Establish any necessary supporting infrastructure.

The EA is not intended to provide a comprehensive study of all aspects of malevolent hazards or risks but rather to provide a credible demonstration of NND's ability to meet the CNSC's requirements related to accidents and malfunctions of malevolent origin. When the NND Project proceeds to Construction licensing, detailed evaluations will be carried out as part of the licensing process.

It is important to understand that regardless of whether an initiating event arises from a malevolent act or an inadvertent nuclear accident, the range of accidents considered in the safety reports and probabilistic risk assessments for the proposed reactors, which will be submitted in support of later stages of the licensing process, is very broad and it is likely that the most severe nuclear accidents considered credible will encompass the consequences of any credible event whether arising from an accident or a malevolent act.

7.4.1 Human Health Effects Related to Malevolent Acts

The FNEP describes malevolent acts as those *"involving improvised nuclear or radiation dispersal devices, or the use of conventional explosives at a facility that stores or uses radioactive materials."* (HC, 2007). Thus, a malevolent act is a deliberate act, designed to cause harm to the environment, to people, or both. Therefore, such an initiating event differs from that resulting from an accident or malfunction. There are federal, provincial and corporate programs in place to respond to a malfunction or accident scenario at existing OPG facilities, including those specifically arising from malevolent acts. Similar measures will be put in place to support NND emergency planning. Providing that the appropriate mitigation measures are put in place, it is not expected that a malevolent act would result in physical human health effects.

It is expected that there will be some social, mental and economic effects arising from a malevolent act, similar to those discussed for nuclear malfunctions and accidents, even if there was no actual release of radioactivity from the station. A malevolent act is likely to result in feelings of loss of security, fear and anxiety that would affect human health. However, these effects would be no different from the effects that could be anticipated following a malevolent act at any other location (e.g. public buildings or transportation systems), and would not be specific to NND or the DN site. Measures to reduce feelings of anxiety or stress among the affected population such as talk therapy and frequent communication with the community may be employed to reduce negative effects on human health as a result of a malevolent act.

8. ASSESSMENT OF CUMULATIVE ENVIRONMENTAL EFFECTS

8.1 Objective and Approach

Section 16(1) of the *CEAA* requires the consideration of cumulative environmental effects, as well as direct environmental effects, of a proposed project. Cumulative environmental effects are defined as effects "*that are likely to result from the project in combination with other projects or activities that have been or will be carried out*". Accordingly, this Chapter provides an assessment of the cumulative effects of the NND Project in combination with other projects and activities within the relevant study areas that have been, or are reasonably likely to be, carried out.

The CEA Agency has issued a number of policy and procedural documents that provide guidance for conducting an assessment of cumulative effects, including the Agency's Operational Policy Statement (CEA Agency 2007), the Cumulative Effects Assessment Practitioners Guide (CEA Agency 1999) and the Reference Guide: Addressing Cumulative Environmental Effects (CEA Agency 1994). According to the CEA Agency's Operational Policy Statement, the scope of a cumulative effects assessment may extend beyond biophysical effects to include the effects of biophysical changes on health and socio-economic conditions, physical and cultural heritage, and other aspects described in the definition of "environmental effects" in the *CEAA* legislation. The EIS Guidelines specify that the assessment include cumulative effects on the physical, biological and human aspects of the environment, but limited to those effects "*that are likely and for which measurable or detectable residual effects are predicted*". As discussed in Chapter 3, a measurable change in the environment is defined as a change that is real, observable and detectable compared with existing (baseline) conditions. A predicted change that is trivial, negligible or indistinguishable from background conditions is not considered to be measurable.

The Practitioners Guide offers "best practices" guidance for conducting cumulative effects assessments. Although the Guide focuses primarily on cumulative biophysical effects, this Project-specific cumulative effects assessment will apply the Guide more broadly, consistent with the CEA Agency's Operational Policy Statement and the Project-specific EIS Guidelines.

The Practitioners Guide notes that the identification of residual effects allows for cumulative effects to be assessed since only those project-environment interactions that result in residual effects can lead to a cumulative effect. The Guide suggests that a cumulative effects assessment for a project under regulatory review should accomplish the following:

1. Determine if the project will have an effect on a VEC;

2. If such an effect can be demonstrated, determine if the incremental effect acts cumulatively with effects of other projects, either past, existing or future; and
3. Determine if the effect of the project, in combination with the other effects, may cause a significant change now or in the future in the characteristics of the VEC after the application of mitigation for that project.

In the case of the NND Project, consistent with the definition in the EIS Guidelines, cumulative effects would be those residual effects that are likely to be caused by the Project combined with the effects likely or potentially caused by other projects and activities on or near the DN site. Using the method described in Section 3.2.10, the steps in the cumulative effects assessment are as follows:

1. Identification of the residual adverse effects of the proposed NND Project (identified in Chapter 5 and summarized in Section 8.3.1).

2. Identification of other projects or activities (presented in Section 8.2) whose effects could potentially coincide with the residual effects of the NND Project. Uncertainties associated with other future projects, and the limited level of detail generally available for assessment of such other projects, are discussed below following Step 4.

3. Determination of the likelihood of coincidence of these effects and any VEC in terms of:
   - The similarity (type) of effects from other projects and activities that might add to those likely to be caused by the NND Project (Section 8.3.2);
   - The timeframe during which these other effects might coincide with those caused by the NND Project (Section 8.3.3); and
   - The geographical area in which these other effects might coincide with those caused by the NND Project (Section 8.3.4).

4. Assessment of the overall cumulative effects and their significance (Sections 8.4 and Chapter 9.0) for those Project residual effects which have been determined as likely to coincide with the effects of other projects and activities on any VEC. This will involve consideration of the effectiveness of proposed mitigation measures and whether additional mitigation, monitoring or other follow-up action is needed.

Uncertainty is inherent in any assessment of future projects, particularly projects which are initiated and controlled by other proponents. The basic uncertainty as to whether a particular other future project will proceed is addressed in Section 8.2. When the details of other future projects (e.g., timeframe, design, technology, effects assessment, mitigation measures, etc.) are unknown, or the information is not accessible, uncertainty about the environmental effects of such future projects and how these effects will interact with those of the proposed Project are increased. In most such cases, the CEA Agency's Reference Guide acknowledges that *only qualitative assessments of cumulative environmental effects will be possible* and recommends that *available information and best professional knowledge and judgement* be used. Furthermore, the Practitioners Guide acknowledges that the level of information and analysis in a cumulative effects assessment may not be as detailed as that in the assessment of the proposed project itself because of the larger area covered.

As for past or present projects and activities, the Reference Guide acknowledges that any environmental assessment which examines "*baseline environmental conditions, which include the … environmental effects of past and existing projects and activities*" (as this NND Project EIS does), already addresses cumulative environmental effects to some extent. Therefore, this chapter is primarily focused on the potential of present and future projects and activities to contribute to cumulative environmental effects.

The Reference Guide and Practitioners Guide are both primarily concerned with adverse cumulative effects. However, the EIS Guidelines for the NND Project specify that both adverse and beneficial cumulative effects be identified and assessed. Therefore, beneficial effects are included in Section 8.4 where appropriate.

As indicated in Section 3.2.10, this cumulative effects assessment does not consider the effects of malfunction or accident scenarios because they are hypothetical and have a very low probability of occurrence. This is consistent with the Practitioners Guide which acknowledges that such events are "rare" and should be assessed as "unique scenarios", as their potential effects are too extreme to be assessed together with those caused by normal operational activities.

8.2 Other Projects and Activities Considered in the Assessment

To determine if the residual effects of the NND Project have the potential to act cumulatively (i.e., coincide or overlap) with the effects of other projects and activities, either past, existing or future, a number of other projects and activities on and around the DN site were identified. Consistent with the general framework of this EIS, the identification of other projects and activities was limited to the area within the RSA. The maximum distance from the DN site to the boundary of the RSA is nearly 50 km. Although the international border which bisects Lake Ontario is less than 50 km south of the site, the shores of New York State are beyond this range. Thus, all of the other projects and activities identified are located within the province of Ontario.

Furthermore, consistent with the EIS Guidelines, the identification of the other projects and activities considered is limited to those for which there is a reasonable degree of certainty that they will actually proceed. The *CEAA* does not require assessment of hypothetical projects and the EIS Guidelines acknowledge that projects that are conceptual in nature or limited as to available information may be insufficiently developed to be considered in a meaningful way.

While the identification of past and existing projects in the area needs no guidance, the identification of future projects does. CEA Agency's Operational Policy Statement indicates that a cumulative effects assessment needs to only consider future projects which are 'certain' or 'reasonably foreseeable'. As recommended in the Practitioners Guide, projects and activities are considered to be 'certain' if they have been approved for development; have been announced by the proponent and/or regulatory agencies; or are currently under review for approval. Projects and activities are considered "reasonably foreseeable" if they are identified in an approved development plan, or are not directly associated with the proposed project under review, but might proceed after/assuming the project is approved. It should be noted that this cumulative effects assessment is not limited to only those projects which are subject to a provincial or federal EA process.

Screening criteria were developed and applied for selecting other projects and activities within the study area for inclusion in the cumulative effects assessment. These criteria were intended to ensure that the potential environmental effects of the other projects and activities are of a type that could act cumulatively with (i.e., overlap) the residual effects of the NND Project. They are similar to screening criteria used for other recent nuclear project EAs. Thus, other projects and activities in the generic SSA, LSA and RSA were selected for cumulative effects assessment if they met one or more of the following criteria (or similar) developed by the EA study team:

- An activity that is likely to occur on or immediately adjacent to the DN site;
- A major change in an existing or ongoing physical work or activity on or adjacent to the DN site;
- A source of additional, ongoing/continued or reduced radiation and radioactivity in the air, land or water that may contribute to radiological doses to humans and non-human biota;
- A source of additional, ongoing or reduced non-radioactive emissions to air, land or water similar to those from the NND Project;
- A source within the RSA likely to generate a change in nuisance effects related to increased traffic;
- A source within the RSA or LSA likely to result in a change in impingement and entrainment of fish;
- A source within the RSA or LSA that may result in a change in thermal loadings to Lake Ontario;

- A source within the RSA or LSA that may result in a change in nutrient loadings to Lake Ontario;
- A need within the RSA or LSA likely to compete for construction labour;
- A need within the RSA or LSA likely to place a change in demand on recreational and community facilities;
- A need within the RSA or LSA that may contribute to a change in enjoyment of property; and
- A major new or enhanced facility along the Lake Ontario waterfront within the Municipality of Clarington.

Using these criteria, other projects and activities were identified by the EA Consulting Team during the course of the EIS preparation. Some of the information on other projects and activities was obtained through the Darlington Planning and Infrastructure Information Sharing Committee (DPIISC) established by OPG in November 2007. DPIISC membership includes representatives from Clarington, Durham Region, the Ministry of Transportation (MTO) and OPG, and from other project representatives. The activities of DPIISC are described in more detail in Chapter 10. OPG sponsored two workshops in 2008 which were relevant to cumulative effects assessment. In June 2008, an intensive two-day workshop was conducted for EA specialists to share technical information related to EA studies for specific projects on or near the DN site, including the Highway 407 East Extension, the Durham-York Energy from Waste Facility, and the NND Project. In November 2008, a workshop on cumulative effects assessment was conducted, involving DPIISC members and consultants as well as GO Transit representatives (OPG 2008c). The projects discussed included the GO Transit Rail Service Expansion project in addition to the projects previously discussed during the June workshop. The results of these workshops have been taken into account in this cumulative effects assessment.

All projects and activities selected for consideration in this cumulative effects assessment, including those mentioned above, are described in Sections 8.2.1 to 8.2.3 and summarized in Table 8.2-1 along with summary rationale as to why each was included. The descriptive sections and table are organized into three major categories:

- Past and existing projects and activities (Section 8.2.1);
- Certain/planned projects and activities (Section 8.2.2); and
- Reasonably foreseeable projects and activities (Section 8.2.3).

The locations of these other projects and activities are shown in Figure 8.2-1 and their timelines are shown in Figures 8.2-2a and 8.2-2b.

TABLE 8.2-1
Other Projects and Activities in the Study Area

Project or Activity	Summary Rationale
1. Past and Existing Projects and Activities	
Darlington NGS (DNGS) Operations	• An activity that occurs on same site as the proposed Project. • A source of ongoing radiation dose to humans and non-human biota. • Limited contribution to fish impingement effects. • Source of thermal loadings to Lake Ontario.
Darlington Waste Management Facility (DWMF) Operations	• An activity that occurs on same site as the proposed Project. • A source of ongoing radiation dose to humans and non-human biota.
Pickering NGS A Operations (Units 1 & 4 fully operational, Units 2 & 3 currently in a shut down condition)	• A source of ongoing radiation dose to humans and non-human biota. • Contribution to fish impingement effects. • Contribution to thermal loading to Lake Ontario.
Pickering NGS B Operations (Units 5-8)	• A source of ongoing radiation dose to humans and non-human biota. • Contribution to fish impingement effects. • Contribution to thermal loading to Lake Ontario.
Pickering Waste Management Facility (PWMF) Operations	• A source of ongoing radiation dose to humans and non-human biota.
Port Hope Area Wastes	• A source of ongoing radiation and radioactivity to the air, land or water that may contribute to radiological doses to humans and non-human biota.
Other (Non-OPG) Facilities Licensed by CNSC	• Sources of ongoing radiation and radioactivity to the air, land or water that may contribute to radiological doses to humans and non-human biota.
St. Marys Cement Operations	• A source of ongoing non-radioactive emissions to air, land or water similar to those from the proposed Project. • A source of potential shock & vibration effects (quarrying operation). • A source of deep excavation into local bedrock and dewatering of the bedrock. • A source of additional traffic on access routes to DN site.
2. Certain/Planned Projects and Activities	
Darlington WMF Expansion in support of DNGS	• An activity that occurs on same site as the proposed Project. • A source of additional radiation dose to humans and non-human biota.
Pickering NGS A – Modification of Units 2 & 3 to Guaranteed Defuelled State	• Interim reduction in radiation dose to humans and non-human biota.
Pickering Waste Management Facility (PWMF) Expansion	• A source of additional radiation dose to humans and non-human biota.
Expansion of Duffin Creek Water Pollution Control Plant	• A source of additional non-radioactive emissions to air, land or water, incl. additional nutrients to Lake Ontario.

TABLE 8.2-1 (Cont'd)
Other Projects and Activities in the Study Area

Project or Activity	Summary Rationale
3. Reasonably Foreseeable Projects and Activities	
Upgrade of 500 kV Transmission System	• An activity likely to occur on or immediately adjacent to the DN site. • Construction project likely to generate nuisance effects such as traffic. • Additional demand for construction labour.
Darlington NGS Refurbishment & Continued Operation	• A major change in an existing, ongoing physical work or activity on the DN site. • Additional demand for construction labour. • Source of additional nuisance effects such as traffic. • A source of continued radiation dose to humans and non-human biota. • Continued limited fish impingement effects. • Continued thermal loading to Lake Ontario.
Pickering NGS B Refurbishment & Continued Operation	• Additional demand for construction labour. • A source of continued radiation dose to humans and non-human biota. • Continued fish impingement effects. • Continued thermal loading to Lake Ontario.
Darlington NGS Decommissioning	• An activity that will eventually occur on DN site. • Ultimate reduction in radiation dose to humans and non-human biota.
New Nuclear - Darlington Decommissioning	• An activity that will eventually occur on DN site. • Ultimate reduction in radiation dose to humans and non-human biota.
Darlington WMF Decommissioning	• An activity that will eventually occur on DN site. • Ultimate reduction in radiation dose to humans and non-human biota.
Pickering NGS A Decommissioning	• Ultimate reduction in radiation dose to humans and non-human biota.
Pickering NGS B Decommissioning	• Ultimate reduction in radiation dose to humans and non-human biota.
Pickering WMF Decommissioning	• Ultimate reduction in radiation dose to humans and non-human biota.
Port Hope Area Initiative Projects: Port Hope Project Port Granby Project	• Sources of additional radiation and radioactivity to the air, land or water that may contribute to radiological doses to humans and non-human biota. • Includes a major new or enhanced facility (Port Granby) along the Lake Ontario waterfront near the Municipality of Clarington.
Other Port Hope Area Projects	• Potential sources of additional radiation and radioactivity to the air, land or water that may contribute to radiological doses to humans and non-human biota.
Highway 407 East Link to Hwy 401	• A project likely to occur near and influence the DN site. • Construction likely to generate nuisance effects such as traffic. • Potential user of some of NND Project's excess soil. • Potential effect on on-site recreational facilities.

TABLE 8.2-1 (Cont'd)
Other Projects and Activities in the Study Area

Project or Activity	Summary Rationale
Highway 401 & Holt Road Interchange Improvements	• A project likely to occur near and influence the DN site. • Construction project likely to generate nuisance effects such as traffic.
GO Transit Rail Extension – Oshawa to Bowmanville	• May attract population growth and indirectly cause increased demand on recreational and community facilities.
Durham-York Energy from Waste Facility	• A source of additional non-radioactive emissions. • Construction likely to generate nuisance effects such as traffic, noise and dust.
Clarington Energy Business Park development	• A project likely to occur near (west of) the DN site. • Construction/development likely to generate nuisance effects such as traffic.
Expansion of Courtice Water Pollution Control Plant	• A source of additional non-radioactive emissions to air, land or water, incl. additional nutrients to Lake Ontario. • A major new or enhanced facility along the Lake Ontario waterfront within the Municipality of Clarington.
Expansion of Other Municipal Water Treatment and Pollution Control Plants	• Sources of additional non-radioactive emissions to air, land or water, incl. additional nutrients to Lake Ontario.
Port Darlington Area Enhancements	• A major new or enhanced facility along the Lake Ontario waterfront within the Municipality of Clarington.
Pickering Airport	• Construction project likely to generate nuisance effects such as traffic and traffic-related emissions. • Additional demand for construction labour. • A source of noise and air emissions during operation.
Oshawa Ethanol Plant	• A source of additional non-radioactive emissions. • A major new or enhanced facility along the Lake Ontario waterfront near the Municipality of Clarington.
Growth and Development in Regional Communities	• Source of increased traffic, stress on municipal infrastructure, recreational facilities, schools, hospitals, etc. • Increased demand on water supply and pollution control facilities and source of additional nutrients to Lake Ontario. • Additional demand for construction labour.

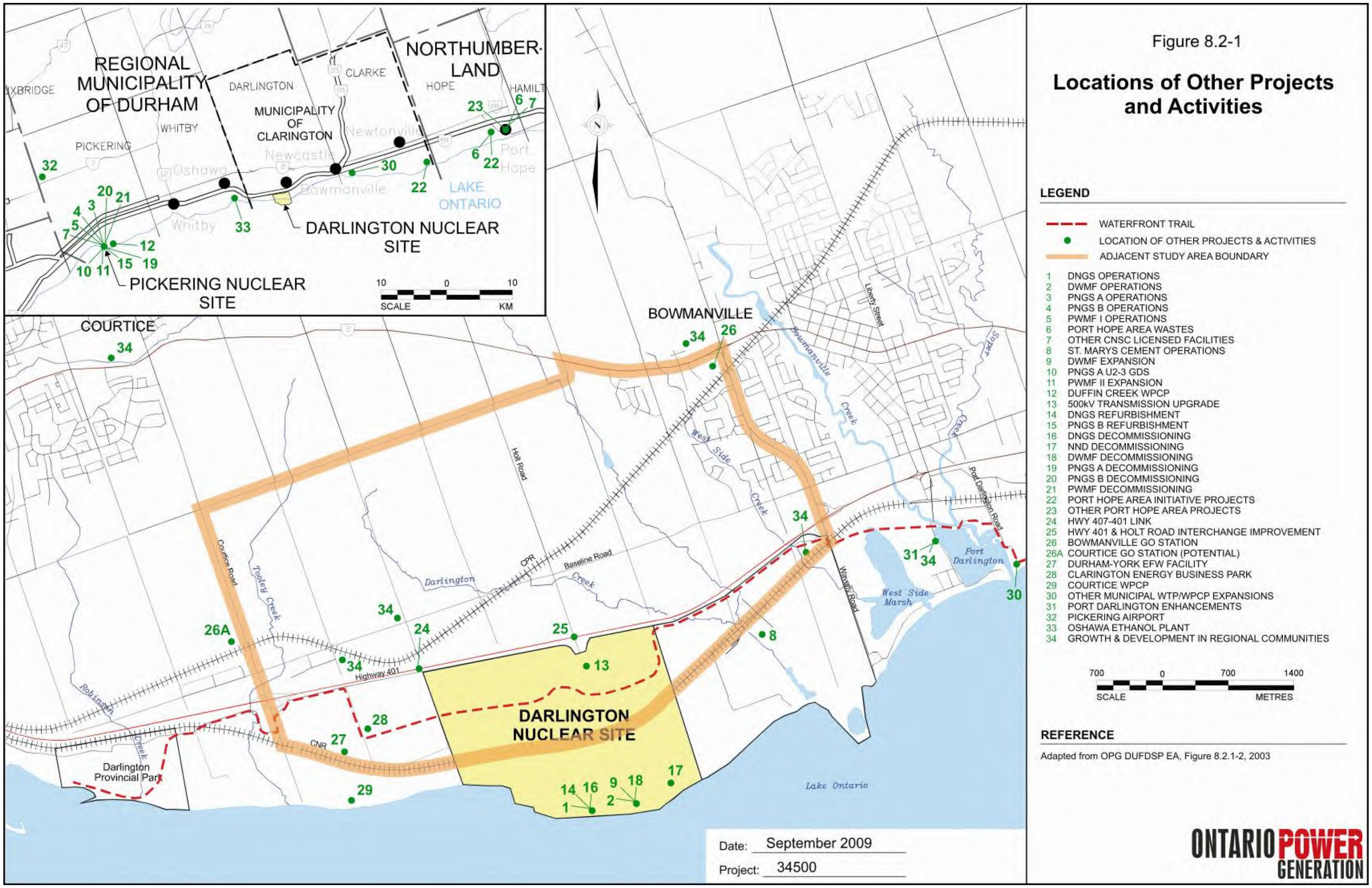


Figure 8.2-1

Locations of Other Projects and Activities

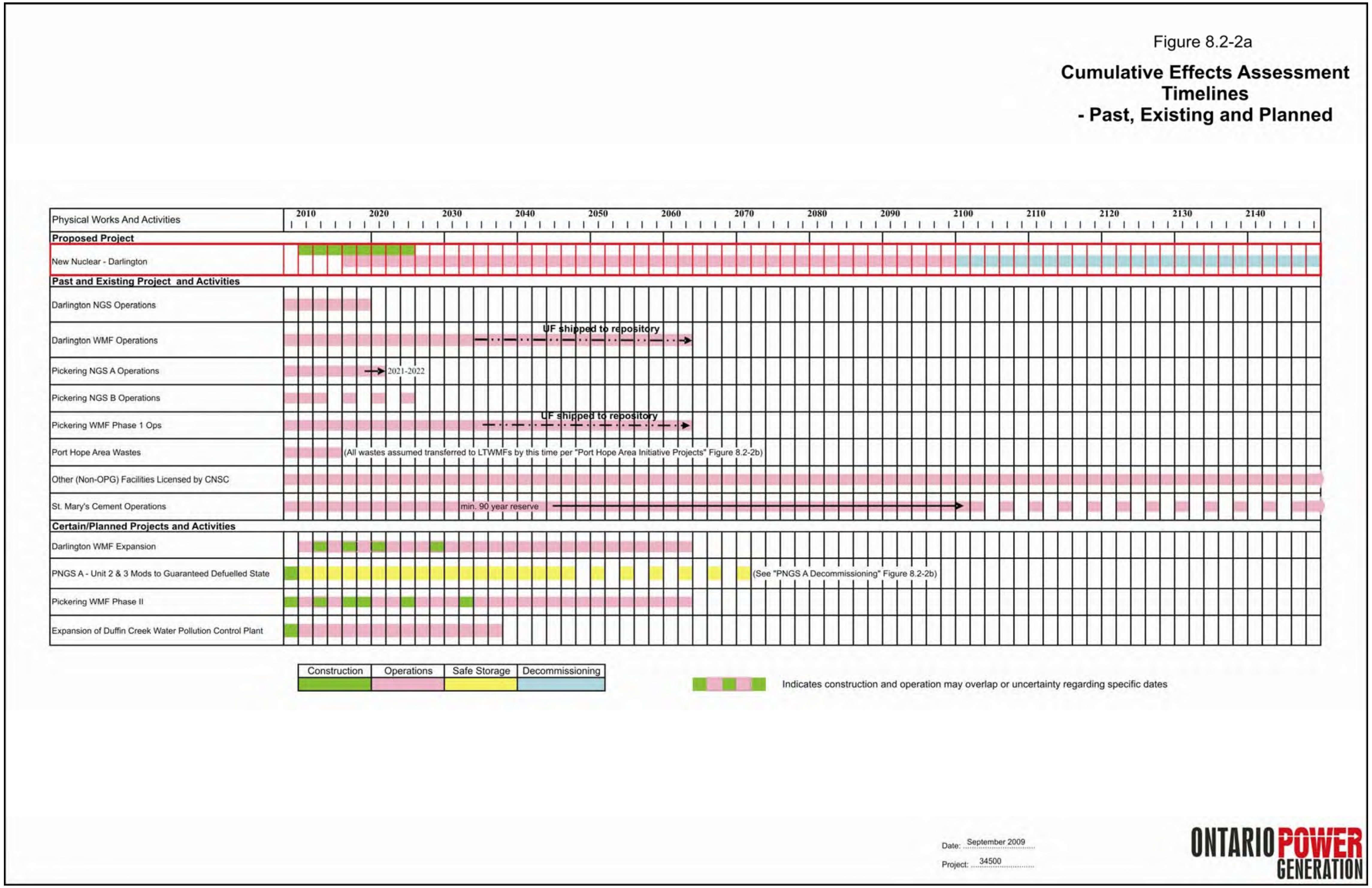
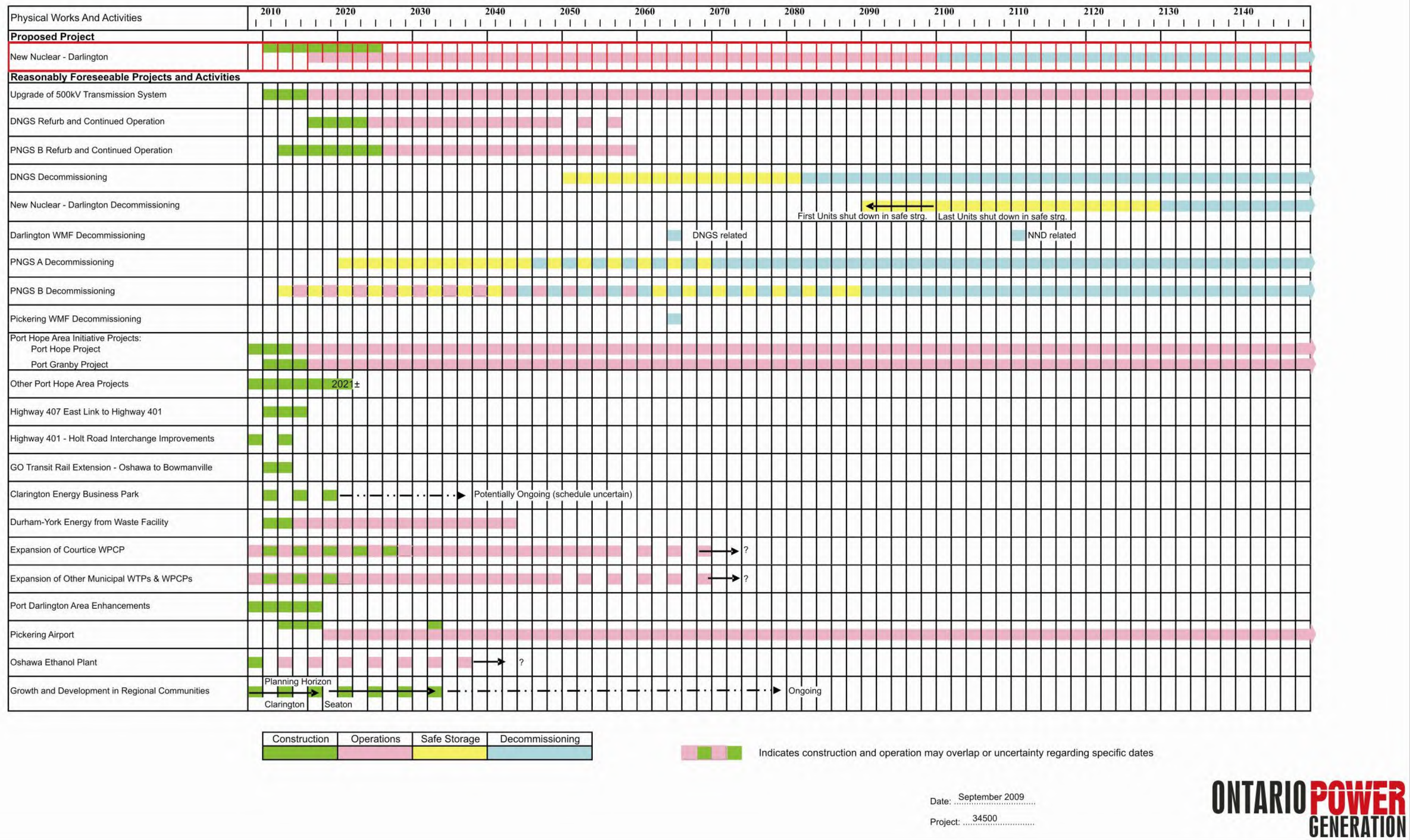


Figure 8.2-2a
Cumulative Effects Assessment Timelines - Past, Existing and Planned
Physical Works And Activities
2010
2020
2030
2040
2050
2060
2070
2080
2090
2100
2110
2120
2130
2140
Proposed Project
New Nuclear - Darlington
Past and Existing Project and Activities
Darlington NGS Operations
Darlington WMF Operations
UF shipped to repository
Pickering NGS A Operations
2021-2022
Pickering NGS B Operations
Pickering WMF Phase 1 Ops
UF shipped to repository
Port Hope Area Wastes
(All wastes assumed transferred to LTWMFs by this time per "Port Hope Area Initiative Projects" Figure 8.2-2b)
Other (Non-OPG) Facilities Licensed by CNSC
St. Mary's Cement Operations
min. 90 year reserve
Certain/Planned Projects and Activities
Darlington WMF Expansion
PNGS A - Unit 2 & 3 Mods to Guaranteed Defuelled State
(See "PNGS A Decommissioning" Figure 8.2-2b)
Pickering WMF Phase II
Expansion of Duffin Creek Water Pollution Control Plant
Construction
Operations
Safe Storage
Decommissioning
Indicates construction and operation may overlap or uncertainty regarding specific dates
Date: September 2009
Project: 34500
ONTARIO POWER GENERATION

Figure 8.2-2b
Cumulative Effects Assessment Timelines - Reasonably Foreseeable



8.2.1 Past and Existing Projects and Activities

Not included in the list of projects and activities (Table 8.2-1) relevant to cumulative effects assessment is OPG's existing non-operational facility at its Wesleyville site on the shore of Lake Ontario in the southwest area of the Municipality of Port Hope. The Wesleyville site was originally developed for the generation of electrical power. Following provincial EA approval in the mid-1970s, construction of a four-unit oil-fired generating station (similar to the existing Lennox GS) was started. However, construction was halted before completion as the cost of oil was increasing substantially. Although the site and facility remain in reserve for future electrical power production, OPG currently has no specific plans for completion of the facility or other development of the site.

Darlington NGS (DNGS) Operations

DNGS is located just west of the proposed NND Project location within the DN site. It consists of four CANDU reactor units, with a total output of 3,524 MWe. Associated with the station is a Tritium Removal Facility (TRF) which removes and stores tritium from heavy water that is shipped to the facility in special containers from all of OPG's operating reactors.

Radioactive emissions to the air and water from this station are similar to the type of emissions expected from the operation of the proposed NND Project. Since DNGS began operating, its radioactive emissions have consistently been a small fraction of the regulatory emission limits and the maximum annual radiation dose to members of the public attributable to the station has been a very small fraction of the regulatory dose limit.

Two important and innovative features of DNGS are its offshore submerged cooling water intake and diffuser-type discharge structures. As a result, there is limited contribution to fish impingement. Similarly, studies have shown that the diffuser discharge system is effective in dissipating heat and thus minimizing thermal effects on local aquatic biota. Nevertheless, despite the effectiveness of the station's innovative cooling water system, operation of DNGS does contribute to the overall thermal load to Lake Ontario.

Darlington Waste Management Facility (DWMF) Operations

The DWMF is located in the south-central area of the DN site between the existing DNGS and the proposed NND station. The existing storage building is a single-storey, commercial-type concrete structure sized to accommodate approximately 480 Dry Storage Containers (DSCs). The current plan for this facility is to expand it in phases as needed to accommodate the used nuclear fuel from DNGS to the end of that station's planned or (if refurbished) extended operating life. This planned DWMF expansion is addressed as a separate project in Section 8.2.2.

Radioactive emissions from the DWMF are expected to remain at very low levels into the future. Under normal operating conditions, no airborne emissions are expected. Gamma radiation levels are expected to increase over time, but the related dose rate is expected to remain less than 10 μSv/y at the DN site boundary (less than 1% of the regulatory dose limit and an even smaller fraction of natural background dose). This dose rate will gradually decrease as the radioactivity continues to decay. The EA conducted for the DWMF concluded that the facility, even at maximum storage capacity, would not result in any adverse residual radiological effects taking into account the proposed design and mitigation measures (OPG 2003c).

The DWMF is an interim storage facility, pending availability of a national long-term used fuel repository, having a service life of at least 50 years or until a long-term facility is available. For planning purposes, it is assumed that a long-term used fuel repository will be in service by about 2035. Accordingly, it is estimated that all used fuel will be removed from the DWMF to the repository by 2064. Similarly, for planning purposes, it is assumed that operational L&ILW from existing facilities at the DN site will be moved to the Deep Geologic Repository (DGR) that has been proposed at OPG's Western Waste Management Facility (WWMF) within the Bruce nuclear site. It is assumed that operational and decommissioning L&ILW from both existing and new facilities at the DN site may go to a separate long-term repository.

Pickering NGS A (PNGS A) Operations

PNGS A consists of four CANDU reactors (Units 1 through 4), the first of which came into service in mid 1971. At the end of 1997, all four reactors were shut down and, in turn, placed in a lay-up (Guaranteed Shutdown State or GSS) state by March of 1998. Following refurbishment, OPG returned two of the units (Units 4 and 1) to service over the period 2003 to 2005.

OPG announced in 2005 that it does not plan to return Units 2 and 3 to service. This is addressed as a separate project in Section 8.2.2.

Units 1 and 4 are expected to continue to operate until 2021, after which each unit will be permanently shut down. Radioactive emissions to the air and water are of the same type as the emissions expected from the operation of the proposed NND Project. Since PNGS A began operating, its radioactive emissions have consistently been a small fraction of the regulatory emission limits and the maximum annual radiation dose to members of the public attributable to the station has been a very small fraction of the regulatory dose limit.

In addition, with an onshore surface type condenser circulating water (CCW) intake and discharge system (shared with Pickering NGS B), the continued operation of PNGS A Units 1 and 4 will contribute to fish impingement as well as to the overall thermal loading to Lake Ontario.

Pickering NGS B (PNGS B) Operations

PNGS B consists of four CANDU reactors (Units 5 through 8), the first of which came into service in 1983. OPG plans to continue to operate these units at least to the end of their planned operating lives, i.e., as early as 2013-2015 assuming no refurbishment. The possible refurbishment and extended operation of PNGS B is addressed as a separate project in Section 8.2.3.

Radioactive emissions to the air and water from this station are of the same type as the emissions expected from the operation of the proposed NND Project. Since PNGS B began operating, its radioactive emissions have consistently been a small fraction of the regulatory emission limits and the maximum annual radiation dose to members of the public attributable to the station has been a very small fraction of the regulatory dose limit.

In addition, with an onshore surface type CCW intake and discharge system (shared with PNGS A), the continued operation of PNGS B will contribute to fish impingement as well as to the overall thermal loading to Lake Ontario.

Pickering Waste Management Facility (PWMF) Operations

The PWMF is a shared facility serving both PNGS A and PNGS B and comprises two main types of facilities: the Used Fuel Dry Storage Facility (UFDSF) for interim storage of used fuel and the Retube Components Storage Facility (RCSF) for interim storage of irradiated reactor components.

There have been no operational activities at the RCSF since 1993, except for periodic inspections, monitoring and maintenance. While the concrete containers for used fuel are stored indoors, the concrete containers for the retube components are stored outdoors.

Radioactive emissions from the PWMF are expected to remain at very low levels into the future. Under normal operating conditions, no airborne emissions are expected. Gamma radiation levels are expected to increase over time, but the related dose rate is expected to remain less than 10 μSv/y at the station exclusion zone boundary (less than 1% of the regulatory dose limit and an even smaller fraction of natural background dose). This dose rate will gradually decrease as the radioactivity continues to decay (OPG 2003c).

Like the DWMF, the PWMF is an interim storage facility and, for planning purposes, it is assumed that a long-term used fuel repository will be in service by about 2035. Accordingly, it is estimated that all used fuel will be removed from the PWMF to the repository by about 2064. Similarly, it is assumed that all operational L&ILW from the Pickering site (except Pickering A retubing waste) will be moved to the Deep Geologic Repository being proposed at the WWMF. It is assumed that decommissioning L&ILW (including Pickering A retubing waste) may go to a separate repository.

Port Hope Area Wastes

A significant inventory of low level radioactive wastes (LLRW) exists in the Port Hope urban area in identified large and small-scale deposits. These wastes are referred to as "historic" in that they resulted from radium and uranium refining during the 1930s to 1980s, and were managed in the past in a manner that is no longer considered acceptable. In addition, large inventories of LLRW also exist at the Welcome Waste Management Facility in the Municipality of Port Hope and at the Port Granby Waste Management Facility in the Municipality of Clarington. Although both waste management facilities are now closed, they continue to be licensed under the *NSCA*.

Other (Non-OPG) Facilities Licensed by the CNSC

Cameco Corporation owns and operates a uranium conversion and metallurgical facility in the Municipality of Port Hope (OPG 2007c). Uranium trioxide (natural uranium) is received at the facility by truck and converted to uranium dioxide and uranium hexafluoride. Small amounts of uranium and gamma radiation may be released to the atmosphere. However, these releases are regulated by licence to ensure that resultant radiation dose to members of the public is well below the regulatory limit, 1 mSv/y. Raw materials and product are shipped by truck to and from the plant and there is potential for effect on the aquatic environment as a result of the exchange of process water and discharge between the plant and the Port Hope Harbour.

Zircatec Precision Instruments Inc. owns and operates a nuclear fuel fabrication facility in the Municipality of Port Hope (OPG 2003c). Zircatec is licensed to process nuclear fuel with up to 20% enrichment (Industry Canada 2008). Small amounts of uranium (different from the emissions expected from the proposed NND Project) are released to the air from this facility. However, these releases are regulated by licence to ensure that resultant radiation dose to members of the public is well below the regulatory limit, 1 mSv/y. Raw materials and product are shipped by truck to and from the plant.

The other major licensee in the RSA is the Low-Level Radioactive Waste Management Office (LLRWMO) of Atomic Energy of Canada Limited. However, the licensed sites maintained by the LLRWMO are inherently included in the Port Hope Area Initiative projects (Section 8.2.3).

Numerous other small CNSC-licensed radioactive sources exist in the area (OPG 2003c, LLRWMO 2006). Most of these include very small sources such as fixed nuclear gauges, teaching aids, calibration sources, x-ray fluorescent and electron capture detectors, which are not expected to result in measurable incremental doses to workers or members of the public. The number of these very small sources within the RSA was estimated in 2003 as about 25 (OPG 2003c). In addition, it was estimated that nine other small facilities in the area, using devices such as industrial radiography sources, portable gauges and radiopharmaceuticals for diagnostic purposes, are likely to contribute somewhat greater doses to workers and the public. However, the operators of all facilities licensed by the CNSC are required to ensure that these doses are as low as reasonably achievable and less than the regulatory limits.

St. Marys Cement Operations

The St. Marys Cement complex located immediately east of the DN site consists of the cement plant plus an adjacent active limestone quarry and a docking facility on the shore of Lake Ontario. The cement plant has a nominal production capacity of 5,900 tonnes of clinker per day and 1.8 million tonnes per year (OPG 2003c).

The entire site is estimated to have at least 90 years of limestone reserves. Traffic entering and leaving the St. Marys site reflects employee, contractor and product movements. Products are moved by a range of modes, including ship, barge, rail and truck, but the majority of limestone and other products entering and leaving the site are moved by ship. Emissions from the cement plant and quarry operations include particulate, greenhouse gases and combustion products from the cement kilns (e.g., CO_2, CO, NO_x, and SO_2) and non-contact, untreated once-through cooling water to Lake Ontario. The maximum height of the St. Marys complex (the stack) is approximately 105 m. Off-site air concentrations of trace metals and organic chemicals are well below the Ministry of the Environment's point-of-impingement limits (St. Marys Cement 2008).

Activities associated with the quarry (including drilling and blasting), cement plant and dock operations also contribute to noise and vibration in the site vicinity. It is expected that the potential effects of blasting at St. Marys' quarry on NND and DNGS facilities will be mitigated by plant design and by controlled blasting methods and strategies. Given the close proximity of the quarry to St. Marys' own buildings and facilities, it is reasonable to assume that St. Marys will rigidly control blasting at the quarry so as to prevent adverse ground motion or vibration effects on its own facilities and operations as well as on any off-site facilities and operations.

The effects of blasting have been monitored by Natural Resources Canada at two monitoring stations located at the east and west sides of the DN site (OPG 2009b). Given the proposed NND Project mitigation measures, including a Noise Management Plan with provisions to alert area residents in advance of blasting operations, it is unlikely that the NND Project will cause any residual adverse noise or vibration effects which could interact with the effects of the St. Marys quarry operation.

In addition to potential noise or vibration effects, the quarry operation may affect the flow of shallow bedrock groundwater flow in the area. St. Marys' current aggregate licence allows for future excavation of the bedrock to an elevation of 11 m above sea level adjacent to the eastern boundary of the NND site and to depths of 116 m below sea level in the main pit area. The extent of excavation allowed under the aggregate licence is shown in the *Geological and Hydrogeological Environment – Existing Environmental Conditions TSD*. Excavations to these depths will require dewatering of the bedrock that may in turn control shallow bedrock groundwater flow in the area. Excavation of the quarry will also require rerouting of Darlington Creek around the quarry pit.

St. Marys Cement recently conducted a short-term (24-day) demonstration project to determine the environmental feasibility of using selected alternative fuels (i.e., residues from municipal composting and recycling processes). The results of the project have not yet been reported. Depending on the results, St. Marys may consider using alternative fuels on a regular basis in future. However, since the demonstration project has been implementation of alternative fuels in future is still uncertain, this aspect of the St. Marys operation will not be included in the cumulative effects assessment.

8.2.2 Certain/Planned Projects and Activities

Darlington WMF (DWMF) Expansion in support of DNGS

Construction of additional storage buildings to accommodate used fuel from DNGS will be phased as additional storage space is required. The number and timing of additional storage buildings will depend on whether OPG decides to refurbish and extend the operation of DNGS (addressed as a separate project in Section 8.2.3). Assuming no refurbishment, a second storage building will be needed by about 2013. If DNGS is refurbished and the operating life of the station extended, a third and fourth storage building would be needed by about 2022 and 2030, respectively. For planning purposes, it is estimated that a Retube Waste Storage Building (RWSB) would be needed by about 2016.

The radiological assessment included in the EA for the DWMF (OPG 2003c) considered the effects of dry storage of used fuel to the end of the planned operating life of DNGS. Under normal operating conditions, no airborne emissions are expected. The dose to members of the public is expected to remain less than 10 µSv/y at the DN site boundary (less than 1% of the regulatory dose limit and an even smaller fraction of natural background dose).

Like the existing facility, the DWMF expansion will have a service life of at least 50 years or until a long-term repository for used fuel is available. For planning purposes, it is estimated that all used fuel will be removed from the DWMF to the repository by about 2064. Similarly, all L&ILW will be removed to an appropriate licensed long-term management facility.

Pickering NGS A – Modification of Units 2 & 3 to Guaranteed Defuelled State

OPG is currently proposing to place Units 2 and 3 in a Guaranteed Defuelled State (GDS) as part of a broader Safe Storage Program, until such time as the entire PNGS A station is decommissioned. The CNSC approved the EA for this project in late 2008. It is expected that the project will be completed by about mid-2010 at which time Units 2 and 3 will be in GDS configuration.

The EA concluded that normal project works and activities would not be likely to cause any measurable incremental effects on the environment and it is expected that radioactive emissions to the environment will decrease after the project is completed. Therefore radioactive emissions to air and the associated doses to the public and non-human biota from Units 2 and 3 are expected to be less than current levels which are already very small.

Pickering WMF (PWMF) Expansion

Construction of additional storage buildings at the PWMF to accommodate used fuel from PNGS A and B will be phased as additional storage space is required.

The number and timing of additional storage buildings will depend on whether OPG decides to refurbish and extend the operation of PNGS B (Section 8.2.3). EA approval for the planned expansion, assuming no refurbishment of PNGS B, has already been obtained from the CNSC. A third storage building was completed and ready for service in June 2009 and a fourth building is expected to be in service by about 2019.

If PNGS B is refurbished, the fourth storage building would be needed sooner, by about 2016, and fifth and sixth buildings by about 2026 and 2034, respectively. For planning purposes, it is estimated that a Retube Waste Storage Building (RWSB) and a Steam Generator Storage Building (SGSB) would be needed by about 2012-2013.

Under normal operating conditions, no airborne emissions are expected. The external gamma dose rates to the public at the PN site boundary were estimated to remain below 10 µSv/y (less than 1% of the regulatory dose limit and an even smaller fraction of natural background dose).

For planning purposes, it is it is estimated that all used fuel will be removed by about 2064. Similarly, all low and intermediate level radioactive wastes (L&ILW) will be removed to an appropriate licensed long-term management facility.

Expansion of Duffin Creek Water Pollution Control Plant (WPCP)

The Duffin Creek WPCP requires expansion to service population growth. Its current treatment capacity (Stages I and II) is 420 MLD (million litres per day). Stage III is planned to provide a total treatment capacity of 630 MLD and Stage IV will eventually increase the total capacity to 727 MLD. These stepwise increases in capacity will result in increases in the volume of the effluent stream discharged to Lake Ontario and potentially water quality impacts (i.e., increased nutrient loading to Lake Ontario). Expansion of the WPCP was planned from 2007 through 2010 and the operational life to approximately 2037 (OPG 2007c).

8.2.3 Reasonably Foreseeable Projects and Activities

As indicated at the beginning of Section 8.2, *a cumulative effects assessment need only consider future projects that are 'certain' or 'reasonably foreseeable'*. In general, projects are considered "reasonably foreseeable" if they are identified in an approved development plan. However, given the uncertainties and limited information associated with some projects, it may not be possible to consider every identified project in a meaningful way. Nevertheless, the following descriptions of Reasonably Foreseeable Projects and Activities, together with the Past and Existing and Certain/Planned Projects and Activities described in the two previous subsections, provide a reasonably comprehensive basis for cumulative effects assessment purposes.

Upgrade of 500 kV Transmission System

The NND Project will require increased transmission capacity along the existing 500 kV corridor that services the DN site. Transmission capacity increase will be assessed in a separate EA by Hydro One, if required. Assuming that the transmission system upgrades will take place within the existing transmission right-of-way, effects on adjacent land uses should be minimal. The existing transmission towers are less than 50 m in height, most towers ranging between approximately 46 to 48 m. The height of any additional towers required for system upgrade purposes would likely be similar. Once the upgrades have been completed, the ongoing operational effects (due to right-of-way maintenance, EMF issues, etc.) are unlikely to be distinguishable from current baseline conditions.

For purposes of this EIS it is assumed that the upgrades necessary to integrate the NND Project will be completed by the time the first NND unit comes into service, i.e., by 2016.

DNGS Refurbishment and Continued Operation

If OPG decides to extend the life of DNGS, a number of major components in each of the units may need to be refurbished or replaced during planned outages. During these outages, after the reactors have been defuelled and dewatered, it is tentatively assumed that the fuel channel assemblies, calandria tubes, feeder pipes, and steam generators would be removed and replaced as required. Management of used fuel and refurbishment waste is considered in Section 8.2.2 as part of the planned expansion of DWMF.

Based on the experience of retubing PNGS A, and on the recent assessment of the PNGS B refurbishment project (OPG 2007c), it is expected that residual environmental effects of the DNGS refurbishment project after mitigation would be limited to the radiological, aquatic, traffic and socio-economic aspects of the environment.

Radiological dose levels to members of the public due to continued operation of DNGS following refurbishment would not be distinguishable from current baseline conditions. Although the collective dose to workers carrying out refurbishment activities would likely be higher than that associated with normal operations, individual worker doses would be managed so that they would remain well within regulatory limits. Following refurbishment, no residual radiological effects on workers would be anticipated during continued operation. Furthermore, no significant adverse effects on non-human biota would be likely.

Regarding aquatic environment effects, relatively minor fish impingement and entrainment effects caused by the station's advanced cooling water system would be expected to continue during both the refurbishment phase and subsequent continued operation. However, these effects would not be expected to exceed historical levels and no population level effects to fishes are predicted.

Most of the expected increase in local traffic congestion is likely to result from population growth in the Region of Durham, not a direct result of the DNGS project. The additional traffic due to the DNGS refurbishment activities is expected to make conditions only marginally worse.

As for effects on socio-economic conditions in local communities, based on PNGS A experience and PNGS B assessment, both adverse and positive effects are likely to result from DNGS refurbishment. Adverse effects may include:

- A change to the regional labour market during the refurbishment phase, but unlikely to contribute to sustained shortages of workers or affect contractors' schedules and activities in Ontario;
- Reduced public use and enjoyment of the Waterfront Trail and other recreational features on or near the DN site due to increased traffic and related noise during refurbishment and potential changes in attitude about DNGS during continued operation;
- Decreased use and enjoyment of residential property during refurbishment due to increased traffic and related noise and/or potential changes in public attitudes about DNGS; and
- Additional involvement of local fire, police and related health and safety services during refurbishment.

Positive socio-economic effects may include:

- Increased population associated with or directly dependent on DNGS related employment during refurbishment, contributing to maintenance of the social structure and stability of local and regional communities;
- New direct, indirect and induced employment opportunities and the maintenance of existing jobs within the study areas during refurbishment, contributing to improved employment stability and maintenance of the existing economic base;
- New business activity due to increased consumer spending associated with households directly or indirectly involved with DNGS during refurbishment;
- Increased attractiveness of the region to leading-edge industry and research organizations involved in the energy sector; and
- Increased revenues (e.g. building permit fees, taxes) to the Municipality of Clarington resulting from the construction of additional buildings and structures on the DN site and the continued operation of DNGS.

For planning purposes, it is tentatively assumed that the refurbishment project would be implemented between 2016 and 2024 and would extend the operation of DNGS to approximately 2050.

PNGS B Refurbishment and Continued Operation

The EA conducted for regulatory approval of the project (OPG 2007c) concluded that residual environmental effects after mitigation would be limited to the radiological, aquatic, traffic and socio-economic aspects of the environment.

Radiological dose levels to members of the public due to continued operation of PNGS B following refurbishment would not be distinguishable from current baseline conditions. Although the collective dose to workers carrying out refurbishment activities would likely be higher than that associated with normal operations, individual worker doses would be managed so that they would remain well within regulatory limits. Following refurbishment, no residual radiological effects on workers would be anticipated during continued operation. Furthermore, no significant adverse effects on non-human biota would be likely.

Impingement and entrainment of aquatic biota by the station's cooling water system would be expected to continue during both the refurbishment phase and subsequent continued operation. However, these effects would not be expected to exceed historical levels and no population level effects are predicted.

It is expected that overall station refurbishment would be completed between 2012 and 2026. Refurbishment would allow PNGS B to continue to operate for a further 25 to 30 years, to approximately 2060 for the last of the four units.

DNGS Decommissioning

If refurbishment does not occur, OPG's preliminary decommissioning plan envisages progressive shutdown of the four reactor units starting in 2018 through to 2020. In accordance with this preliminary plan, the DNGS units would then be placed in a "safe storage" state with surveillance spanning a period of approximately 30 years. This would be followed by a dismantling and site restoration stage beginning about 2047-2050 and spanning a period of approximately 10 years.

This phased decommissioning process is expected to result in a staged reduction of material and radioactivity at the site, and of related exposures to workers, the public and the environment. The radiological effects will be even further below applicable regulatory limits than the effects associated with current operation and maintenance of the station. Furthermore, the effects of the cooling water system (fish impingement/entrainment and thermal discharge) will be gradually eliminated.

If OPG decides to refurbish the DNGS units, the decommissioning process would be expected to be delayed as follows: permanent shutdown of the four units 2049-2055 and dismantling starting 2082-2085.

NND Decommissioning

Overall, it is assumed that the decommissioning process for the NND Project will be similar to that planned for DNGS. Discussion of a preliminary decommissioning plan is provided in Chapter 12.

It is projected that the radiological environmental effects of NND decommissioning (primarily the reduction in exposures to workers, the public and the environment) will be generally comparable to the effects of DNGS decommissioning. Furthermore, the effects of the cooling water system (fish impingement/entrainment and thermal discharge) will be gradually eliminated.

The timeline involved is tentatively projected as follows: permanent shutdown and preparation of up to four units for Safe Storage are assumed to be completed by about 2100 (end of the Operation and Maintenance phase) and the subsequent decommissioning activities (balance of the Safe Storage stage and the final Dismantling and Site Restoration stage) are assumed to span from some time before 2100 for the initial unit(s) until approximately 2150 for the later unit(s).

DWMF Decommissioning

For planning purposes, it is assumed that a long-term used fuel repository will be in service by 2035 and that shipment of used fuel from the DWMF to the repository will occur during the period 2035-2064. Decommissioning of the used fuel related facilities at the DWMF would be expected to occur during the period 2064-2066. If OPG decides to refurbish DNGS, the used fuel related facilities of the DWMF would still be decommissioned during 2064-2066, but the refurbishment waste related facilities would be decommissioned sooner, by 2064.

Decommissioning of the additional facilities required for dry storage of used fuel and any refurbishment wastes from the proposed NND (whether it is an expansion of the existing DWMF or a separate on-site facility) is tentatively expected to occur at least 10 years beyond the end of the proposed NND operating phase, i.e. beyond 2110. This part of the DWMF decommissioning project therefore will not overlap the operating phase of the proposed NND Project.

PNGS A Decommissioning

OPG plans to decommission PNGS A and PNGS B together as one station. The timing of decommissioning of the four PNGS A units will therefore depend on whether or not the PNGS B units are refurbished and the operating life of the B station is thus extended.

If OPG decides not to refurbish PNGS B, the preliminary plan is to permanently shut down the remaining operational PNGS A units (Units 1 and 4) in the early 2020s. This would be followed by a dismantling and site remediation phase for all four units beginning about 2048-2051 and spanning a period of approximately 10 years. The decommissioning process is expected to result in a staged reduction of material and radioactivity at the site, and of related exposures to workers, the public and the environment. The radiological effects will be even further below applicable regulatory limits than the effects associated with current operation and maintenance of the station. Furthermore, the effects of the cooling water system (fish impingement/entrainment and thermal discharge) will be gradually eliminated.

If OPG decides to refurbish PNGS B, the start of dismantling of the four PNGS A units would be delayed to about 2072-2075 (followed by dismantling of the four PNGS B units starting 2076-2079 as indicated below).

PNGS B Decommissioning

If OPG decides not to refurbish PNGS B, the preliminary decommissioning plan envisages progressive shutdown of the four B units when they reach their end-of-service life, as determined through technical assessment of component condition and reviewed by the CNSC. The B units would then be placed in a Safe Storage state with surveillance spanning a period of approximately 30 years. This would be followed by a dismantling and site remediation stage beginning about 2044-2047 and spanning a period of approximately 10 years. This decommissioning process is expected to result in a staged reduction of material and radioactivity at the site, and of related exposures to workers, the public and the environment. The radiological effects will be even further below applicable regulatory limits than the effects associated with current operation and maintenance of the station. Furthermore, the effects of the cooling water system (fish impingement/entrainment and thermal discharge) will be gradually eliminated.

If OPG decides to refurbish the PNGS B units, the start of the decommissioning process would be delayed beyond 2060, the projected end of life of the last PNGS B unit in the refurbishment scenario. The duration of the decommissioning phase thereafter would be similar to that planned for other stations.

PWMF Decommissioning

In general, decommissioning of PWMF would begin after a decision is reached to cease storing radioactive materials on the site and after all of the used fuel in the DCSs has been removed to a national long-term repository. For planning purposes, it is assumed that a long-term used fuel repository will be in service by 2035 and that shipment of used fuel from the PWMF to the repository will occur during the period 2035-2064. If OPG decides not to refurbish PNGS B, the PWMF would continue to operate until approximately 2064, by which time all used fuel is expected to be have been removed to the long-term repository. Decommissioning of the used fuel related facilities at the PWMF would occur during the period 2064-2066, but the refurbishment waste related facilities (i.e., PNGS A refurbishment waste only) could be decommissioned sooner, approximately 2045. If OPG decides to refurbish PNGS B, the PWMF used fuel related facilities would still be decommissioned during 2064-2066, along with any associated refurbishment waste facilities.

Port Hope Area Initiative Projects

The Port Hope Area Initiative (PHAI) includes two remediation projects, the Port Hope Project and the Port Granby Project (LLRWMO 2008):

Port Hope Project

The Port Hope Project, assumed to begin in 2009, involves: (i) remediation of contaminated sites in the Port Hope urban area (including Port Hope Harbour); (ii) construction of a new long-term waste management facility (LTWMF) at the site of the existing closed Welcome Waste Management Facility and (iii) the maintenance and monitoring of the LTWMF for a period of several hundred years. In general, the work associated with the project is expected to be typical of heavy civil works and will include earth-moving, excavation and grading, loading and transport of contaminated soils, installation of ancillary structures and buried services, transport of backfill and construction materials, and long-term maintenance and monitoring of the LTWMF. Low levels of radioactive emissions may result from the project, particularly during the LLRW excavation and transfer activities. In addition, the project is likely to cause changes to the local biophysical environment and also to the local socio-economic, human health and safety conditions in the longer term.

Port Granby Project

The Port Granby Project involves the stabilization and long-term management of LLRW at a proposed new LTWMF to be located in the general vicinity of the existing closed Port Granby

Waste Management Facility in the Municipality of Clarington. The Port Granby Project, assumed to begin approximately 2009-2010, involves the following main components: (i) the transfer of all wastes from within the existing facility to the new LTWMF; and (ii) the maintenance and monitoring of the LTWMF for a period of several hundred years.

In general, the work associated with the project is expected to be typical of heavy civil works and will include earth-moving, excavation and grading, loading and transport of contaminated soils, installation of ancillary structures and buried services, transport of backfill and construction materials, and long-term maintenance and monitoring of the LTWMF. Low levels of radioactive emissions may result from the project, particularly during the LLRW excavation and transfer activities. In addition, the project is likely to cause changes to the local biophysical environment and also to the local socio-economic, human health and safety conditions in the longer term.

Other Port Hope Area Projects

Cameco Site and Plant Remediation (Vision 2010) Project

The project will involve construction of replacement facilities and the removal of all redundant buildings, structures and derelict equipment. As the buildings are removed, contaminated soils will be relocated to the Port Hope Project LTWMF. Construction activities are expected to be typical of heavy civil works and will include building demolition, earth moving and grading, installation of buried services, formwork, concrete and structural, mechanical and electrical components. The work will generally be limited to the area of the existing Cameco site. However, traffic will result from the shipment of contaminated materials to the LTWMF and the import of construction materials and services. Low levels of radioactive emissions may result from the project, particularly during the LLRW excavation and transfer activities. Given that the project activities will be mostly on a pre-developed site, it is not expected that there will be adverse changes to the biophysical environment associated with the project.

As of the Fall of 2007, it was anticipated that construction and related work would occur over the next four to five years (LLRWMO 2008).

Port Hope Waterfront Plan

Conceptual features in the Waterfront Plan include an expanded east beach with a marina, new yacht club, waterfront trails and improved connections with the downtown area. For EA purposes, the waterfront construction and redevelopment activities are assumed to take place only after the Port Hope Project construction and development phase is completed, i.e., after approximately 2015.

Highway 407 East Link to Highway 401

The Ontario Ministry of Transportation (MTO) plans to extend and complete Highway 407 from Brock Road in the City of Pickering to Highway 35/115 in the Municipality of Clarington. Based on the ongoing EA process, the extension will run more or less west-east through the northern portion of the City of Pickering, in close proximity to the existing Highway 7, to the proposed junction with Highway 35/115, a total distance of approximately 70 km (MTO 2008b). In addition, this 407 East extension project will include two links to the existing Highway 401. The link closest to the DN site, referred to as the Durham East Connector, will run north-south and join Highway 401 between Courtice Road and Holt Road. The 407 right-of-way will be designed to accommodate future bus and light rail transit facilities.

Construction activities for the 407 East project can reasonably be expected to be typical of major highway works such as earth moving and grading (including “cut-and-fill” operations along the project corridors), pile-driving, stormwater drainage and buried services, hauling of construction materials, placement of formwork and concrete, and paving. The main offsite effects of the 407 East project will likely be construction traffic, general traffic congestion due to roadway realignment (including lane reductions, road closures, detours, etc.), related vehicle emissions, dust and noise effects in the local area and additional demand on the construction labour force in the region. It is anticipated that the 407 East project will require more soil and other fill material than is likely to be available from the “cut-and-fill” operations within the project corridors. This represents an opportunity for utilization of some of the excess soil from excavation of the NND Project.

In addition, construction of the southern end of the 407 Durham East Connector, where it joins Highway 401, will likely require additional land for a southward realignment of the South Service Road across the northern perimeter of the DN site, particularly the west-central part of the northern site perimeter. This in turn will cause disruption of recreational facilities on the DN site (i.e., the soccer fields and the Waterfront Trail) and may contribute to the need for removal or relocation of these facilities.

The timeline of the 407 East project is currently understood to be as follows: EA was submitted in July 2009, construction start by 2010, and phased completion by 2013-2016 (OPG 2008c).

Highway 401 and Holt Road Interchange Improvements

MTO has recently completed improvements to Highway 401 within the RSA and other improvements to the 401 and other highways in the area are planned or being considered. Widening of the 401 from Westney Road to Salem Road in Ajax and from Port Hope to Cobourg is completed. Widening of the 401 from Salem Road in Ajax to Brock Street in Whitby is planned. Widening of Highway 7 between Pickering and Whitby is also planned. A new interchange at Stevenson Road in Oshawa and resurfacing of the 401 from Stevenson Road to the Highway 35/115 split are targeted for completion in 2009 (MTO 2008a).

In addition, in the foreseeable future, MTO intends to widen Highway 401 between Courtice Road and Highway 35/115 and to improve the 401-Holt Road interchange. Although EAs for these two projects have not yet been initiated, MTO has indicated that planning studies will begin in the near future. These projects must therefore be taken into account in the planning and assessments associated with the Highway 407-401 connection project and the NND Project.

Construction activities for these two Highway 401 improvement projects can reasonably be expected to be typical of major highway works such as earth moving and grading, pile-driving, stormwater drainage and buried services, hauling of construction materials, placement of formwork and concrete, and paving. The main offsite effects of these projects will likely be construction traffic, general traffic congestion due to roadway realignment, related vehicle emissions, dust and noise effects in the local area and possible disruption of wildlife habitat/corridor adjacent to the Holt Road overpass and South Service Road.

For EA purposes, it is assumed that the 401-Holt Road interchange improvement project will be completed about 2011-2012. In reality, however, it is likely that the project will be delayed beyond that time.

GO Transit Rail Extension – Oshawa to Bowmanville

GO Transit intends to extend its commuter rail service from Oshawa eastward to Bowmanville based on the outcome of a recently completed feasibility study (GO Transit 2009). The feasibility study evaluated both CN and CP rail lines as options for the extension. In addition to these basic rail alignment options, the study identified a number of site options for the three commuter train stations (one each in Oshawa, Courtice and Bowmanville) and one rail maintenance facility required as part of the extension project. The study concluded that both the CN and CP rail corridors are feasible options for the proposed extension, recommending the CP option as best overall taking environmental and other factors into account. However, the study did not recommend particular sites for the commuter train stations or the rail maintenance facility, leaving the identified site options to be evaluated in more detail through the Transit EA Process.

Prior to completion of the feasibility study, the Municipality of Clarington had expressed its preference for the CP corridor north of Highway 401 (thus requiring a transition from the present

CN alignment) which would utilize lands previously acquired in the Bowmanville area by GO Transit. The Municipality also favoured an intermediate station in south Courtice that would serve the Darlington nuclear site, the Clarington Energy Business Park and other industrial lands in Courtice. Furthermore, the Municipality expressed interest in coordination of the Courtice station with the transit infrastructure (future bus and light rail transit facilities) planned in conjunction with the 407 Durham East Connector project (Clarington 2008a).

In general, the effects of the GO train station component of this project can reasonably be expected to be typical of urban rail transit works, such as earth moving and grading, stormwater drainage and buried services, hauling of construction materials, placement of formwork and concrete, and parking lot paving. Off-site effects during construction are likely to include increased road traffic, vehicle emissions, dust and noise. Rail construction may be more or less adjacent to haul routes used for off-site disposal of excess soil from NND Project site preparation. During operation, noise from additional commuter rail traffic and maintenance yard activities is likely to be noticeable in the communities served. On the other hand, availability of commuter train service to Bowmanville, with an intermediate station in Courtice, is likely to reduce commuter road traffic to and from the DN site.

If the CPR alignment is selected for the extension, the required transition from the CN alignment currently used by GO Transit could potentially be disruptive to existing land uses, depending on the selected route of the transition (all identified transition route options being in the Thickson Road-Stevenson Road vicinity, west of the LSA). If the CN alignment is selected in the end (despite the feasibility study recommendation and the Municipality of Clarington's expressed preference for the CPR alignment), this could result in some increase in rail traffic, noise and other emissions through the DN site.

While this GO rail service extension is intended to service existing and anticipated future population and other growth in the area, it could potentially attract or at least facilitate even more growth, in turn leading to increased demand on community, recreational and other facilities and services.

Assuming that GO Transit initiated the EA process shortly after the feasibility study was issued (i.e., by mid-2009), construction could begin in 2011 and be completed by about 2013.

<u>Durham-York Energy from Waste (EFW) Facility</u>

In 2005, the Regions of Durham and York agreed to proceed jointly in the planning and development of an energy from waste (EFW) facility as part of a strategy to manage municipal waste in the long term (Durham 2008). The EFW project, proposed to be located within Durham

Region, would initially involve "thermal treatment" of up to 140,000 tonnes per year of post-diversion municipal solid wastes from Durham and York Regions using modern incineration technology, including state-of-the-art emission control equipment, with provision for capacity expansion up to 400,000 tonnes per year in future. The facility is expected to produce more than 750 kilowatt-hours of electricity for every tonne of waste processed. Furthermore, in future, waste heat from the facility could be captured and directed to a local district heating system. The recommended site for the proposed EFW facility is within the new Clarington Energy Business Park (see separate description below).

Construction activities are expected to be typical of civil works and will likely include earth moving and grading, pile-driving, installation of buried services, formwork, concrete and structural, mechanical and electrical components. Off-site effects during construction are likely to include increased traffic, vehicle emissions, dust, noise from traffic and other construction activities. Traffic effects will continue during the operations phase associated with haulage of municipal solid wastes to the EFW facility and removal of ash from the facility. In addition, there is potential for overlap between EFW traffic and the traffic to and from the DN site during and after NND Project construction.

Emissions of heavy metals and dioxins from the facility, which will incorporate modern pollution control technology, are expected to be very small and well within regulatory limits. However, the facility stacks (one to begin with and a second added during future expansion) both approximately 88 m in height, would contribute to an increasing industrialization of the landscape in the vicinity of the DN site.

The EFW project needs municipal and provincial EA approvals before it can proceed. An EA was submitted in July 2009, supported by technical studies including environmental baseline and effects assessments (Durham 2008 and 2009). It is tentatively projected that the facility will be constructed starting in 2010, be in service by 2013, and operate until 2043 (OPG 2008d). The operation phase may include mid-life refurbishment.

Clarington Energy Business Park Development

The designated Clarington Energy Business Park (CEBP) is a 129 hectare area located immediately west of the Darlington nuclear site. The CEBP has been identified by the Municipality of Clarington as an appropriate location for prestige employment uses that would benefit from close proximity to the Darlington nuclear site, the University of Ontario Institute of Technology (UOIT) and/or other major employers within the energy and environment sectors of the regional economy (Clarington 2007a).

In 2007, OPG purchased a parcel of land (approximately 25 ha) in the area of the CEBP. The land was purchased for future OPG office facilities if/when needed to support the growing nuclear program. Preparation of a subdivision plan application is underway, but timing of construction is still uncertain.

The nature of potential developments within the CEBP can only be anticipated in general terms based on the goals of the municipality's plan for the park. It can reasonably be assumed that off-site environmental effects of future CEBP developments relevant to this cumulative effects assessment, other than the EFW facility, will be minor and likely limited to nuisance effects associated with increased traffic to and from the park. The development of the CEBP over time will gradually increase the commercial-industrial landscape in the vicinity of the DN site.

For EA purposes, it is assumed that the timeline of development of this park will initially parallel that of the EFW Project (2010-2013) and continue indefinitely thereafter.

Expansion of Courtice Water Pollution Control Plant

Durham Region's new Courtice Water Pollution Control Plant (CWPCP) is located on the lakeshore, east of the Oshawa-Clarington border, immediately south of the proposed Clarington Energy Business Park. The first phase of the plant was opened in May 2008. The plant is designed to handle the present wastewater treatment requirements of Oshawa and Courtice and to provide capacity for future growth of Whitby as well as Oshawa and Courtice (Durham 2008b).

Construction activities associated with expansion of the CWPCP is likely to be typical of heavy civil works, including earth moving and grading, installation of buried services, formwork and concrete and structural, mechanical and electrical components. The work will generally be limited to the CWPCP site, although traffic will result from the transportation of materials and services to and from the site. Expansion of the CWPCP may affect wildlife habitat and recreational uses along the lakeshore, possibly including the Waterfront Trail.

The primary operational interaction of the CWPCP with the NND Project is expected to be related to residual nutrients in the effluent from the CWPCP. The location of the CWPCP outfall (approximately 1000 m offshore) was chosen so that it would benefit from the dilution of the DNGS discharge. This arrangement not only helps to keep the CWPCP effluent away from the beaches of Darlington Provincial Park, but also away from the existing DNGS intake and even more so from the intake of the proposed NND Project.

Future expansion is expected to be phased over a period of approximately 20 years. For EA purposes, operation of the existing plant and future additions is assumed to continue indefinitely.

Expansion of Other Municipal Water Treatment and Pollution Control Plants

Other foreseeable municipal projects in the region include planned expansions of the Newcastle Water Treatment and Water Pollution Control Plants; Bowmanville Water Treatment Plant and the Port Darlington Water Pollution Control Plant (LLRWMO 2006).

The Regional Municipality of Durham is planning to expand all of these plants over the period 2007-2021 approximately. Construction activities associated with each of these expansion projects can reasonably be expected to be typical of heavy civil works and will include earth moving and grading, installation of buried services, formwork and concrete and structural, mechanical and electrical components. The work will generally be limited to the specific area of each site, although traffic will result from the transportation of materials and services to and from the sites. There are also likely to be changes to the local biophysical environment associated with each project and likely changes to the local socio-economic, and human health and safety conditions as a result of ongoing operations of each facility.

Port Darlington Area Enhancement

The Municipality of Clarington began conceptual planning in 2000 for enhancement of the Port Darlington neighbourhood area of Bowmanville (OPG 2003c). In 2007, the Municipality issued a secondary plan to guide further development of this area (Clarington 2007).

The planned new neighbourhood would accommodate a population of approximately 3,200 people. Other developments are anticipated to include marina and related facilities, village commercial and prestige industrial areas, waterfront greenspace, parklands, and environmental protection areas.

Interaction between the Port Darlington area enhancement project and the NND Project are expected to be minor and gradual. For EA purposes, it is assumed that this enhancement project began in early 2007 when the municipal secondary plan was issued and will continue over a period of 5-10 years.

Pickering Airport

The Greater Toronto Airport Authority (GTAA) developed a draft plan in 2004 for a new international airport proposed to be located on the federally-owned "Pickering Lands" site in the northwest corner of the City of Pickering (GTAA 2009). These lands were originally acquired in the early 1970s for a new international airport initiative. While that initiative was halted and interim development focused on the existing Toronto Pearson airport, the option of building an additional airport at Pickering has remained. Although Transport Canada has indicated that a federal decision on whether to proceed with the Pickering Airport will not be made until 2009 at the earliest, this project is considered reasonably foreseeable for purposes of this assessment.

According to the GTAA's draft plan, the Pickering airport will initially service demand that exists due to the closures of Buttonville, Oshawa and Markham Airports. Facilities at the Pickering Airport will be further developed as the demand for air transportation service grows. The draft plan includes two phases. In the initial phase (2012 plan), development would primarily take place in the northern area of the proposed airport with the construction of general aviation and support facilities, including one primary runway and one crosswind runway. In the second phase (2032 plan), additional development would include three full runway layouts, a passenger terminal and apron, additional parking, another control tower, de-icing facilities, a cargo area, airport support, aircraft maintenance and a general aviation area.

The construction phases of the airport project would be expected to generate temporary nuisance effects such as traffic, dust and noise and place additional stress on the construction and labour market in the region. Given the distance between the airport project and NND Project sites, their construction traffic, dust and noise effects are not likely to overlap to a noticeable or measurable extent. Operation of the airport, however, is likely to be a longer-term source of additional traffic, noise and air emissions. The GTAA's draft plan includes consideration of ground-based traffic and access to the proposed airport, taking into account planned road network development and improvement projects such as the Highway 407 East project and Highway 404-Highway 48 arterial connection, as well as local road network improvements. Operation of the airport is therefore not likely to be a major contributor to cumulative traffic effects around the NND Project site. While the magnitude of these potential operational effects (traffic, noise and air emissions) will be greatest in the communities closest to the airport, the additional noise will to some extent affect all regional communities located under designated flight paths. However, based on noise analysis in the draft plan, the noise contours within which community annoyance may result are not likely to extend eastward beyond the northeastern boundary of the City of Pickering.

The timeline of the airport project is tentatively projected as follows: initial construction 2012-2018; initial operation 2019-2031; expansion/operation 2032-2034; and full operation 2035 and beyond.

Oshawa Ethanol Plant

FarmTech Energy Corporation is proposing an ethanol production plant on the Lake Ontario waterfront in the City of Oshawa (Durham 2008c). If the project receives all the required approvals, ethanol will be produced by fermenting corn and other crops including wheat, barley and sugar cane, then distilling the fermented material into alcohol. The remaining by-product is generally used as feed by the livestock industry. The carbon dioxide created in the ethanol production process is captured and sold to the food and beverage industry for carbonating drinks and fast-freezing foods.

The current status of the project (approval process not yet complete), plus an assumed construction period of at least a year, suggest that 2010 is a more realistic in-service target than originally proposed by the proponent.

Growth and Development in Regional Communities

The Seaton community in the central area of the City of Pickering is expected to become the largest master-planned community in Durham Region within the current regional planning horizon, 2001-2031 (Pickering 2008). Future population of up to 70,000 and 35,000 jobs are planned by 2031.

Growth and related developments within the Municipality of Clarington (the host municipality) is considered most relevant for purposes of the NND Project cumulative effects assessment. Growth and development in south Clarington, including industrial development, has been planned at the regional and municipal levels for years and continues to be planned for in the relevant Official Plan documents. At the end of 2007, there was a 5-6 year supply of draft-approved and registered residential subdivision lots in the urban areas of Clarington. It is estimated that, with the addition of potential development applications, the supply could increase to 10-13 years or enough to accommodate approximately 32,000 additional people in Clarington (Clarington 2008b). The Municipality's focus is on meeting its servicing commitments for lands within a 10-year development plan.

For EA purposes, therefore, it is assumed that construction activities associated with the identified growth and development in Clarington will take place during the period 2008-2017. The growth and development planned for the Seaton community in central Pickering is assumed to continue to 2031. These and other growth and development areas across the Region are likely to result in increased demand for construction labour and materials and increased traffic. In addition to traffic, construction activities are likely to result in typical nuisance effects such as vehicle emissions, dust and noise. Once the subdivisions are completed, there will likely be increased demand on community and recreational facilities. It will also put additional demand on regional water supply and water pollution control facilities, thus increasing the effluents (including nutrients) into Lake Ontario.

8.3 Coincidence of Effects of the NND Project and of Other Projects and Activities

8.3.1 Summary of Residual Effects of the NND Project

As indicated in Section 8.1, the first step in the cumulative effects assessment process is the identification of residual adverse effects (i.e., effects that remain after mitigation) of the NND Project. These residual effects are derived from the analyses in Chapter 5 and are summarized in Table 8.3-1(a) along with the relevant components of the environment and VECs. Consistent with CEA Agency guidelines, cumulative effects based on residual Project effects are the primary consideration in this assessment. However, as indicated in Section 8.3.2, certain other issues identified during the course of consultation with government and public stakeholders are considered also, even though the degree of overlap between these issues and NND Project effects have been assessed as not likely to be measurable or detectable.

TABLE 8.3-1(a)
Residual Adverse Effects of the NND Project and Relevant VECs

Environment Component	Likely Adverse Residual Effects	Relevant VECs
Atmospheric Environment	None	N/A
Surface Water Environment	None	N/A
Aquatic Environment	Loss of some aquatic biota (i.e., benthic invertebrates, fish) during the construction of the lake infill and the cooling water intake and discharge structures.	Benthic Invertebrates and VEC Fish Species
	Fish impingement and entrainment losses associated with the operation of the once-through lakewater cooling option and, to a far lesser degree, the cooling tower option.	
Terrestrial Environment	Loss within the DN site of approximately 40 to 50 ha of mostly Cultural Meadow Ecosystem.	Cultural Meadow and Thicket Ecosystem
	The net loss of approximately 24 to 34 ha of on-site habitat currently used as butterfly habitat during migration.	Butterfly stopover areas
	Decrease in populations of breeding birds on the DN site.	Breeding birds and communities
	Loss of nesting habitat for up to 1,000 Bank Swallow nests; however, some mitigation not directly comparable to effect, will result in advances for the species elsewhere.	Breeding birds and communities
	Bird strike mortalities associated with cooling towers (estimated at <110 in the spring and <300 in the fall, assuming four natural draft cooling towers).	Migrant song birds and their habitat
	Periodic and short-term disruption to wildlife travel along the east-west wildlife corridor during the Site Preparation and Construction Phase of the Project.	Landscape connectivity
Geological and Hydrogeological Environment	None	N/A

TABLE 8.3-1(a) (Cont'd)
Residual Adverse Effects of the NND Project and Relevant VECs

Environment Component	Likely Adverse Residual Effects	Relevant VECs
Radiation & Radioactivity Environment	None	N/A
Land Use	Changes in the quality of existing views of the DN site throughout the operating life of the Project from viewing locations in the LSA and the RSA as a result of the presence of natural draft cooling tower structures and the associated vapour plumes released from either natural draft or mechanical draft cooling towers.	Visual aesthetics
Traffic & Transportation	None	N/A
Physical and Cultural Heritage Resources	None	N/A
Socio-Economic Environment	Change in the character of communities in the RSA and LSA as a result of the presence of the natural draft cooling tower structures, and the associated plumes released from either natural draft or mechanical draft cooling towers (if the NND Project were to be implemented with cooling towers).	Community character
	Reduced use and enjoyment of community and recreational features on the DN site (e.g., Waterfront Trail, soccer fields) during the Site Preparation and Construction phase.	Community and recreational facilities
	Disruption to use and enjoyment of property because of nuisance-related effects (e.g., dust, noise, traffic) during the Site Preparation and Construction phase for some residents living along the truck haul routes.	Use and enjoyment of property
	Reduced enjoyment of private property in the RSA and LSA as a result of the visual dominance of the natural draft cooling tower structures and the associated vapour plumes released from either the natural draft or mechanical draft cooling towers (if the NND Project were to be implemented with cooling towers).	Use and enjoyment of property
Aboriginal Interests	None	N/A

TABLE 8.3-1(a) (Cont'd)
Residual Adverse Effects of the NND Project and Relevant VECs

Environment Component	Likely Adverse Residual Effects	Relevant VECs
Health - Human	Reduced enjoyment of private property in the RSA and LSA as a result of the visual dominance of the natural draft cooling tower structures and the associated vapour plumes released from either the natural draft or mechanical draft cooling towers.	Members of the public
	Disruption to use and enjoyment of property because of nuisance-related effects (e.g., dust, noise, traffic) during the Site Preparation and Construction phase for some residents living along the truck haul routes.	Members of the public
	Reduced use and enjoyment of community and recreational features on the DN site during the Site Preparation and Construction phase.	Members of the public
Health - Non-Human Biota	None	N/A

Note: N/A = not applicable

As described in Section 5.13 the three residual adverse effects identified for Human Health all relate to the use and enjoyment of private property, and community and recreational features; and were also identified in the Socio-Economic Environment. The relevance of these residual adverse effects to Human Health is based on the fact that changes in use and enjoyment of private property and community/recreational features are a consideration in terms of mental and social well-being. However, to avoid double counting of the same effects, the residual adverse effects that are common to both the Socio-Economic Environment and Human Health are considered further in terms of cumulative effects only in the Socio-Economic Environment. If cumulative effects were to be identified in the Socio-Economic Environment relative to these residual effects, those cumulative effects will also be considered in terms of Human Health.

The number of residual adverse effects of the Project, is relatively small due to the comprehensive scope of OPG's proposed environmental and safety design features, procedures and additional mitigation measures identified through the EA process.

In addition to residual adverse effects, as identified in Chapter 5, the Project is likely to result in a number of beneficial effects. These beneficial effects are summarized in Table 8.3-1(b) along with the relevant components of the environment and VECs. They will be considered in the cumulative effects assessment along with residual adverse effects of the Project.

TABLE 8.3-1(b)
Beneficial Effects of the NND Project and Relevant VECs

Environment Component / Sub-Component	Likely Beneficial Effects	Relevant VECs
Socio-Economic Environment / Human Assets	Increased population associated with, or directly dependent on, NND Project-related employment resulting in the maintenance of the social structure and stability of LSA communities and selected municipalities across the RSA. The NND Project will be a positive contributor to the anticipated population growth in all RSA and LSA municipalities.	Local and regional population
	The NND Project is likely to create new apprenticeship opportunities that would generate a substantial number of new certified tradespeople available for the Project itself and/or Ontario's construction labour market subsequently.	Local and regional population
	The NND Project will serve to maintain the skilled employment base of the RSA's and LSA's energy sector in the short term and contribute to the expansion of the skills base over the long term.	Local and regional population
	The NND Project will likely be a driver for increased enrolment in post-secondary educational programs that provide energy or nuclear related degrees or certificates and other training programs that support certification in a skilled trade.	Education
	The NND Project will likely be a driver for increased local and regional economic development during each phase of the Project, as well as a catalyst for the further development of the Durham Energy Industry Cluster and the Clarington Energy Centre through the likely establishment of new business operations in the RSA that are involved in the nuclear service industry.	Local and regional population

TABLE 8.3-1(b) (Cont'd)
Beneficial Effects of the NND Project and Relevant VECs

Environment Component / Sub-Component	Likely Beneficial Effects	Relevant VECs
Socio-Economic Environment / Financial Assets	The NND Project is likely to create new direct, indirect and induced employment opportunities for existing and potential in-movers to the RSA and LSA which will positively influence employment growth in these municipalities.	Local & regional population and economic development
	The NND Project is likely to create new business activity and opportunities due to increased spending associated with households, directly or indirectly associated with the NND Project employment, and increased Project expenditures of goods and services during the Site Preparation and Construction Phase and the Operation and Maintenance Phase.	Local & regional economic development
	The NND Project is likely to result in improved economic viability and increased investment in tourist accommodation businesses (i.e., hotels and motels), resulting in improved stock of tourist accommodations in the LSA during the Site Preparation and Construction Phase.	Tourism
	The NND Project is likely to result in increased total household income during both the Site Preparation and Construction and Operation and Maintenance phases of the Project.	Local & regional population and economic development
	The NND Project is likely to result in increased rate of growth in property values and increased sales volumes in the LSA municipalities.	Residential property values
	The NND Project is likely to result in increased municipal tax and other revenues resulting in an improved financial status during the Site Preparation and Construction Phase and the Operation and Maintenance Phase.	Municipal revenues & financial status
Socio-Economic Environment / Physical Assets	The NND Project is likely to serve as a driver for the initiation of new housing developments in the Municipality of Clarington, the provincially identified growth centres of the Cities of Pickering and Oshawa, and other communities within Durham Region.	Housing
	The NND Project is likely to result in diversification of the housing stock in the Municipality of Clarington.	Housing
Aboriginal Interests	The NND Project will create a substantial number of new employment opportunities and these will be available to Aboriginal Peoples.	Aboriginal Peoples

The likelihood of these residual adverse and beneficial Project effects coinciding with (and thus adding to or subtracting from) the effects of other projects and activities in the area and any VEC depends on three factors: (i) the similarity (type) of the effects; (ii) the extent to which the timeframes of the effects overlap (temporal overlap); and (iii) the extent to which the geographical areas of the effects overlap (spatial overlap). All three of these factors must apply to each of the other projects or activities considered in order for them to be included as contributors in the cumulative effects assessment. These factors are discussed below.

8.3.2 Types of Effects that May Coincide

The following list includes those components of the environment that are associated with the residual adverse Project effects identified in Table 8.3-1(a):

- Aquatic Environment;
- Terrestrial Environment;
- Land Use; and
- Socio-economic Environment.

It may be noted that the Radiation and Radioactivity and Human Health components are not included in the list. No residual radiological health effects were assessed as likely due to the very low emission and exposure levels expected with the proposed Project design and mitigation measures. Nevertheless, the Human Health component is discussed further in Section 8.4.6 because of concerns generally expressed by some members of the public that their health, safety and well-being may be affected by radiation and radioactivity from any nuclear project or operation.

Similarly, Atmospheric Environment, Traffic and Transportation and other environmental components are not included in the list due to the expected effectiveness of Project design and mitigation measures. Nevertheless, because of concerns expressed by the host municipality, special consideration of the expected concentration of new projects in the near future within Clarington (and associated traffic, air quality and other potential effects) will be included in Section 8.4.7, even though no residual traffic or air quality effects were assessed as likely to result from the NND Project.

The four environmental components plus the additional considerations presented above form the framework (breakdown of Section 8.4) within which the potential for adverse cumulative effects of the proposed Project, in combination with some of the other identified projects and activities, will be discussed. The beneficial Project effects identified in Table 8.3-1(b) will be discussed in terms of their potential for offsetting some of the adverse Project and cumulative effects.

8.3.3 Timing of Effects that May Coincide

As described in Chapter 2 and summarized in Figure 8.2-2, the timeline of the proposed NND Project (site preparation, construction, operation and maintenance, and decommissioning) extends more than 100 years from approximately 2010 to beyond 2100. For EA purposes, it was originally assumed that site preparation for up to 4,800 MW (up to four units) of nuclear generation capacity could begin as early as 2010. More recently, however, the site preparation start assumption has been refined to mid-2011, as indicated in Figure 1.5-1. Construction of the first two units, in turn, is assumed to begin in the latter half of 2012. The Operation and Maintenance phase for the first two units is still assumed to start in 2016. It is further assumed that construction of the additional one or two units (depending on the unit size of the reactor technology/vendor option selected) would begin by approximately 2017-18 and operation of the additional unit(s) would begin around 2021-25. Again for EA purposes, it is assumed that the Operation and Maintenance phase will extend to approximately 2100, providing approximately 60 years of power production for each reactor (equivalent to about 70 calendar years with planned outages). Mid-life refurbishment of the NND units is an option for future OPG consideration, but for EA purposes it is tentatively assumed that refurbishment may be undertaken during the decade or so following 2050. Decommissioning is assumed to extend beyond 2100 to approximately 2150. These assumed timeframes of course may change as the planning and regulatory process for the Project evolves.

Figure 8.2-2 also presents the estimated timelines of all of the other projects and activities listed in Table 8.2-1. It is clear from this figure that most of the other projects and activities overlap some part of the proposed Project timeline. However, more detailed screening is required to determine if all three overlap factors (type, temporal and spatial) apply in each case. This screening is presented in Section 8.3.5. In addition, more detailed discussion of the temporal concentration of near-future projects and activities within the Municipality of Clarington is presented in Section 8.4.7.

Furthermore, the EIS Guidelines require a brief historical overview of the timelines of the construction, commissioning and operating periods of the various existing facilities at the DN site, beginning with first construction start in 1981. This historical overview is summarized in Table 8.3-2.

TABLE 8.3-2
Darlington Nuclear Site Approval, Development and Operation History

Facility / Approvals	Construction & Commissioning Period	Operation Period
Darlington NGS Units 1-4 • Provincial project approval 1977 • AECB site approval 1977 • AECB construction approval 1981 • AECB operating licence 1989	1981-90	1990-continuing
Tritium Removal Facility • AECB construction approval 1985 • AECB operating approval 1988	1985-88	1988-continuing
Darlington Waste Management Facility (Phase I) • CNSC EA approval 2003 • CNSC construction approval 2004 • CNSC operating licence 2007	2004-07	2008-continuing

8.3.4 Geographical Extent of Effects that May Coincide

The identification of other projects and activities for cumulative effects purposes was limited to those located within the RSA, consistent with general EA practice. Locations of all of the other projects and activities identified are shown in Figure 8.2-1. However, the extent to which the residual effects of the NND Project are likely to spatially overlap those of the other identified projects and activities cannot be assumed simply because they are located within the RSA. While spatial overlap is obvious in some cases (e.g., other projects on or near the DN site); it is not as obvious in other cases (e.g., other projects or activities more distant from the DN site). More detailed screening is required to determine if all three overlap factors (type, temporal and spatial) apply in each case. This screening is presented in Section 8.3.5. In addition, more detailed discussion of the geographical concentration of near-future projects and activities within the Municipality of Clarington is presented in Section 8.4.7.

8.3.5 Screening of Other Projects and Activities for Effects that May Coincide

For each residual adverse environmental effect predicted for the NND Project (as summarized at the end of Section 8.3.1), each of the other projects and activities described in Sections 8.2.1-8.2.3 was screened to determine if the effects associated with it would be similar (and therefore additive) and likely to occur within the same geographical space and timeframe as the effect of the NND Project. This screening is summarized in Table 8.3-3. Part (a) of this table includes all of the past, existing and certain/planned projects and part (b) includes the reasonably foreseeable projects from Table 8.2-1.

A solid dot (●) in the table represents a residual effect of the proposed Project in relation to the indicated component of the environment. Only those components of the environment for which a residual Project effect has been predicted are included in the table. An open dot (○) in the table represents a potential overlapping effect of one of the other projects and activities in relation to the indicated aspect of the environment within the same geographical space and timeframe as the residual effect of the NND Project. For each of the other projects and activities, the determination as to whether and where (under which environmental component) to allocate an open dot in this table was based on careful examination of the nature (per Table 8.2-1 and Sections 8.2.1-8.2.3), location (per Figure 8.2-1) and timeline (per Figure 8.2-2) of that project or activity in relation to those of the NND Project and on professional judgement. Where the predicted residual effects of the NND Project and potential effects of the other projects and activities coincide fully (i.e., type, temporal and spatial overlaps are likely or at least reasonably possible), as indicated by the open dots in Table 8.3-3, the potential for cumulative environmental effects is examined further in Section 8.4.

TABLE 8.3-3(a)
Potential Coincidence of Effects of the NND Project and Effects of Other Projects and Activities – Past, Existing & Planned

Projects and Activities	Environmental Components Involved			
	Aquatic Environment	Terrestrial Environment	Land Use	Socio-Economic Environment
New Nuclear Darlington Project	●	●	●	●
Darlington NGS (DNGS) Operations	○	▒	▒	▒
Darlington Waste Management Facility (DWMF) Operations	▒	▒	▒	▒
Pickering NGS A Operations	○	▒	▒	▒
Pickering NGS B Operations	○	▒	▒	▒
Pickering Waste Management Facility (PWMF) Operations	▒	▒	▒	▒
Port Hope Area Wastes	▒	▒	▒	▒
Other (Non-OPG) Facilities Licensed by CNSC	▒	▒	▒	▒
St. Marys Cement Operations	▒	○	○	○
Darlington WMF Expansion in support of DNGS	▒	○	▒	○
Pickering NGS A – Modification of Units 2 & 3 to Guaranteed Defuelled State	▒	▒	▒	▒
Pickering Waste Management Facility (PWMF) Expansion	▒	▒	▒	○
Expansion of Duffin Creek Water Pollution Control Plant	▒	▒	▒	▒

● Indicates likely residual adverse environmental effect of the New Nuclear Darlington Project
○ Indicates potential overlapping environmental effect of other projects and activities
▒ Indicates that one or more of the overlap requirements (type, temporal or spatial) is not applicable

TABLE 8.3-3(b)
Potential Coincidence of Effects of the NND Project and Effects of Other Projects and Activities – Reasonably Foreseeable

Projects and Activities	Environmental Components Involved			
	Aquatic Environment	Terrestrial Environment	Land Use	Socio-Economic Environment
New Nuclear Darlington Project	●	●	●	●
Upgrade of 500 kV Transmission System		○	○	○
Darlington NGS Refurbishment & Continued Operation	○			○
Pickering NGS B Refurbishment & Continued Operation	○			○
Darlington NGS Decommissioning				
New Nuclear - Darlington Decommissioning				
Darlington WMF Decommissioning		○		○
Pickering NGS A Decommissioning				○
Pickering NGS B Decommissioning				○
Pickering WMF Decommissioning				
Port Hope Area Initiative: Port Hope & Port Granby Projects				○
Other Port Hope Area Projects				○
Highway 407 East Link to Hwy 401		○		○
Highway 401 & Holt Road Interchange Improvements		○		○
GO Transit Rail Extension				○
Durham-York Energy from Waste Facility		○	○	○
Clarington Energy Business Park development		○		○
Expansion of Courtice Water Pollution Control Plant	○			○
Expansion of Other Municipal Water Treatment and Pollution Control Plants	○			○
Port Darlington Area Enhancements				○
Pickering Airport				○
Oshawa Ethanol Plant				○
Growth and Development in Regional Communities				○

● Indicates likely residual adverse environmental effect of the New Nuclear Darlington Project
○ Indicates potential overlapping environmental effect of other projects and activities
(shaded) Indicates that one or more of the overlap requirements (type, temporal or spatial) is not applicable

8.4 Determination of Cumulative Effects

8.4.1 Introduction

The cumulative adverse effects on the environment which may result from the NND Project, in combination with other identified projects and activities in the study area coinciding with any VEC, are examined in more detail in the following subsections. Cumulative effects may take different forms (e.g., synergistic as opposed to merely additive, induced as opposed to direct, broad-based as opposed to localized, and ongoing or long-term as opposed to temporary or short-term). All forms are considered explicitly or implicitly in this assessment. For residual adverse effects of the Project (as summarized in Table 8.3-1(a)), consistent with general practice and the CEA Agency guidance, the effects of mitigation measures are inherently considered. If the initial assessment were to identify a likelihood of a cumulative effect, further or different mitigation would be considered and the effect re-evaluated to determine whether a final residual cumulative effect is likely or not.

As indicated in the previous section, open dots (○) in Table 8.3-3 represent "potential" overlapping effects of one of the other projects and activities within the same timeframe and geographical space as the corresponding residual effects of the NND Project. However, an open dot does not necessarily mean that the potential overlapping effects are measurable or identifiable. Rather, in many cases it only means that one or more of the overlap requirements (type, temporal or spatial) could not be discounted without further examination.

Accordingly, the following subsections examine the potential cumulative effects on those components of the environment that are associated with the potential for residual adverse Project effects identified in Table 8.3-1(a). In addition, although no residual radiological health effects were found to be likely, the Human Health component is discussed further in subsection 8.4.6 because of concerns generally expressed by some members of the public that their health, safety and well-being may be affected by radiation and radioactivity from any nuclear project or operation. Similarly, although no residual Project traffic or air quality effects were found to be likely, related community concerns are discussed in subsection 8.4.7.

Any adverse cumulative residual effects that remain after this analysis are forwarded for analysis of significance in Chapter 9.

8.4.2 Effects on the Aquatic Environment

The following projects and activities were identified through screening (Table 8.3-3) as having the potential to cause adverse environmental effects on VECs within the aquatic environment overlapping the identified residual effect of the proposed NND Project on the same VECs (Table 8.3-1(a)):

- Darlington NGS (DNGS) Operation;
- Pickering NGS A (PNGSA) Operation;
- Pickering NGS B (PNGSB) Operation;
- Darlington NGS (DNGS) Refurbishment and Continued Operation;
- Pickering NGS B (PNGSB) Refurbishment and Continued Operation;
- Expansion of Courtice Water Pollution Control Plant; and
- Expansion of Other Municipal Water Treatment and Pollution Control Plants.

Aquatic Biota

Placement of lake infill and development of the cooling water intake and discharge structures will result in the loss of some VEC species (e.g., benthic invertebrates and round goby) within the footprints of the physical works. However, given the open nature of the shoreline involved, the extent of VEC species affected is expected to be relatively minor. Furthermore, OPG is committed to the development of a Fish Habitat Compensation Plan to offset any habitat losses associated with the NND Project. None of the other projects listed above is expected to involve construction or expansion of marine works. Therefore, these projects will not add to the residual effect of the NND Project.

Operation of the cooling water intake system associated with the Project (particularly with the once-through cooling option) will result in some loss of aquatic biota due to impingement and entrainment. However, as described in Section 5.4.5, these effects are expected to be relatively minor. The combined intake effect of the NND Project and operation of DNGS (including continued operation after refurbishment) is similarly expected to be relatively minor and no population level effects are expected to result. Operation of the cooling water discharge system associated with the Project was found to result in no residual effects, thus no potential for cumulative effects.

This assessment is supported by decades of pre-operational and post-operational environmental studies and monitoring at the DN site dating back to the late 1970s following provincial government approval of the original DNGS project (Ontario Hydro 1997b). This multi-year study and monitoring program showed that the innovative design of the DNGS cooling water intake and discharge system is effective in reducing effects on the aquatic environment. The offshore submerged intake, flush with the lake bottom, is effective in reducing the quantity and size of fish entrapped. Fish losses at Darlington are much less than at other large power plants on the Great Lakes equipped with more conventional intake designs.

As concluded in Section 5.4, any effects of the NND Project on the aquatic environment are not expected to be measurable at the Regional Study Area level. The assessment is therefore focused within the SSA and LSA. NND impingement losses for the relevant VEC species are estimated to be very small relative to their populations in Lake Ontario. As indicated in Section 5.4.5, based on recent DNGS impingement monitoring experience, annual NND impingement loss for the relevant VEC species is estimated to range up to 43,500 fish for the once through cooling option. This is a very small quantity relative to total fish populations in Lake Ontario. Although NND Project entrainment losses, with the once-through cooling option, are likely to be greater than those associated with DNGS because of the larger flows, the losses are expected to remain on the level of thousands of adult equivalents against lake-wide populations numbering in the many millions. Entrainment effects with the cooling tower options are expected to be extremely low due to the relatively small flow rate.

Consistent with the assessment in Section 5.4, the effects of impingement and entrainment are generally limited to the SSA with some recruitment from the LSA (OPG 2007c). Therefore, there is likely to be only minimal, if any, spatial interaction with PNGS A and PNGS B. The populations of fish and other aquatic life impinged and entrained are represented lake-wide, dominated by invasive species, and commonly found within the LSA. Furthermore, other industrial plants and municipal water treatment and pollution control plants drawing water from the lake in the LSA are not known to cause significant impingement and entrainment effects on the aquatic environment. Consequently, no measurable cumulative effect is likely to occur with any of the projects identified in Table 8.3-2.

Therefore, taking the foregoing analysis into account, no mitigation measures beyond those already identified are considered necessary and no cumulative residual effects on aquatic biota are considered likely.

Beneficial Effect on Darlington Creek

No residual adverse effects of the Project on the flow or aquatic life in Darlington Creek were identified in Chapter 5. However, one of the beneficial effects of the Project will tend to occur in this area. It was noted, that the baseflow in the creek will be moderately affected by dewatering during construction, however, increased groundwater recharge in the vicinity of the Northwest Landfill Area will serve to offset some of this loss thereby resulting in no residual effect. This added baseflow will also reduce or offset a potential adverse effect of future expansion of the adjacent St. Marys Cement quarry operation.

As indicated in Section 8.2.1, future expansion of the St. Marys Cement quarry operation (including dewatering to facilitate excavation) may affect the flow of shallow bedrock groundwater flow in the area. This in turn is likely to reduce the baseflow of Darlington Creek to some extent. Excavation of the quarry will also require rerouting of Darlington Creek around the quarry pit. However, increased groundwater recharge resulting from landfilling of surplus NND Project soil in the north-east area of the DN site will add new baseflow to Darlington Creek, offsetting flow reduction which might be caused by future expansion of the St. Marys Cement quarry operation.

Since no residual adverse Project effect is involved in this case, no mitigation measures beyond those already identified are considered necessary and no cumulative residual effects on Darlington Creek and related aquatic biota are considered likely.

8.4.3 Effects on the Terrestrial Environment

The following projects and activities were identified through screening (Table 8.3-3) as having the potential to cause adverse environmental effects on VECs within the terrestrial environment overlapping the identified residual effect of the proposed NND Project on the same VECs (Table 8.3-1(a)):

- St. Marys Cement Operations;
- Darlington WMF Expansion;
- Upgrade of 500 kV Transmission System;
- Darlington WMF Decommissioning;
- Highway 407 East Link to Highway 401;
- Highway 401 Improvements and Holt Road Interchange;
- Durham-York Energy from Waste Facility; and
- Clarington Energy Business Park development.

<u>Vegetation and Habitat Removal and Disruption</u>

As indicated in Table 8.3-1(a), site preparation and construction of the NND Project is likely to result in permanent loss of some on-site vegetation (mostly cultural meadow) and wildlife habitat (for Bank Swallows, other birds and insects including Monarch Butterfly). Periodic and short-term disruption of overall habitat connectivity is likely during construction. Regarding Bank Swallows, it is noted that the predicted Project effect is not unique, as natural forces periodically cause damage to the face of shoreline embankments and destruction of any habitat contained within them.

It should be emphasized that the vegetation and habitat removed or disrupted during site preparation and construction for the NND Project is entirely within the existing DN site boundaries. Furthermore, the possibility that other nearby projects, such as the Highway 407 East project, may be able to use a portion of the excess soil and other fill material from the NND Project may reduce the extent of on-site landfilling of these excess materials. Although uncertain, this could in turn reduce the extent of on-site vegetation and habitat loss during NND Project site preparation and construction.

Regarding habitat connectivity, the east-west corridor that extends through the DN site is not considered to be a major one, although the function does exist. Wildlife using this corridor are already adapted to the road network and high levels of human disturbance that characterize the SSA and LSA.

Nevertheless, it is recognized that such on-site changes can have off-site effects that may need to be mitigated. Most of the vegetation to be removed consists of common plant species that are abundant throughout the DN site and the RSA. In order to minimize the residual effects caused by removal of vegetation and habitat, the mitigation strategy includes the creation of new or enhanced habitat at other locations within and beyond the DN site (including a new amphibian breeding pond, new wetland pond, artificial bird habitat, protection of existing off-site Bank Swallow colonies and research funding), as well as replanting and restoration of some areas after NND Project development in order to offset the loss of the vegetation and habitat to be removed. Widening of wildlife migration corridors past the planned bridge structures will minimize the disruption of overall site habitat connectivity.

The potential for cumulative effects with other on-site and off-site projects and activities is considered to be limited. Expansion of the DWMF will use land that is considered relatively unsuitable for wildlife habitat (due to nearby buildings, parking lots and human activity) and its terrestrial effects have previously been assessed as not significant (OPG 2003c). Eventual decommissioning of the DWMF will result in only temporary disruption, followed by site remediation. The terrestrial effects of the 500 kV transmission system upgrade project are expected to be localized and short term, contained within the existing transmission right-of-way, separated physically from most of the effects of the NND Project and DWMF projects by the CN rail corridor.

Because of the noise and vibration associated with the ongoing St. Marys Cement quarrying operation, discouraging local habitation by wildlife, future expansion of the St. Marys operation is not likely to cause measurable incremental effects on wildlife even though substantial areas of vegetation and potential wildlife habitat will be removed.

Most of the reasonably foreseeable Highway 401 improvements in the area (including widening and resurfacing) are expected to be completed before the site preparation and construction of the proposed NND Project begins. However, improvement of the 401-Holt Road interchange is expected to overlap the early stages of NND Project site preparation. In addition, construction of the Highway 407 East Link to Highway 401 is expected to begin at about the same time as site preparation for the NND Project and be completed before NND construction is completed. Both of these highway/interchange projects will involve clearing of land, some of which has wildlife habitat potential. However, the parts of these two projects that are near or adjacent to the DN site (therefore potentially relevant for cumulative terrestrial effects assessment purposes) are also near or adjacent to existing busy roadways, thus discouraging local habitation by wildlife. Therefore, the nearby and adjacent parts of these highway/interchange projects are not likely to cause significant incremental effects on local wildlife.

Land clearing and habitat removal associated with the Clarington Energy Business Park (CEBP) and the Durham-York Energy from Waste Facility planned within the CEBP are not likely to add measurably to the residual terrestrial effects of the NND Project. While local wildlife in the habitat corridor between the CEBP and DN sites may be driven towards either site depending on where land is being cleared, the overall cumulative effect is expected to be a series of relatively minor and short-term effects as individual business facilities are developed within the CEBP over time. These effects are likely to be reversible.

Most of the NND Project site and related site preparation activities are separated from the CEBP site by DNGS and the western half of the DN site and by the CN rail corridor (i.e., the CEBP site is west of the DN site and north of the rail corridor as shown in Figure 8.2-1). However, some surplus NND Project soil may be stockpiled in the northwest corner of the DN site. Furthermore, the Municipality's plans for the CEBP ("prestige employment uses") imply that remediation and landscaping of local business facilities will have to meet a relatively high standard. This will tend to at least partly mitigate any terrestrial effects resulting from land clearing for those business facilities and associated roadways.

Therefore, taking the foregoing analysis into account, no mitigation measures beyond those already identified are considered necessary and no cumulative adverse residual effects on vegetation and wildlife habitat are considered likely.

Bird Mortality at Tall Structures

Operation of the NND Project, with the natural cooling tower option (towers over 150 m tall), is expected to result in a relatively small number of bird mortalities (a few hundred estimated) due to collision with the cooling towers under inclement weather conditions during spring and fall migration periods.

The only other project or activity that is expected to occasionally experience similar bird mortality, for similar reasons, is the St. Marys Cement Operation. Its stack and other tall plant structures are also potential impediments in the way of bird migration. The height of the stack associated with the proposed Durham-York EFW Facility is only expected to be of the order of 88 m, little more than half the height of the NND cooling towers, thus less likely to be a bird migration hazard. Although the 500 kV transmission upgrade project also involves tall structures, the additional towers will be erected within the existing transmission corridor and are therefore not expected to result in a measurable incremental hazard to bird migration.

Therefore, no mitigation measures beyond those already identified are considered necessary and no cumulative adverse residual effects on migrant birds are considered likely to result from the presence of tall Project and other structures in the area.

8.4.4 Effects on Land Use and Visual Setting

No residual NND Project effects on land use *per se* were identified within the Land Use component of the environment. The only residual effect identified in this component relates to the visual setting. More specifically, permanent changes in the quality of existing views of the DN site from viewing locations in the LSA and RSA would result from the presence and operation of cooling tower structures, if implemented as part of the NND Project. Therefore, only the identified residual visual effect is included in this cumulative effects assessment.

If the natural draft cooling tower option is selected, the towers would be noticeable from local viewpoints and the vapour plumes from more distant viewpoints. If the mechanical draft cooling tower option is selected, the cumulative visual effect would be significantly less. If the once-through cooling option is selected, no additional visual effect would result. The following other projects and activities were identified through screening (Table 8.3-3) as having the potential to cause adverse effects on the visual aesthetics of the landscape from some local viewpoints overlapping the identified residual visual effect of the NND Project from the same viewpoints (Table 8.3-1(a)):

- St. Marys Cement Operation;
- Upgrade of 500 kV Transmission System; and
- Durham-York Energy from Waste Facility.

The existing local landscape is already influenced by the presence of visible industrial and commercial facilities. The stack and other tall structures of the St. Marys cement plant, along with the plume emitted from the stack, have been a familiar part of the local landscape for many years, since well before the construction of DNGS. Similarly, the addition of transmission towers and conductors with the 500 kV transmission system upgrade project, within the existing transmission right-of-way, is not likely to fundamentally alter the appearance or visibility of the existing transmission corridor from local off-site viewpoints. The Durham-York Energy from Waste Facility, proposed within the planned Clarington Energy Business Park (CEBP) west of the DN site and just south of Hwy 401, is expected to fit into the increasingly commercial-industrial character of the local landscape without significant adverse visual effect. Its contribution to the cumulative visual effect is likely to be reduced over time as other developments occur within the CEBP.

Other land uses which contribute to the industrial-commercial character of the local area, although to a lesser degree than those discussed above, include the Courtice Water Pollution Control Plant and two auto related commercial properties, all west of the DN site. In addition, the presence of Highway 401 and the railways contribute to the developed character of the area around the DN site.

Overall, while the cooling tower options, if implemented as part of the NND Project, would certainly contribute to a cumulative visual effect, the cumulative effect is not likely to fundamentally alter the visual landscape of the local area which has already been influenced by visible industrial and commercial developments. It is reasonable to expect that the magnitude of the visual effect will diminish over time, as the new structures and plumes become familiar features of the landscape, just as the existing structures (associated with St. Marys Cement and the transmission corridor) have become familiar over time.

Nevertheless, OPG is aware of attitudes within the host community concerned with the visibility of cooling towers. Consultations with the public and focused public attitude research has made it clear that the heightened visibility of the DN site, if cooling towers were implemented (as opposed to the once-through lakewater cooling option), might result in the site being seen as a more negative feature in the community. This might in turn cause a negative change in the perceptions of local residents as to the character of the community they live in. This is examined further in Section 8.4.5.

Although, OPG has stated (see Section 13.2.2) that on balance, it prefers the once-through lakewater cooling option for a number of reasons, it may be that other forms of condenser cooling (e.g., natural draft cooling towers) will be constructed. Therefore, the cumulative visual effects associated with the possible presence and operation of NND Project cooling towers in combination with the other tall structures existing or expected in the area, are carried forward to Chapter 9 for determination of significance.

8.4.5 Effects on Socio-Economic Conditions

A number of residual adverse socio-economic effects of the NND Project were identified in Section 5.11 and summarized in Table 8.3-1(a). In addition, a number of beneficial socio-economic effects were identified and summarized in Table 8.3-1(b). Some of these beneficial effects will be discussed in terms of their potential for offsetting some of the adverse cumulative socio-economic effects. However, not all beneficial effects identified are relevant to the residual adverse effects and these beneficial effects are therefore not discussed further in this section.

Because many of the other projects have the potential to interact with the NND Project in this area of the environment, and thus potentially contribute to adverse cumulative residual socio-economic effects, a two-step screening process was carried out to narrow the scope of the cumulative residual effects assessment.

Screening of Likely Interactions of Socio-Economic Effects

The first step in the screening process, a broad screening (summarized in Table 8.3-3), identified the following projects and activities as having the potential to cause adverse effects on the socio-economic environment overlapping one or more of the identified residual effects of the proposed NND Project:

- St. Marys Cement Operation;
- Darlington WMF Expansion;
- Pickering WMF Expansion;
- Upgrade of 500 kV Transmission System;
- Darlington NGS Refurbishment and Continued Operation;
- Pickering NGS B Refurbishment and Continued Operation;
- Darlington WMF Decommissioning;
- Pickering NGS A Decommissioning;
- Pickering NGS B Decommissioning;
- Port Hope Area Initiative: Port Hope and Port Granby Projects;
- Other Port Hope Area Projects;
- Highway 407 East Link to Highway 401;
- Highway 401 and Holt Road Interchange Improvements;
- GO Transit Rail Extension – Oshawa to Bowmanville;
- Durham-York Energy from Waste Facility;

- Clarington Energy Business Park development;
- Expansion of Courtice Water Pollution Control Plant;
- Expansion of Other Municipal Water Treatment and Pollution Control Plants;
- Port Darlington Area Enhancements;
- Pickering Airport;
- Oshawa Ethanol Plant; and
- Growth and Development in Regional Communities.

This list includes only three of the past, existing and certain/planned other projects, but all except three of the reasonably foreseeable other projects. Because of the number and diversity of the residual socio-economic effects of the NND Project, a more detailed screening of these other projects was carried out. Table 8.4-1 summarizes in more detail (i.e., for each residual effect) where other projects are likely to overlap in type of effect, time and space and, therefore, where there is a potential overlap of socio-economic effects. It should be noted that the third column in Table 8.4-1 combines the two residual effects related to cooling towers as described in Table 8.3-1(a). Similar to Table 8.3-3, a solid dot (●) in the table represents a residual effect of the proposed Project. An open dot (○) in the table represents a potential overlapping effect of one of the other projects and activities within the same geographical space and timeframe as the residual effect of the NND Project.

TABLE 8.4-1
Potential Coincidence of Socio-Economic Effects of the NND Project and Effects of Other Projects and Activities

Project and Activities	Reduced Use & Enjoyment of Community & Recreational features on the DN site	Reduced Use & Enjoyment of Property	Effects of Cooling Towers
New Nuclear Darlington Project	●	●	●
St. Marys Cement Operation	○	○	○
Darlington WMF Expansion in support of DNGS		○	
Pickering WMF Expansion			
Upgrade of 500 kV Transmission System	○	○	○
Darlington NGS Refurbishment & Continued Operation		○	
Pickering NGS B Refurbishment & Continued Operation			
Darlington WMF Decommissioning		○	
Pickering NGS A Decommissioning			
Pickering NGS B Decommissioning			
Port Hope Area Initiative: Port Hope & Port Granby Projects			
Other Port Hope Area Projects			
Highway 407 East Link to Hwy 401	○	○	
Highway 401 Improvements & Holt Road Interchange	○	○	
GO Transit Rail Extension – Oshawa to Bowmanville		○	
Durham-York Energy from Waste Facility	○	○	○
Clarington Energy Business Park development	○	○	
Expansion of Courtice Water Pollution Control Plant	○	○	
Expansion of Other Municipal Water Treatment and Pollution Control Plants	○	○	
Port Darlington Area Enhancements	○		
Pickering Airport			
Oshawa Ethanol Plant		○	
Growth and Development in Regional Communities	○	○	

● Indicates likely residual adverse environmental effect of the New Nuclear Darlington Project
○ Indicates potential overlapping environmental effect of other projects and activities
[grey shading] Indicates that one or more of the overlap requirements (type, temporal or spatial) is not applicable

Cumulative Residual Socio-Economic Effects

Reduced Use and Enjoyment of Community and Recreational Features on the DN Site

The Project may require the displacement of the Upper and Lower Soccer Fields and the fitness loop (integrated with the Waterfront Trail) currently located on the DN site. This would be a direct loss to those who use these facilities. Although OPG will strive to maintain public access to the Waterfront Trail within the DN site, the trail is likely to be modified and reconfigured on occasion for the safety of users. Overall, it is likely that during the Site Preparation and Construction phase, current users of the recreational facilities on the DN site would use them less and may go elsewhere to undertake the recreational activities that they would normally undertake on the DN site. The assessment in Section 5.11 indicates that there are many options available and residents will not need to travel far to reach an alternate facility or location should they choose to do so. Overall, it is expected that people would resume their use and enjoyment of the DN site for recreational purposes once the site is restored following NND Project site preparation and construction.

Other nearby projects listed in Table 8.4-1 that are considered to have the potential to contribute noticeably to this cumulative effect include the following:

- St. Marys Cement Operation;
- Upgrade of 500 kV Transmission System;
- Highway 407 East Link to Hwy 401;
- Highway 401 & Holt Road Interchange Improvements;
- Durham-York Energy from Waste Facility;
- Clarington Energy Business Park;
- Expansion of Courtice Water Pollution Control Plant;
- Expansion of Other Municipal Water Treatment & Pollution Control Plants;
- Port Darlington Area Enhancements; and
- Growth & Development in Regional Communities.

All of these other projects and activities are located on or near the lakeshore and thus have the potential to disrupt or displace the Waterfront Trail. The DNGS refurbishment project is not listed above as it is not expected to involve much additional land clearing, soil disposal or other construction activities that might interfere with on-site recreational features or activities. Because the St. Marys Cement Operation and related traffic and visual effects have been present for many years, the continued operation of this facility is not expected to fundamentally alter the use and enjoyment of the Waterfront Trail or the attractiveness of views from it. Assuming that the upgrades of the 500 kV transmission system take place within the existing right-of-way, effects on the Waterfront Trail and other adjacent land uses should be minimal. The Highway 407 East Link and Highway 401-Holt Road Interchange projects will require a southward realignment of the South Service Road and other modifications to the northern perimeter of the DN site, particularly the west-central part of the northern site perimeter. This in turn will contribute to disruption of the Waterfront Trail and soccer fields on the DN site.

The Durham-York EFW Facility is proposed to be located in an area that is already industrialized and designated for further commercial-industrial development (i.e., within the Clarington Energy Business Park (CEBP)). The Municipality's plans for the CEBP ("prestige employment uses") imply that remediation and landscaping of facilities within the park will have to meet a relatively high standard. It is therefore reasonable to assume that the EFW Facility and all other future facilities within the CEBP will be designed to accommodate and minimize effects on the Waterfront Trail which passes through the area.

Since the Courtice Water Pollution Control Plant (CWPCP) is located south of the CN Rail line, future expansion of the CWPCP is not likely to disrupt or displace the Waterfront Trail which is north of the rail line in this area. Potential interactions between future expansions of other municipal water treatment and pollution control plants in the area and the Waterfront Trail are likely to be mitigated by the municipality's planning process. This assumption is supported by the municipality's plans for enhancement of the Port Darlington area, including waterfront greenspace, parklands, and environmental protection areas. The latter is likely to have beneficial effects on community and recreational facilities, including the Waterfront Trail. Similarly, effects of growth and development in other community neighbourhoods close to the Waterfront Trail are likely to be mitigated by the same municipal planning process. It is reasonable to assume that this growth and development will be accompanied by additional community and recreational facilities, including soccer fields and enhancements along the Waterfront Trail where applicable.

Status of the proposed Oshawa Ethanol Plant is uncertain. However, given the federal, provincial and municipal approval process that this project has to go through, it is unlikely that the project will be allowed to significantly affect the Waterfront Trail or other recreational amenities along the lakeshore.

As indicated in Section 5.11, OPG has addressed the direct effects on the portion of the Waterfront Trail and the soccer fields within the DN site. However, the possibility that off-site projects will be able to use a portion of the excess soil from the NND Project may reduce the extent of on-site landfilling of these excess materials, particularly in the NW quadrant of the site.

While uncertain, this reduced on-site landfilling would in turn reduce the potential extent of effects on some of the on-site recreational features.

Therefore, taking the foregoing analysis into account, no mitigation measures beyond those already identified are considered necessary and no residual adverse cumulative effects associated with reduced use and enjoyment of recreational features on the DN site are considered likely.

Reduced Use and Enjoyment of Property

The residual NND Project effects in this context include the potential for some residents living along the truck haul routes to experience a disruption to their use and enjoyment of their property during DN site preparation and construction. It should be noted that the Traffic and Transportation assessment in Section 5.9 concluded that, with the design and mitigation measures proposed, no residual adverse traffic or transportation effects are likely to be caused by the NND Project. However, as noted in Section 8.4.7, because of concerns expressed for cumulative traffic throughout the southwest Clarington area, potential combined traffic effects are further considered.

Other nearby projects listed in Table 8.4-1 that are considered to have the potential to contribute noticeably to this cumulative effect include the following:

- St. Marys Cement Operation;
- Darlington WMF Expansion;
- Upgrade of 500 kV Transmission System;
- Darlington NGS Refurbishment and Continued Operation;
- Darlington WMF Decommissioning;
- Highway 407 East Link to Highway 401;
- Highway 401 and Holt Road Interchange Improvements;
- GO Transit Rail Extension – Oshawa to Bowmanville;
- Durham-York Energy from Waste Facility;
- Clarington Energy Business Park development;
- Expansion of Courtice Water Pollution Control Plant;
- Expansion of Other Municipal Water Treatment and Pollution Control Plants;
- Oshawa Ethanol Plant; and
- Growth and Development in Regional Communities.

All of the other projects listed above are likely to involve ongoing or additional truck traffic. However, most of these other projects are located in areas that are accessible by provincial highways or other major roadways. It is common practice for construction projects to avoid routing construction traffic through residential areas. Furthermore, as indicated in Section 8.2.3 (*Growth and Development in Regional Communities*), Durham Region and the local communities within the RSA are planning for future growth and development. Durham Region's Master Transportation Plan (Durham 2005) includes measures intended to reduce speed and volume of traffic through residential neighbourhoods. It is reasonable to assume that infrastructure improvements, including transportation system improvements, will be implemented as needed to support the planned growth and developments. Furthermore, it is reasonable to assume that OPG's proposed Traffic Management Plan (not to be confused with the Region's Transportation Master Plan), Dust Management Program and Nuisance Effects Management Plan will help to mitigate cumulative concerns/effects related to residential properties along transportation routes affected by the NND and other nearby projects. These other projects are therefore not considered likely to contribute measurably to cumulative concerns about truck traffic in residential areas or related property value effects.

The cumulative effect is likely to be offset to some extent by some of the beneficial effects of the NND Project as summarized from Table 8.3-1(b), including increased rate of growth in property values and increased sales volumes in the LSA municipalities.

Therefore, taking the foregoing analysis into account, no mitigation measures beyond those already identified are considered necessary and no residual adverse cumulative socio-economic effects associated with the possible reduced use and enjoyment of property are considered likely. Nevertheless, based on feedback from OPG's communication and consultation program, it is recognized that there are some concerns in the host community that the concentration of new projects planned and foreseeable over the next decade, in addition to ongoing activities, may (among other things) cause disruption to their use and enjoyment of their property during site preparation and construction of the NND and other projects. This is addressed further in Section 8.4.7.

<u>Effects of Cooling Towers</u>

The assessment of visual effects of any new development is inevitably very subjective and variable across different receptors in the study area. The residual NND Project effects in this context are the likely adverse effects on some local residents' attitudes regarding the character and image of their community, and reduced use and enjoyment of their property, if natural draft cooling towers are constructed and become a dominant part of the landscape. The towers would certainly be noticeable from local viewpoints and the vapour plumes from more distant viewpoints. Only a few of the other projects and activities in the area are considered to have the potential to contribute to cumulative concerns based on visible industrial structures:

- St. Marys Cement Operation;
- Upgrade of 500 kV Transmission System; and
- Durham-York Energy from Waste Facility.

Although the existing land uses around the DN site include rural uses, the local landscape is not pristine. The landscape is already influenced by the presence of visible industrial and commercial facilities. As indicated in Section 8.4.4, the stack and other tall structures of the St. Marys cement plant, along with the plume emitted from the stack, have been a familiar part of the local landscape for many years, since well before the construction of DNGS. Similarly, the addition of transmission towers and conductors with the 500 kV transmission system upgrade project, within the existing transmission right-of-way, is not likely to fundamentally alter the appearance or visibility of the existing transmission corridor from local off-site viewpoints. The Durham-York EFW Facility is expected to fit into the increasingly commercial-industrial character of the local landscape without significant adverse visual effect. Its contribution to the cumulative visual effect is likely to be reduced over time as other developments occur within the CEBP.

Other land uses which contribute to the industrial-commercial character of the local area, although to a lesser degree than those discussed above, include the Courtice Water Pollution Control Plant and two auto related commercial properties, all west of the DN site. In addition, the presence of Highway 401 contributes to the non-pristine character of the area around the DN site.

In summary, while the cooling tower options, if implemented as part of the NND Project, would certainly contribute to a cumulative visual effect, the overall cumulative effect is not likely to fundamentally alter the visual landscape of the area around the DN site which has already been influenced by visible commercial and industrial developments. It is reasonable to expect that the magnitude of the visual effect will diminish over time, as the new structures and plumes become familiar features of the landscape, just as the existing structures (associated with St. Marys Cement and the transmission corridor) have become familiar over time.

Nevertheless, as indicated in Section 8.4.4, OPG is aware of attitudes within the host community concerned with the visibility of cooling towers. Consultations with the public and focused public attitude research has made it clear that the heightened visibility of the DN site, if cooling towers were implemented (as opposed to the once-through lakewater cooling option), might result in the site being seen as a more negative part of the community. This might in turn cause a negative change in the perceptions of local residents as to the character of the community they live in.

Therefore, although no mitigation measures beyond those already identified are considered necessary, the residual cumulative visual effects associated with the possible presence and operation of NND Project cooling towers, in combination with the other tall structures existing or expected in the area, are carried forward to Chapter 9 for determination of significance. (It is to be noted that OPG has stated its preference for the once-through lakewater cooling option; see Section 13.2.2).

8.4.6 Effects of Radiation and Radioactivity on Human Health

As already indicated in Sections 8.3.1 and 8.3.2, no residual radiological health effects were assessed as likely due to the very low emission and exposure levels expected with the NND Project design and mitigation measures. Nevertheless, the Human Health component is discussed further in this section because of concerns generally expressed by some members of the public that their health, safety and well-being may be affected by radiation and radioactivity from any nuclear project or operation.

The following other projects and activities were identified earlier (Table 8.2-1) as being sources of radiation and radioactivity and thus having the potential to cause related adverse effects on human health:

- Darlington NGS Operation;
- Darlington WMF Operation;
- Pickering NGS A Operation;
- Pickering NGS B Operation;
- Pickering WMF Operation;
- Port Hope Area Wastes;
- Other (Non-OPG) Facilities Licensed by CNSC;
- Darlington WMF Expansion;
- Pickering NGS A – Modifications of Units 2 & 3 to Guaranteed Defuelled State;
- Pickering WMF Expansion;
- Darlington NGS Refurbishment & Continued Operation;
- Pickering NGS B Refurbishment & Continued Operation;
- Darlington NGS Decommissioning;
- New Nuclear – Darlington Decommissioning;
- Darlington WMF Decommissioning;
- Pickering NGS A Decommissioning;
- Pickering NGS B Decommissioning;
- Pickering WMF Decommissioning;
- Port Hope Area Initiative: Port Hope & Port Granby Projects; and
- Other Port Hope Area Projects.

Screening of Likely Interactions of Radiological Effects

Because of the number of other projects (sources of radiation and radioactivity) which have the potential to interact with the NND Project, as listed above, a screening step (summarized in Table 8.4-2) was carried out to narrow the scope of this special consideration of cumulative radiological health effects.

Table 8.4-2 summarizes where other projects are likely to overlap in type of effect (●), time (✓) and space (■) and, therefore (in cases where all three factors apply), where there is a potential for a cumulative radiological effect.

Cumulative Radiation Doses

Cumulative Doses to Members of the Public

The assessment of cumulative radiation doses to members of the public living and working near the DN site due to gamma radiation from the NND Project, and from other present and future licensed radiation and radioactivity sources, was conducted for maximally exposed receptors who live, work or participate in recreational activities in close proximity to the DN site. Only radionuclides of the type released from nuclear facilities are used to estimate the doses (i.e., doses from background levels of naturally occurring radionuclides are excluded).

People living, working and participating in recreational activities in regions between the DN and PN sites, or between the DN site and Port Hope area sites, may be exposed to radioactivity releases and radiation emitted from licensed activities on both or all sites. However, the magnitudes of the cumulative doses to these people are expected to be small fractions of the estimated doses to the receptors near the DN site, as described below.

TABLE 8.4-2
Likely Interaction of Radiation and Radioactivity Effects – Other Projects

Other Projects and Activities	Radiation and Radioactivity		
	Doses to Members of the Public	Doses to Nuclear Energy Workers	Doses to Non-Nuclear Energy Workers
Past and Existing Projects & Activities			
Darlington NGS Operation	● √ ■	● √ ■	● √ ■
Darlington WMF Operation	● √ ■	● √ ■	● √ ■
Pickering NGS A Operation	● √ ■	● √	● √
Pickering NGS B Operation	● √ ■	● √	● √
Pickering WMF Operation	● √ ■	● √	● √
Port Hope Area Wastes	● √ ■	● √	● √
Other (Non-OPG) Facilities Licensed by CNSC	● √	● √	● √
Certain/Planned and Reasonably Foreseeable Projects & Activities			
Darlington WMF Expansion	● √ ■	● √ ■	● √ ■
Pickering NGS A – Modifications of Units 2 & 3 to Guaranteed Defuelled State	●	● √	● √
Pickering WMF Expansion	● √	● √	● √
Darlington NGS Refurbishment & Continued Operation	● √ ■	● √ ■	● √ ■
Pickering NGS B Refurbishment & Continued Operation	● √ ■	● √	● √
Darlington NGS Decommissioning	● √ ■	● √ ■	● √ ■
New Nuclear – Darlington Decommissioning	● √ ■	● √ ■	● √ ■
Darlington WMF Decommissioning	● √ ■	● √ ■	● √ ■
Pickering NGS A Decommissioning	● √ ■	● √	● √
Pickering NGS B Decommissioning	● √ ■	● √	● √
Pickering WMF Decommissioning	● √ ■	● √	● √
Port Hope Area Initiative: Port Hope & Port Granby Projects	● √ ■	● √	● √
Other Port Hope Area Projects	● √	● √	● √

● Effects are similar to those of the NND Project or may combine to result in an adverse effect on a VEC
√ Likely temporal overlap with the NND Project.
■ Likely spatial overlap with the NND Project

The airborne concentrations of radioactivity and the radiation levels from licensed activities that contribute to the radiation doses to the receptors near the DN site decrease with increasing distance from the site due to natural environmental phenomena, such as atmospheric dispersion and radioactive decay. Therefore, radiation doses also decrease with increasing distance from the DN site. The cumulative doses to humans living between the DN and PN sites, or between the DN and Port Hope area sites, are attributable to sources of radiation and radioactivity at both sites, but the highest combined doses are expected to occur at the respective site boundaries and are almost entirely from the immediately adjacent facility.

The cumulative doses to the most exposed members of the public are expected to be small fractions of the CNSC regulatory dose limit for members of the public and within the variability of natural background dose. Table 8.4-3 summarizes the estimated cumulative doses to the most exposed members of the public from the NND Project in combination with other identified projects and activities in the region.

TABLE 8.4-3
Summary of Estimated Cumulative Doses to Public

Project and Activity	Estimated Public Dose at DN Site Boundary (μSv/y)	Reference
Existing DN & PN Operations*	0.9-1.7	Section 4.7.8 of this EIS
Future NND Operations**	4	Section 5.7.5 of this EIS
Future DWMF Expansion & Operation***	0.03	DUFDS Project EA (OPG 2003c)
OPG Subtotal	< 5.7	
Existing & Future Port Hope Area Wastes & Related Projects	<< 0.2	DUFDS Project EA (OPG 2003c), Port Hope Project EA (LLRWMO 2006)
Total Cumulative Dose	< 6	

* This DN operations dose range includes contributions from similar off-site sources such as PN operations. The higher end of this range is also considered sufficient to cover the potential effect of future DNGS refurbishment.

** The NND dose estimate is conservative and is thus considered sufficient to cover the potential effects of mid-life refurbishment, on-site dry storage of used fuel from NND, and eventual decommissioning of the station.

*** Does not include used fuel from NND operation (only from DNGS operation).

As indicated in Section 5.7.5, the maximum annual dose from the NND Project to members of the public near the DN site is estimated to be approximately 4 μSv/y. Because of conservatisms in this estimate, it is considered sufficient to cover the potential effects of mid-life NND refurbishment, on-site dry storage of NND used fuel (separate from dry storage of DNGS used fuel at the existing DWMF), and eventual decommissioning of the NND station. The maximum annual dose from DNGS since it began operating in 1990 has always been estimated as less than 10 μSv per year, much less in recent years. Since the year 2000, the maximum estimated doses have ranged between 1 and 2 μSv per year. More recently, as indicated in Section 4.7.8, the maximum annual dose from existing DN site operations in 2007 was estimated as 1.4 μSv/y, having ranged from 0.9 to 1.7 μSv/y since 2003. These estimates are based on measured environmental levels (data from OPG's ongoing REMP monitoring at DN) and therefore inherently include contributions from other similar sources in the region such as OPG's operations at the PN site. In addition, based on recent assessment of PNGS B refurbishment (OPG 2007c), the incremental effect of possible future refurbishment of DNGS is considered likely to be covered by the upper end of the DN-PN operations dose range. Similarly, future projects at the PN site (including PNGS B refurbishment and eventual PN decommissioning) are not expected to give rise to dose levels significantly greater than current operational levels. Therefore, as indicated in Table 8.4-3, the total annual cumulative dose to members of the public at the DN site boundary from OPG sources is expected to be less than 6 μSv/y.

Regarding the existing and future sources in the Port Hope area (existing low-level wastes and related waste management initiatives), the types of radionuclides associated with these sources may be somewhat different from those associated with OPG's operations at the DN and PN sites and may, therefore, not be completely covered by OPG's REMP monitoring at DN. Therefore, for conservative assessment purposes, a separate estimate for the Port Hope area sources is included. This estimate, based on a similar analysis in the EA for the DWMF (OPG 2003c), assumes that the maximum public dose at the boundary of the Port Hope area sources will be less than 10% (possibly less than 1%) of the regulatory dose limit. The corresponding dose to members of the public at the DN site boundary is expected to be much less than 0.2 μSv/y. This is supported by the EA conducted for the Port Hope Area Initiative (LLRWMO 2006) which concluded that the Initiative projects are not likely to cause a measurable cumulative radiological effect on air quality beyond a distance of 10 km. Therefore, as indicated in Table 8.4-3, the total annual cumulative dose to members of the public at the DN site boundary from OPG and Port Hope area sources combined is still expected to be less than 6 μSv/y.

This estimated total annual cumulative dose is less than 1% of the CNSC's regulatory limit for members of the public (1,000 μSv/y) and within the variability of natural background dose (averaging about 1,840 μSv/y across Canada). Furthermore, as indicated in Section 5.7.5, an individual dose rate of less than 10 μSv/y is considered to represent a *"risk level that would generally be regarded as negligible in comparison with other risks"* (ACRP/ACNS 1990).

Nevertheless, OPG recognizes that there is a general public interest in potential health effects associated with nuclear electricity generation and how they are assessed (as documented in Section 10.3). It should be noted that OPG's estimates of public exposure have been supported by independent assessments. In 2007, the Durham Region Health Department reported the results of its latest study on radiation and health in the region (Durham Health 2007). The study compared health indicators for communities in Durham Region against indicators for Halton Region and Simcoe County where there are no nuclear stations. The study found that "*patterns of health indicators in Ajax-Pickering and Clarington were similar to those in the comparison areas. Given the extremely low levels of radiation exposure from the nuclear stations, it is unlikely that any health effects would occur*". This study was an update of the Department's 1996 study which reached similar conclusions.

Therefore, considering both OPG and independent assessments, no mitigation measures beyond those already identified are considered necessary to meet the regulatory dose limit for members of the public and no residual adverse cumulative human health effects associated with doses to the general public from the NND Project are considered likely.

Cumulative Doses to Workers at the DN Site

Workers on the DN site will include NND workers (NEWs), DNGS workers (NEWs), DWMF workers (NEWs), and other workers (NEWs and non-NEWs).

Before work in areas of potential radiation exposure is carried out, OPG conducts radiation surveys to evaluate the potential for worker exposures, and plans activities and the use of protective equipment. These preparations are undertaken with the objectives of maintaining doses (i) below CNSC regulatory limits, (ii) below OPG's administrative limits, and (iii) as low as reasonably achievable (ALARA), with social and economic factors taken into consideration. During potential work exposures, workers are monitored to ensure that the objectives are met.

The dose contributions from all past, present and future nuclear projects and operations at the DN site (as listed in Table 8.4-2) will be included in the occupational dose measurements when those activities occur. Since each worker's dose is individually monitored and recorded, regardless of where the dose originates, cumulative doses to individual workers are inherently addressed through the dosimetry program, as well as ALARA initiatives. The dose planning and monitoring program for the NND Project will implicitly incorporate the dose contributions from all licensed activities.

The annual cumulative doses to NEWs at DN are expected to remain well below regulatory limits (100 mSv per five-year dosimetry period with a maximum of 50 mSv in any one-year dosimetry period, i.e., an average of 20 mSv per year). In addition, doses will be controlled to ALARA using OPG's administrative and procedural controls.

The planning for the NND Project will ensure that the cumulative dose to non-NEWs is maintained below 1000 μSv/y, the regulatory dose limit for members of the public.

Therefore, no mitigation measures beyond those already identified are considered necessary to meet regulatory limits and no residual adverse cumulative human health effects associated with doses to workers from the NND project are considered likely.

8.4.7 Community Concerns Regarding Concentration of Projects and Activities

As documented in Chapter 5 and summarized in Table 8.3-1(a), no residual effects on local traffic, air quality, noise, labour market or community infrastructure were identified to result from the NND Project. Accordingly, the Project is not likely to be a contributor to cumulative effects in these regards. Based on feedback from the public, OPG addressed concerns for potential overlapping effects of projects in the southwest Clarington area during the next 10 years for which details have not yet been confirmed. This concern is discussed in the following pages.

Description of the Concentration of Projects and Activities within Clarington

Of the 35 projects and activities identified within the RSA for cumulative effects assessment purposes, including the NND Project itself, 20 are located wholly or partly within the Municipality of Clarington. Of these 20 projects and activities, 17 are expected to develop or continue within one or two decades after 2010. Based on the outcome of the cumulative effects workshop conducted in November 2008 (see Chapter 10), it is concluded that the greatest concern for cumulative traffic and other effects is focused on the NND Project plus the following seven other projects and activities. These projects and activities are all located well within the LSA, most near the DN site, and are expected to develop or continue within one decade after 2010 (most development by 2016):

Other Projects & Activities	**Development Timelines**	**Decades ***
• St. Marys Cement Operation	Ongoing operation & expansion	Ongoing
• Durham-York EFW Facility	2010-2013	1
• Clarington Energy Business Park	2010-undefined	1+
• Hwy 407-401 East Link	2010-16	1
• Hwy 401-Holt Road Interchange Improvements	Ongoing-2012	1
• GO Transit Rail Service Extension – Oshawa to Bowmanville	2011-13	1
• Growth and Development in Regional Communities	2009-31	2+

*Number of decades counted from year 2010.

The location of these seven projects and activities (as shown in Figure 8.2-1) suggests that their combined effects are likely to be concentrated mostly within the area bounded by Courtice Road to the west, Waverly Road to the east, Bloor Street-King Street to the north, and the CN Rail line to the south. This area, adjacent to and within approximately 3 km of the DN site, will be referred to in this section only as the Adjacent Study Area (ASA). This ASA is outlined in Figure 8.2-1. A special effort was made to obtain descriptive and effects assessment information relating to the projects and activities within this ASA, subject to the limitations discussed in Section 8.1.

Cumulative Traffic, Air and Noise Effects

The analysis in Chapter 5 concluded that the NND Project, taking into account proposed in-design and mitigation measures, is not likely to result in residual traffic, air quality or noise effects. However, OPG acknowledges that some environmental consequence is likely to be associated with Project soil handling, in proportion to the quantity of soil to be handled, particularly the quantity of soil that will have to be transported off site for disposal. Accordingly, it is OPG's preference to minimize the quantity of excavated material to be managed and the distance it will have to be transported. To the extent practicable, it is OPG's preference to accommodate the excavated material within the DN site.

In the absence of NND Project residual effects, an overview analysis of the potential cumulative effect of the seven other projects and activities (listed above) is provided below. As in Section 8.4.6, the term "cumulative effect" is used in this context even though the combined effects discussed here are not expected to include residual effects of the NND Project.

Cumulative Traffic Effects

Insufficient traffic-related data is available for all seven subject projects to allow an integrated traffic network analysis to consider the combined future traffic flows associated with them. Therefore, the cumulative traffic effects within the LSA/ASA of these seven projects and activities can only be examined in a semi-quantitative / semi-qualitative manner, extrapolating from quantitative traffic analyses for individual projects where available (including analysis for the NND Project), augmented by qualitative assessment, reference to Durham Region's Transportation Master Plan and professional judgement.

NND Project and Future Baseline Traffic

Although the analysis in Section 5.9 concluded that there would be no adverse residual traffic effects from the NND Project, the results of this analysis are referred to here because the analysis

(a) did indicate the likelihood of some acceptable reduction in performance of the local road system as a result of Project traffic (particularly at Highway 401 intersections and in the road network south of Highway 401 between Courtice Road and Waverly Road) and (b) took into account existing and future traffic associated with regional growth. The existing and future traffic baseline for this analysis was subdivided into four time horizons to represent traffic conditions at key stages in the evolution of the Project and other on-site activities:

- 2012 – maximum NND site preparation plus DNGS operation activities;
- 2016 – maximum NND construction plus DNGS operation and refurbishment activities;
- 2021 – NND construction (2 units) and NND operation (2 units) plus DNGS operation and refurbishment activities; and
- 2031 – NND construction completed, full NND operation plus DNGS operation and nominal refurbishment activities.

The traffic analysis for the NND Project indicated that regional growth is largely responsible for the traffic congestion expected at local intersections prior to the start of the Project, pending transportation system improvements planned by the provincial, regional and municipal jurisdictions responsible. These improvements are expected to include widening of Highway 401 between Courtice Road and Highway 35/115, a new interchange at the intersection of Highway 401 and Holt Road, completion of Highway 407 to Highway 401 (Durham East Connector), installation of traffic signals at key intersections and Highway 401 ramps, and addition of turning lanes at key intersections. These improvements, adopted as part of the future baseline conditions on which the analysis of NND Project effects was based (i.e., including the 2012 to 2031 time horizons), will serve to mitigate traffic issues related to other nearby projects and activities as well as the NND Project.

More specifically, baseline conditions assumed for the NND Project traffic analysis implicitly included traffic from existing nearby activities, particularly the St. Marys Cement operation. Planned improvements to the Waverly Road intersections at Highway 401 and the South Service Road, when completed, are expected to mitigate the combined effects of the NND Project, St. Marys Cement operation and other background traffic. The proposed NND Project construction access road (entering the Project area from the DN site east boundary) and planned improvements to the Highway 401/Holt Road intersection will likely minimize NND traffic interaction with the identified future projects west of the DN site, as the latter will likely use Courtice Road as their primary access to and egress from Highway 401.

The traffic effects of the six other nearby projects (not including the ongoing St. Marys Cement operation) are considered further in the following.

Durham-York EFW Project and Other CEBP Developments

The Durham-York EFW project is tentatively scheduled to begin construction in 2010, be in service by 2013, and operate until 2043 (OPG 2008c). A traffic assessment recently completed for the EFW project EA (Durham-York 2009a) also took into account future traffic associated with general growth and some proposed developments in the area. This included an estimate for general background traffic growth, based on historical traffic data for Courtice Road, plus more specific estimates for development of the Clarington Energy Business Park (CEBP) within which the EFW facility is proposed to be located. The CEBP was assumed to be partially developed by 2013 and fully developed by 2023. Based on this assessment, traffic volume related to construction of the facility is expected to increase to a maximum in the last year of construction (2013), although truck traffic will likely be maximum in the first year (2010). This construction traffic is not expected to cause adverse effects or necessitate additional mitigation measures at any of the intersections in the ASA.

However, reconstruction/resurfacing improvements to sections of the South Service Road and Osbourne Road (part of the main site access/egress route in conjunction with Courtice Road/ Highway 401) may be required to accommodate truck traffic associated with both construction and operation of the facility. Traffic volume related to operation of the facility (mainly trucks hauling municipal waste to the facility and removing ash from the facility) was found to require some mitigation, particularly later in the life of the operation, assuming the capacity of the facility is expanded to the maximum 400,000 tonnes per year and the CEBP is also fully developed. During the early years of operation, the traffic effects at all intersections in the area were found to be acceptable (i.e., good Levels of Service), except at the Courtice Road/401 West intersection, which could be mitigated by the addition of traffic signals. During the later years of operation (assuming maximum facility capacity and full CEBP development by 2023), traffic effects at both Courtice Road/401 West and Courtice Road/401 East intersections would require mitigation.

Highway 407 East Link and Highway 401 Improvement Projects

The potential traffic congestion at Highway 401 intersections and south of Highway 401 between Courtice Road and Waverly Road, due to the combined effect of the existing St. Marys Cement operation and the NND Project, Durham-York EFW project and other CEBP developments, will likely be reduced to acceptable levels once the planned local highway/interchange and other transportation infrastructure improvements are completed. The Highway 401 widening and Holt Road interchange improvements are anticipated to begin by about 2010 and be completed by 2011 (MTO 2008a). The Highway 407 East Durham Connector is also anticipated to begin by 2010 and be completed in phases by 2013/16 (OPG 2008c).

At the time of writing, the EA process for the 407 East Link project has not yet progressed to the cumulative assessment stage. Furthermore, no EA process has yet been initiated for the other local highway projects planned by MTO (widening of Highway 401 between Courtice Road and Highway 35/115 and improvement of the 401-Holt Road interchange), although MTO has indicated that planning studies for these projects will begin in the near future, possibly in 2009. All of these highway projects can therefore only be taken into account in general or qualitative terms in this assessment.

Until they are completed and in service, these transportation infrastructure improvement projects will likely exacerbate the traffic effects of the other projects and activities occurring in the local area within the same timeframe. In general, the trucks and other construction traffic associated with these transportation improvement projects will add to the local traffic volume and the lane reductions, detours and other construction measures likely to be associated with these improvement projects may temporarily restrict the flow of traffic associated with all projects and activities, as well as background traffic, in the ASA. More specifically, construction of the southern end of the 407 Durham East Connector, where it joins Highway 401, will likely require a southward realignment of the South Service Road across the northern perimeter of the DN site, particularly the west-central part of the northern site perimeter. Additional road realignments will be associated with the Highway 401/Holt Road interchange improvement. Furthermore, if it is confirmed that grading for the 407 project will require more soil than is available from cut-and-fill operations within the 407 project corridor, and some of the additional soil is obtained from the NND Project, truck traffic between the NND site and the 407 construction corridor could increase. However, the effects of these road realignments and inter-project traffic would likely be limited to the SW quadrant of the ASA being examined in this section. It is anticipated that OPG's proposed collaboration with, and support to, the Municipality of Clarington and the Region of Durham for purposes of the NND Project will help to minimize any adverse cumulative traffic effects of these improvements to the local transportation system.

GO Transit Rail Service Extension – Oshawa to Bowmanville

Depending on the final outcome of GO Transit's feasibility study and ongoing EA process, construction of the extension could begin in 2011 and be completed by about 2013 (GO Transit 2009). Although specific sites have not yet been selected, it is reasonable to assume that construction of the GO train station and rail maintenance facility components of this project are likely to result in temporary increases in local road traffic and restrictions (lane reductions, road closures, detours, etc.) in the vicinity of the potential sites identified. As indicated in Section 8.2.3, three commuter train stations (one each in Oshawa, Courtice and Bowmanville) and one rail maintenance facility (somewhere between Oshawa and Bowmanville) are required as part of the extension project. In addition, depending on which rail alignment option is selected in the end (the CPR option, as recommended by the feasibility study and preferred by the Municipality of Clarington, or the CNR option), related rail construction may take place more or less adjacent to haul routes used for off-site disposal of excess soil from NND Project site preparation.

Overall, however, based on the potential locations of most of the key components of the GO Transit extension project relative to the locations of the other projects in the area (as shown in Figure 8.2-1) and on the assessments of the other projects considered earlier in this section, it is not likely that traffic effects of the GO Transit extension project will overlap the effects of the St. Marys Cement operation, NND Project, EFW facility or other CEBP developments to a major extent. An exception would be if the rail maintenance facility were to be sited within the Adjacent Study Area, across Solina Road between Baseline Road and the CP rail corridor (one of three site options identified by GO Transit's feasibility study, the other two being east and west of the ASA). This site option would be in direct conflict with the south end of the Durham East Connector corridor of the Highway 407 East project. Since this area has already been recommended for the 407 East project, and other site options are available for the rail maintenance facility, it is assumed for purposes of this assessment that the rail maintenance facility will be located elsewhere beyond the ASA.

Assuming the CPR alignment is selected, construction of the required transition from the CN alignment currently used by GO Transit is not likely to contribute to the cumulative traffic concern being examined here as all identified transition route options are west of the Local and Adjacent Study Areas. Although the final rail alignment, station and maintenance facility site selections and traffic estimates are not yet available for this extension project, it is noted that provisions for two GO train stations (the terminal one in Bowmanville and an intermediate one in south Courtice), both along the CPR corridor, are included in the Clarington Official Plan and in the Regional Official Plan. It is therefore reasonable to assume that the traffic effects associated with construction of the rail service extension project will be managed within the Region's Transportation Master Plan (Durham 2005).

On the other hand, once completed, availability of commuter train service to Bowmanville (particularly with an intermediate GO train station in south Courtice) is likely to reduce commuter road traffic to and from the commercial and industrial sites in the area, including DN, CEBP and St. Marys Cement. A further improvement could result if the Courtice GO station is coordinated with the transit infrastructure (future bus and light rail transit facilities) planned in conjunction with the 407 Durham East Connector project (Clarington 2008a).

Growth and Development in Regional Communities

Durham Region's Transportation Master Plan (TMP) (Durham 2005) anticipates growth and development across the region over the next 20 years. In order to achieve the Region's vision and objectives for future improvements of the transportation system, the TMP sets out three comprehensive and coordinated strategies:

- Provision of more travel choices;
- Improvements to the road system; and
- Mitigation of environmental and community effects.

The provision of more travel choices is expected to involve transportation demand management (including measures such as public transit improvements and reduced single-occupant auto use), improved transit and other public transportation services, land use management and improved provisions for walking and cycling. The proposed extension of GO Transit rail service eastward from Oshawa to Bowmanville and the provision for future bus and light rail transit facilities within the Highway 407 East Link corridor both respond to this strategy.

The TMP emphasizes protection, improvement and best use of the existing road system across Durham Region. The TMP encourages the provincial Government to improve the freeway system in the Region and to invest in trade corridors connecting the Region to markets in other parts of Canada and the U.S. A number of proposed improvements to the road system within the Region have already been discussed.

Overall Traffic Mitigation

In addition to the project-specific mitigation measures discussed in the foregoing, and the provisions of the Region's TMP, a number of mitigation measures intended primarily for the NND Project (as proposed in Chapter 5) are also expected to be helpful (as procedural models at least) to the Region, the Municipality of Clarington and other organizations involved in dealing with the cumulative traffic effects of the other seven projects and activities considered here. The following measures are considered most relevant in this context:

- Continuing collaboration with and support to the Municipality of Clarington and the Region of Durham (within a framework of agreements) to identify transportation system deficiencies and facilitate improvements;

- Continuing collaboration with the responsible agencies to ensure that NND Project-related traffic is fully considered in the design of off-site road improvements; and

- Implementation of a Traffic Management Plan (not to be confused with the Region's Transportation Master Plan) with the objective of reducing disruption and maintaining safe traffic conditions during the NND Project Site Preparation and Construction phase.

It is anticipated that the development of OPG's Traffic Management Plan will include further traffic analysis.

Cumulative Air Quality and Noise Effects

No integrated air quality or noise analysis, covering the cumulative effects of all seven other projects and activities examined in this section, is available at this time. Therefore, the cumulative air quality and noise effects of these seven projects and activities are only examined in a semi-quantitative / semi-qualitative manner, extrapolating from quantitative analyses for individual projects where available (including analysis for the NND Project), augmented by qualitative assessment and professional judgement.

NND Project and Future Baseline Conditions

Although the analysis in Section 5.2 concluded that there would be no adverse residual air quality or noise effects from the NND Project, the results of this analysis are referred to here because the analysis (a) did indicate the likelihood of some measurable but acceptable air quality and noise effects as a result of the Project and (b) took into account the expected evolution of other known emission and noise sources in the vicinity plus increasing emissions and noise from local traffic due to future growth in the region. The existing and future baseline for this analysis was subdivided into different time horizons, similar to those used for the traffic assessment in Section 5.9, to represent air quality and noise conditions at key stages in the evolution of the Project and other on-site activities.

The analysis, based on very conservative bounding assessment scenarios, indicates that the total concentrations of air contaminants (including contributions from sources other than the NND Project) are likely to remain below applicable regulatory criteria, with limited exceptions. The exceptions are related to the site preparation and construction activities. During site preparation activities, several nearby locations will be exposed to occasional elevated particulate (suspended particulate matter, PM_{10} and $PM_{2.5}$) and nitrogen dioxide concentrations. This is due to the movement of large quantities of soil within the two-year site preparation phase combined with the strong influence of traffic volumes. The concentration of acrolein is also predicted to exceed applicable criteria, on occasion, during site preparation and construction activities primarily due to elevated background conditions of acrolein. Regardless, the analysis concluded that the predicted air quality changes due to the combination of emissions from the NND Project and from other identified sources (stationary and mobile) do not represent an adverse effect in the atmospheric environment. Furthermore, analyses in Sections 5.13 and 5.14 concluded that no adverse residual effects on human health and non-human biota, respectively, are likely to result.

Similarly, the analysis indicated that the total noise levels and durations (including contributions from traffic background and stationary sources other than the NND Project) do not represent an adverse effect in the atmospheric environment. Noise conditions in residential areas were found to be largely related to background traffic and, to a lesser extent, the St. Marys Cement operation. A moderate increase in noise levels at the closest residence west of the DN site is predicted during site preparation, but will be limited in duration and time of day. Analyses in Sections 5.13 and 5.14 concluded that no adverse residual effects on human health and non-human biota, respectively, are likely to result.

Durham-York EFW Project and Other Area Developments

An air quality assessment recently completed for the EFW project EA (Durham-York 2009b) took into account future emissions associated with some proposed developments and general growth in the area, as well as existing industrial, transportation and other emissions. The existing emissions baseline used for the assessment included St. Marys Cement, DN and many other existing sources. The assessment assumed that the EFW facility will eventually be expanded to the ultimate 400,000 tonnes per year capacity envisaged by Durham-York. The other future emission sources considered in the assessment included the St. Marys Cement alternative fuel option, CEBP development beyond the EFW facility, the Highway 407-401 East Link, local Highway 401 widening and the GO Transit rail extension projects, as well as the NND Project. However, the consideration of these other future sources was mostly qualitative due to uncertainties and limited information.

The effects of the existing St. Marys Cement operation were covered by the baseline conditions. Implementation of the alternative fuel option tested by St. Marys in 2008 is uncertain at this time, but it was considered unlikely to adversely affect local air quality significantly if it were implemented. The nature of future developments within the CEBP, beyond the EFW project, was considered too uncertain at this time to support any further assessment of potential CEBP air quality effects. Similarly, limited information about the timeline and nature of the local Highway 401 widening project precluded further assessment of that project at this time. The GO Transit rail extension project was considered unlikely to significantly affect regional air quality. Future emissions from the NND Project were considered too different from those of the EFW facility to be assessed in conjunction with the facility emissions. Regarding the 407-401 East Link project, the assessment recognized that, once in service, this East Link is likely to bring additional traffic and related emissions into the local area. However, combined emissions of carbon monoxide and nitrogen oxides from the EFW facility and the 407 East Link were estimated to amount to only about 5% of the total existing industrial and other emissions in the area. Other emissions for the two facilities combined (including particulates and volatile organic compounds) were estimated to be only 2% or less of total area emissions. Thus, emissions from the 407 East project (similar to the other future projects examined here) were not included in the quantitative part of the air quality effects assessment.

Emissions from facility construction were also not included in the quantitative part of the EFW air quality effects assessment, in part because construction emissions do not require a provincial Certificate of Approval. The assessment concluded that overall facility construction emissions, including offsite construction related vehicle emissions, would generally be minor and temporary compared to operational emissions. Emissions from EFW facility operation, including vehicle emissions associated with municipal waste delivery to the facility and ash removal from the facility, were analysed quantitatively taking into account the emissions and air quality effects of existing industrial and other sources in the area. Based on this quantitative analysis, operational emissions from the EFW facility (operating at the 400,000 tonnes per year ultimate capacity) are expected to meet or be below the emission limits specified in the provincial guideline for municipal waste incinerators and all contaminants of potential concern are expected to be well below the applicable regulatory air quality criteria. Furthermore, related assessment of human health and ecological risks indicated that facility air emissions are unlikely to result in any adverse health risks to human or non-human receptors in the local area. The location of the maximum predicted air concentrations is more than 1 km to the west of the DN site. The maximum predicted particulate concentration associated with the operation of the facility is 1 $\mu g/m^3$. Even when combined with the predicted particulate concentrations during the NND site preparation activities, no measurable increase in health effects due to particulate emissions is expected.

Assessment of potential noise effects at key off-site receptor points, taking into account background noise from existing industrial and other sources in the area, concluded that construction of the EFW facility is expected to meet applicable provincial and federal noise criteria with two possible exceptions: (i) pile driving activities (temporary and short duration, if required) and (ii) peak offsite construction vehicle traffic (short-term), both of which can be mitigated to some extent by good planning, scheduling and other measures. Operation of the facility, on the other hand, is expected to meet applicable noise criteria without exception. Regarding the potential for combined effects in conjunction with other future projects in the local area, the assessment notes that the facility is proposed to be located in an area already influenced by industrial and highway traffic noise. The assessment indicates that background noise (existing and future) is likely to mask the noise effect of the facility itself (excluding effects of off-site truck traffic related to operation of the facility). Significant cumulative noise effects during facility operation are therefore not considered likely.

Highway 407 East Link and Highway 401 Improvement Projects

At the time of writing, as indicated earlier, the EA process for the 407 East Link project has not yet progressed to the cumulative assessment stage and no EA process has yet been initiated for the other local highway projects planned by MTO. These highway projects can therefore only be taken into account in general or qualitative terms in this assessment. Further to the basic description of project activities in Section 8.2.3, the sources of air emissions and noise during construction of these highway improvements are expected to include site preparation, grading and earth moving, construction of new bridges and overpass structures (including pile-driving), demolition of existing structures (including drilling and blasting), and roadway surfacing. The major types of construction air emissions, other than noise, are expected to be emissions from trucks, other construction vehicles and equipment, and dust from large areas of soil disturbance.

In the absence of project-specific assessments, for purposes of this assessment, it is assumed that these projects will follow Good Industry Management Practices so as to minimize adverse air quality and noise effects of construction in the local area (i.e. the ASA). Measures for mitigating air quality effects of such projects typically include regular dust suppression on unpaved haul roads and other traffic areas, covering of fine-grained materials during transport, covering of stockpiles of some construction materials, regular clean-up of construction sites and access roads, and regular maintenance of construction vehicles and equipment. Measures for mitigating noise effects typically include scheduling of construction activities in accordance with local by-laws, proper maintenance of construction vehicles and equipment, and noise barriers (walls or earth berms) built early in the construction phase.

Should the construction phase of the Highway 407 East Link where it connects to Highway 401 coincide with the short duration site preparation activities associated with the NND, maximum predicted particulate concentrations could be slightly higher than predicted for the NND project. However, as noted for the NND activities, the spatial extent of these elevated concentrations is limited to within a few hundred meters of the construction activities. No measurable increase in health effects due to particulate emissions is expected.

Once completed and in service, these highway and related improvements will inevitably result in increased traffic volumes and associated vehicle emissions and noise in the local area. However, based on the EFW project assessment referred to earlier, vehicle emissions from the 407 East Durham Connector are estimated to amount to less than 3% of the total existing industrial and other emissions in the area. While increases along the existing Highway 401 corridor will likely be gradual and familiar, the increase along the new Highway 407 East Durham Connector corridor will be relatively sudden and less familiar, particularly in the northwest quadrant of the ASA where residents have been less exposed to highway traffic than those living closer to Highway 401. The effects of these increased traffic volumes in the ASA may be offset to some extent by the beneficial effects of improved traffic flow in and through the area (i.e., reduced vehicle emissions due to reduced congestion and idling), particularly at or near key intersections.

GO Transit Rail Service Extension – Oshawa to Bowmanville

Based on the distance from most of the key components of the GO Transit extension project and the other projects in the area (as shown in Figure 8.2-1) and on the assessments of the other projects considered earlier in this section, it is not likely that air quality and noise effects of the GO Transit extension project (particularly the Bowmanville GO train station component) will overlap to a measurable extent the effects of St. Marys Cement Operation, NND Project, EFW facility or other CEBP developments. An exception would be if the rail maintenance facility were to be sited within the Adjacent Study Area, across Solina Road between Baseline Road and the CP rail corridor (one of three site options identified by GO Transit's feasibility study, the other two being east and west of the ASA). This site option would be in direct conflict with the south end of the Durham East Connector corridor of the Highway 407 East project. Since this area has already been recommended for the 407 East project, and other site options are available for the rail maintenance facility, it is assumed for purposes of this assessment that the rail maintenance facility will be located elsewhere beyond the ASA. Regarding the option of an intermediate GO station in south Courtice (near the Courtice Road/CP rail intersection), as identified in the GO Transit feasibility study and recommended by the Municipality of Clarington, its air quality and noise effects would likely be masked by the effects of nearby Highway 401 traffic.

Growth and Development in Regional Communities

Transportation is recognized as a large source of air pollution in the Region, similar to situations in other regions of North America. The Region's Transportation Master Plan anticipates that measures such as reduction of traffic congestion (through transportation system improvements), more travel options (including public transit improvements), technological advances and public education will help to reduce adverse air quality effects.

Overall Air Quality and Noise Mitigation

In addition to the project-specific mitigation measures discussed in the foregoing, and the provisions of the Region's TMP, OPG's proposal to implement a Dust Management Program and a Nuisance Effects Management Plan for residential properties along transportation routes affected by the NND Project (as proposed in Chapter 5) is also expected to be helpful (i.e., as a model) to the Region, the Municipality of Clarington and other organizations involved in dealing with the cumulative air quality and noise effects of the other seven projects and activities considered here.

Cumulative Socio-Economic Effects

As noted in the foregoing, feedback from OPG's communication and consultation program included some concern that the concentration of new projects and ongoing activities within the Municipality of Clarington over the next decade may result in adverse effects on local labour supply, infrastructure and community character. The analysis in Chapter 5 concluded that the NND Project, taking into account proposed mitigation measures, is not likely to result in residual adverse effects on the regional labour market or infrastructure. Effects on community character have already been addressed in Sections 5.11 and 8.4.5 in the context of potential effects of cooling towers and therefore will not be considered further. In the absence of NND Project residual effects, an overview analysis of the potential cumulative effect of the seven other projects and activities (listed above) on the regional labour market and infrastructure is provided below.

Regional Labour Market Effects

As discussed in Section 5.11, the skills and amount of labour available in a community reflect the proportion of its labour needs that can be met locally and hence the potential for individuals and households to realize employment and income benefits. These in turn determine the potential for in-migration and the amount of commuting that occurs, thereby affecting housing, transportation infrastructure in a community; and influence the quality of education, health, safety and social services in a community.

The seven other projects and activities, which are the focus of this section, all have some potential to affect the regional labour market (i.e., increase competition for labour). However, the potential of these projects and activities to affect the labour market is likely to be relatively small compared to the effects of larger projects on the DN site (including the NND Project and possible mid-life refurbishment of DNGS), the PN site (possible mid-life refurbishment of PNGS B) and the Pickering Airport Project. For example, the initial construction workforce for the Durham-York EFW project is expected to peak at only 200 workers (Durham-York 2009d) compared to approximately 3,500 for the NND Project. Similarly, the initial EFW facility operation workforce is expected to be less than 50 workers compared to approximately 1,400 (for 2 units) to 2,800 (for 4 units) for the NND station. Even if the EFW facility is eventually expanded to the ultimate maximum capacity envisaged (400,000 tonnes per year), the potential effects of its construction and operational workforces will remain relatively small. The analysis in Section 5.11 indicates that although these major projects will likely place a sustained demand on the regional and provincial construction labour force, sustained initiatives by government, employers, labour groups and educational institutions are aimed at establishing a stable, qualified construction workforce. The smaller projects may benefit from new apprenticeship opportunities which are likely to be offered by the larger, longer-duration projects. In addition, the larger projects will likely contribute to expansion of the skills base of the labour market over the long term, benefiting those municipalities with economic development initiatives focused on the energy sector (including Durham Region and the Municipality of Clarington).

A number of mitigation measures intended primarily for the NND Project (as proposed in Chapter 5) are also expected to be helpful (as procedural models) to the Region, the Municipality of Clarington and other organizations involved in dealing with the cumulative labour market effects of the other seven projects and activities considered here. The following measures are considered most relevant in this context:

- Sharing of information with local and regional land use planners, economic development staff, and social service providers with respect to the timing and magnitude of on-site labour; and
- Working with government, other electricity sector employers, labour groups and educational institutions through existing liaison mechanisms and programs.

Community Infrastructure Effects

In the context of the overall water supply and waste management system that is emerging in Durham Region, the water supply and sewage treatment needs of the seven other projects considered in this section are not expected to exceed the existing or planned capacities of the municipal system. This is based on comparison with the needs of the NND Project. The analysis in Section 5.11 indicates that the NND Project and associated population increase will increase the demand on the regional water supply system by only a small fraction of the existing and proposed capacity of the system. Similarly, the increased demand for sewage treatment will be only a small fraction of the total waste volumes processed in Durham Region (only 0.06% based on the Region's 2007 volumes). Transportation system infrastructure is addressed earlier in this section.

Mitigation of the effects on municipal services and infrastructure of the projects examined in this section can reasonably be expected to be resolved by the proponents of those projects and the host Municipality (and the Region as applicable), such as is proposed for the EFW project

(Durham-York 2009d). No specific information is available at this time for the other projects involved.

A number of beneficial socio-economic effects of the NND Project were identified in Section 5.11 and summarized in Table 8.3-1(b). Several of them are considered relevant in this context also, but are not repeated here.

No additional mitigation measures beyond those referred to throughout this section, as well as those which may be proposed by the proponents/operators of the other projects and activities in the vicinity, are considered necessary to meet regulatory requirements or minimize the cumulative environmental effects considered in this section (traffic, air quality, noise, labour market and infrastructure).

8.5 Summary of Cumulative Effects Assessment

A total of 34 other projects and activities within the RSA was identified at the outset as having the potential to interact with the proposed NND Project. Of this total, eight are past or existing, four are certain or planned, and the balance (22) are considered reasonably foreseeable projects or activities. Residual adverse effects of the proposed NND Project were identified in the aquatic, terrestrial, visual landscape and socio-economic components/sub-components of the environment. Therefore, the assessment of potential cumulative effects focused on relevant VECs within these four areas of the environment. In all four areas, the cumulative effects were found to be such that no additional mitigation measures were considered to be necessary.

Several beneficial effects, mostly related to the Socio-Economic Environment were identified. These will tend to offset both the residual effects of the NND Project and the limited cumulative adverse effects identified.

In addition, although no residual radiological health effects had been assessed as likely to result from the NND Project, this aspect of the Human Health component was examined further. The reason for this additional consideration was the general concern expressed by some members of the public that their health, safety and well-being may be affected by radiation and radioactivity from any nuclear project or operation. The cumulative doses to members of the public and workers were found to be low, well below regulatory limits, and thus no additional mitigation measures were considered to be necessary.

Although no residual effects on local traffic, air quality, noise, labour market or community infrastructure were identified to result from the NND Project, based on feedback from the public, OPG addressed concerns for potential overlapping effects of projects in the southwest Clarington area during the next 10 years for which details have not yet been confirmed. OPG has indicated its intention to work with the proponents of such other projects (e.g., MTO, the Region of Durham, GO Transit, Municipality of Clarington) to identify opportunities and undertake cooperative initiatives (where appropriate) that would minimize potential cumulative effects should these projects materialize. The mitigation measures identified to address effects of the Project will also be effective in ameliorating the potential cumulative effects of other projects and activities should they occur.

Finally, it should be noted that the CEA Agency's *Sustainable Development Strategy 2007-2009* is relevant to cumulative effects assessment in that it recognizes that while *"EA is an effective tool for addressing local environmental concerns associated with a specific development, it is not designed for debating broader environmental regional or policy issues"*. From this it is reasonable to conclude that an individual project EA, such as this one, should not be expected to resolve broad-based environmental policy issues.

As a result of this analysis, only one residual cumulative adverse effect was identified and carried forward to Chapter 9 for determination of Significance:

- Combined visual and related community effects (concerns about a negative change in community character and reduced enjoyment of private property) resulting from the possible NND Project cooling towers and other tall structures existing and foreseeable in the vicinity of the DN site.

While no additional mitigation measures are proposed for this residual cumulative effect, it should be noted that the preliminary scope of the EA follow-up and monitoring program (Section 11.3) includes public attitude research and surveys of local residents and users of on-site recreational facilities to verify the predicted residual effect and significance determination.

9. SIGNIFICANCE OF RESIDUAL ADVERSE EFFECTS

9.1 Context for Determination of Significance

The *CEAA* (Sections 16(1) and 37) and the EIS Guidelines (Section 11.3) require an assessment of the significance of the environmental effects that are likely to result from implementation of the Project, having taken into account the implementation of the proposed mitigation measures. Such effects are called "residual effects". All residual adverse effects identified in earlier chapters have been advanced to this chapter for an assessment of significance. It is noted that the Project will also result in a number of beneficial effects, however, the beneficial effects are not considered further in terms of their significance, as there is no requirement to do so under *CEAA*.

Residual adverse effects from the NND Project are assessed for significance using the following broad criteria:

Magnitude	The size or degree of the effect compared against baseline conditions or thresholds, and other applicable measurement parameters (i.e., standards, guidelines, objectives);
Spatial (Geographic) Extent	The area over or throughout which the effects will be measurable;
Duration/Timing	The time period over which the effect will last;
Frequency or Probability	The rate of recurrence of the effect (or conditions causing the effect);
Reversibility	The degree to which the effect can or will be reversed (typically measured by the time it will take to restore the environmental attribute or feature);
Physical Human Health	The degree to which the physical aspects of human health may be affected;
Psycho-social Human Health	The degree to which psychological or social behaviour of the public may be affected;
Ecological Importance	The importance of the environmental attribute or feature to ecosystem health and function;
Societal Value	The value of the environmental attribute or features to society; and
Sustainability	The degree to which the effect would impact the ability for the attribute or feature to meet the needs of the present without compromising the ability of future generations to meet their own needs.

The majority of these criteria are based on criteria that are generally used in environmental assessments required by the *CEAA* and are listed in the EIS Guidelines for this Project. Other criteria were added by the proponent to reflect a particular interest shown by the public, or experience with other EAs. Specifically, physical human health was included to capture comments and concerns raised by the public during public consultation activities; psycho–social human health and societal value were added based on experience and reviewer feedback on the EA carried out for the Pickering B Refurbishment and Continued Operation project (OPG 2007c); and sustainability was added as a criterion to be consistent with evolving best environmental practices. The criteria can generally be broken down into two groups. The first five criteria listed deal with the nature or extent of the residual adverse effect while the remaining five criteria deal with the environmental and/or social implications of the effect.

Table 9.1-1 describes the measurement parameters established for each criterion and applied to each residual adverse effect. Where possible, the parameters and measurement values were formulated to reflect criteria, guidelines or other published standards. In cases where these were not available, the measurements were made by the EA Study Team based on previous EAs, and best professional judgement concerning the nature of the residual adverse environmental effect. The effects levels within each parameter are ranked low, medium or high.

TABLE 9.1-1
General Criteria for Determination of Significance of Residual Adverse Effects on VECs

Effects Criteria	Effects Levels and Parameters		
	Low	Medium	High
Magnitude of Effect	Effect exceeds baseline conditions; however, is less than reference criteria or guideline values.	Effect will likely exceed reference criteria or guideline values but has limited effect on VEC or pathway to VEC.	Effect will likely exceed reference criteria or guideline values and may cause an effect on VEC or pathway to VECs.
Spatial (Geographic) Extent of Effect	Effect limited to Site Study Area.	Effect limited to Local Study Area.	Effect extends into the Regional Study Area.
Duration / Timing (of effect)	Effect is limited to short-term events (i.e., Site Preparation and Construction phase).	Effect is limited to the Operation and Maintenance phase and/or the Decommissioning phase.	Effect extends beyond the Decommissioning phase.
Frequency (or Probability) (of conditions causing effect)	Conditions or phenomena causing the effect rarely occur.	Conditions or phenomena causing the effect may occur on one or more occasions over the project life.	Conditions or phenomena causing the effect may occur often and at regular and frequent intervals.

TABLE 9.1-1 (Cont'd)
General Criteria for Determination of Significance of Residual Adverse Effects on VECs

Effects Criteria	Effects Levels and Parameters		
	Low	Medium	High
Reversibility	Effect is reversible (i.e., ceases once source/stressor is removed).	Effect persists for some time after source/stressor is removed, but eventually ceases (i.e., reversible during the lifetime of the Project)	Effect is not readily reversible.
Effect on Physical Human Health	Effect exceeds baseline conditions; however, is less than reference criteria or guideline values.	Effect will likely exceed reference criteria or guideline values but has limited effect on human health or pathway to human health.	Effect will likely exceed reference criteria or guideline values and may cause an effect on human health or pathway to human health.
Effect on Psycho-social Human Health	Effect is not generally noticeable to the public.	Effect is somewhat noticeable, but not generally of concern to the public.	Effect is noticeable, and of concern to the public and as such, may affect people's sense of health, safety and well-being.
Ecological Importance (of VEC)	The VEC is common and abundant within the Local Study Area.	The VEC is less common and of limited abundance within the Regional Study Area	The VEC is less common and of limited abundance within Ontario.
Societal Value (of VEC)	The VEC plays a limited and indirect role in maintaining the economic base, social structure, community stability and the character of local communities.	The VEC plays an important yet indirect role in maintaining the economic base, social structure, community stability, and the character of local communities or people's sense of health, safety and well-being.	The VEC plays a highly important and direct role in maintaining the economic base, social structure, community stability, and the character of local communities or people's sense of health, safety and well-being.
Sustainability	The effect does not affect the existence of the VEC or its continued use.	The effect will substantially inhibit the use of the resource during the life of the project. The VEC will still be available thereafter.	The effect will, within a very short time, permanently affect the life of the VEC and, hence, its ability to continue to be available for use by future generations.

9.2 Methodology for Determining Significance

The determination of the significance of the residual adverse effects was undertaken in the following sequence:

- Application of the general criteria outlined in Table 9.1-1 to each residual adverse effect (i.e., ratings)
- Determination of significance based on the ratings using a two-step process
- Confirmation of methodology to ensure consistency in application of criteria and best professional judgement

Each of these is described below.

9.2.1 Application of General Criteria

The criteria and thresholds for determining significance were established early in the EA study. Also, the general criteria described in Section 9.1 and Table 9.1-1 were applied in a consistent manner to all of the residual adverse effects identified in Chapters 5, 7 and 8. Each criterion was rated as low, medium or high for each residual adverse effect. These measures helped to ensure that the rating of each criterion for each residual adverse effect was undertaken as objectively as possible.

9.2.2 Determination of Significance

To determine the overall significance of the residual adverse effect, an assessment methodologhy was developed that incorporated the criteria ratings. Based on this assessment, one of the following two significance levels was assigned to each residual effect:

- Minor Adverse Effect: The residual adverse effect is minor or not significant; no further or more effective mitigation is considered necessary;

- Significant Adverse Effect: The residual adverse effect is significant; further or more effective mitigation is not considered feasible.

The methodology used to determine whether or not a residual adverse effect is classified as significant was developed from a similar approach used by the CNSC in its Environmental Assessment Screening Report for the Pickering B Refurbishment and Continued Operation project (CNSC 2007c, Section 11.1). For the NND Project, this methodology was developed after the criteria were rated. A two-step process was applied by the respective EA specialists to determine significance of the residual adverse effects, based on their criteria ratings. The potential for a re-assessment of a residual adverse effect was also incorporated into the process.

Step 1: If a medium or high rating is assigned to all of the criteria dealing with the nature or extent of the effect (as follows):
- magnitude;
- spatial (geographic) extent;
- duration;
- frequency; and
- reversibility;

then proceed to Step 2. If a low rating is assigned to any of the Step 1 criteria, the effect is deemed a minor residual adverse effect (not significant), and no further assessment is required.

Step 2: If a medium or high rating is assigned to at least one of the criteria dealing with the environmental and/or social implications of the effect (as follows):

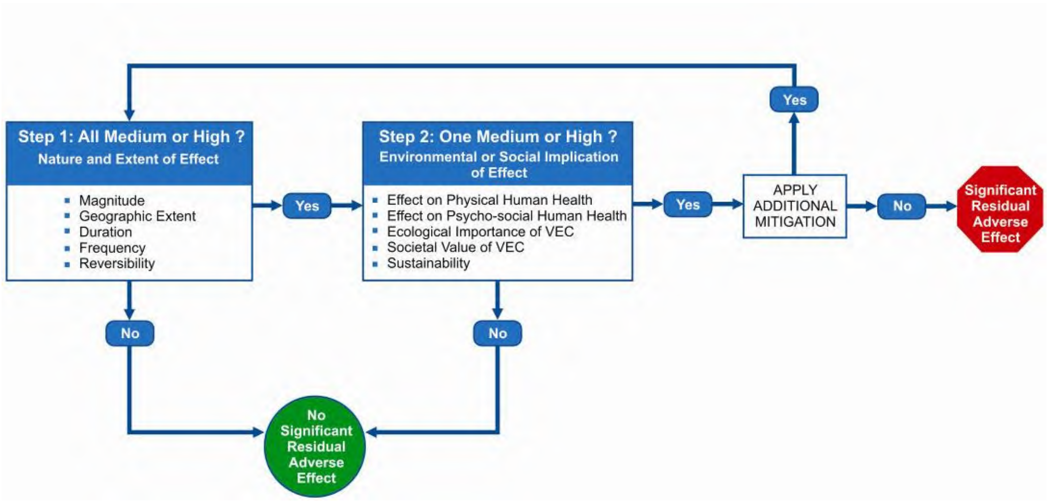
- effect on physical human health;
- effect on psycho-social human health;
- ecological importance of VEC;
- societal value of VEC; and
- sustainability;

then the effect is forwarded for an assessment of the possibility of applying additional mitigation measures. If additional mitigation measures cannot be applied to the residual adverse effect, then the effect is deemed a significant residual adverse effect. If additional mitigation can be applied, then the residual adverse effect is sent back to Step 1 for re-assessment.

If all Step 2 criteria are assigned a low rating, the effect is deemed a minor residual adverse effect (not significant).

This methodology is shown graphically on Figure 9.2–1.

FIGURE 9.2-1
Methodology for Determining Significance



The assessment methodology outlined above has been intentionally designed to structure and standardize the subjective professional judgments that must be applied in such an analysis. In creating the assessment methodology, it was necessary to determine thresholds for classifying the residual adverse effects as significant or not. To do this, professional judgment had to be applied for each of Steps 1 and 2 of the assessment methodology.

For Step 1, the criteria were based on the size and extent of the effect and thresholds were established such that any residual adverse effect that was rated as "low" for any one of the criteria used in Step 1 would necessarily be a residual adverse effect that was so minimal that it could not be significant, no matter how high the ratings that were achieved for the other Step 1 criteria or the Step 2 criteria. For residual adverse effects that were carried forward to Step 2, which involved the environmental/social effect on the VEC, the criteria and thresholds for that step were established to ensure that any residual adverse effect would be considered significant if only one achieved a medium or high rating.

9.2.3 Confirmation of Methodology

After the determination of significance was applied to the ratings of the significance criteria, and, hence, to the residual adverse effects, it was considered prudent for confirmatory purposes to test the reasonableness or sensitivity of the overall significance determined. This was accomplished by subjecting the results of the formal assessment methodology to further professional judgment by the respective EA specialists. Additionally, the significance analysis was taken to the public at Open Houses as described in Section 10.3.1.7 and the public generally supported the approach and results.

9.3 Significance of Residual Adverse Environmental Effects

Based on the results of the assessment of effects of the Project on the environment (Chapter 5), several residual adverse effects were identified and advanced for determination of significance. These are listed below and evaluated for significance in Table 9.3-1. Residual cumulative effects advanced from Chapter 8 are also included in the listing below and are evaluated for significance in Table 9.3-1. Table 9.3-1 also indicates where no residual adverse effects were identified for an environmental component.

For further context concerning residual adverse effects advanced for evaluation of significance, reference is made to Table 5.15-1 which provides a summary of adverse environmental effects and the associated VECs, identified mitigation measures, and residual adverse effects.

Atmospheric Environment:

- No residual adverse effects.

Surface Water:

- No residual adverse effects.

Aquatic Environment:

- Loss of some aquatic biota (i.e., benthic invertebrates, fish) during the construction of the lake infill and the intake and discharge structures;
- Impingement and entrainment losses associated with operation of the once-through lake water cooling option, and to a lesser degree, with the cooling tower option.

The assessment has concluded that the loss of aquatic habitat will not result in a residual adverse environmental effect because of the mitigation measures that will be implemented. Notwithstanding that mitigation measures will ensure there is no net loss of nearshore aquatic habitat, the following is advanced for consideration of significance as if it were, in fact, considered a residual adverse effect

- Loss of approximately 40 ha of Lake Ontario nearshore aquatic habitat as a result of lake infilling and construction of cooling water intake and discharge structures.

Terrestrial Environment:

As described in Section 5.5 (and summarized in Table 5.15-1) six individual residual adverse effects were identified in the Terrestrial Environment. Of these six, three were associated directly with the same consequence of the Project; specifically, the loss of terrestrial habitat on the DN site as a result of its development. It was important to identify these effects individually in Section 5.5 because they related to different environmental sub-components. However, because they are all a result of the same loss of habitat and to avoid triple-counting of the same effect, the three individual residual adverse effects have been consolidated into a single residual adverse effect (i.e., loss of approximately 50 ha of terrestrial habitat) for determination of significance. All of the VECs collectively affected by the three individual effects are considered in the determination of significance of the effect. Therefore, the residual adverse effects in the Terrestrial Environment considered further for significance are:

- Loss of approximately 50 ha of terrestrial habitat on the DN site;
- Loss of nesting habitat for up to 1,000 Bank Swallows;
- Bird strike mortalities associated only with natural draft cooling tower structures; and
- Disruption to wildlife travel along the east-west wildlife corridor during the Site Preparation and Construction phase.

Geological and Hydrogeological Environment:

- No residual adverse effects.

Radiation and Radioactivity Environment:

- No residual adverse effects.

Land Use:

- Changes in the quality of existing views of the DN site throughout the operating life of the Project from viewing locations in the RSA and LSA as a result of the presence of the natural draft cooling tower structures and the associated plumes released from either natural draft or mechanical draft cooling towers.

Traffic and Transportation:

- No residual adverse effects.

Physical and Cultural Heritage Resources:

- No residual adverse effects.

Socio-Economic Environment:

- Change in the character of communities in the RSA and LSA as a result of the presence of the natural draft cooling tower structures, and the associated plumes released from either natural draft or mechanical draft cooling towers;
- Reduced use and enjoyment of community and recreational features on the DN site during the Site Preparation and Construction phase;
- Disruption to use and enjoyment of property because of nuisance-related effects (e.g., dust, noise, traffic) during the Site Preparation and Construction phase for some residents living along the truck haul routes; and
- Reduced enjoyment of private property in the RSA and LSA as a result of the visual dominance of the natural draft cooling tower structures and the associated vapour plumes released from either the natural draft or mechanical draft cooling towers.

Aboriginal Interests

- No residual adverse effects.

Human Health

As described in Section 5.13 (and summarized in Table 5.15-1) three residual adverse effects were identified for Human Health. These same three residual adverse effects, which are related to the use and enjoyment of private property, community and recreational features, were also identified in the Socio-Economic Environment. The relevance of these residual adverse effects to Human Health is based on the fact that changes in use and enjoyment of private property and community/recreational features are a consideration in terms of mental well-being. However, to avoid double counting of the same effects, the residual adverse effects that are common to both the Socio-Economic Environment and Human Health are considered for significance only in the Socio-Economic Environment. These residual adverse effects are described above and repeated as follows:

- Reduced use and enjoyment of community and recreational features on the DN site during the Site Preparation and Construction phase;
- Disruption to use and enjoyment of property because of nuisance-related effects (e.g., dust, noise, traffic) during the Site Preparation and Construction phase for some residents living along the truck haul routes; and
- Reduced enjoyment of private property in the RSA and LSA as a result of the visual dominance of the natural draft cooling tower structures and the associated vapour plumes released from either the natural draft or mechanical draft cooling towers.

Non-Human Biota

- No residual adverse effects.

Malfunctions, Accidents and Malevolent Acts:

- No residual adverse effects.

Cumulative Effects:

- Combined visual and related community effects (concerns about a change in community character and reduced enjoyment of private property) resulting from the possible NND Project cooling towers and other tall structures existing and foreseeable in the vicinity of the DN site.

Table 9.3-1 shows the results of applying the criteria to the residual adverse effects described above. The Evaluation component of Table 9.3-1 is divided into the rating of criteria (low, medium or high) and the application of the significance methodology (i.e. Step 1 and Step 2). Also provided in the Table under the last column are the results of the professional judgement from the respective EA specialists.

TABLE 9.3-1
Determination of Significance of Residual Adverse Effects

Likely Residual Adverse Effect (After Mitigation)	Valued Ecosystem Component Affected	Evaluation		Significance Result and Comments from Technical Specialists
		Rating of Criteria	Assessment of Significance	
ATMOSPHERIC ENVIRONMENT				
No residual adverse effects				
SURFACE WATER ENVIRONMENT				
No residual adverse effects				
AQUATIC ENVIRONMENT				
Loss of some aquatic biota (i.e., benthic invertebrates, fish) during the construction of the lake infill and the intake and discharge structures.	Benthic Invertebrates, VEC Fish Species	**Magnitude: LOW** Small proportion of populations affected. **Spatial Extent: LOW** Small proportion of range of species affected. **Duration / Timing: LOW** Effect occurs in the Site Preparation and Construction phase over a short period of time. **Frequency (or Probability): MEDIUM** Occurs once. **Reversibility: HIGH** Affected organisms are permanently lost.	<u>Step 1:</u> At least one is low; therefore, not significant and Step 2 not needed.	**Minor Adverse Effect (Not significant)** Near shore environment of proposed infill is a high energy zone (typically shallow; influenced by waves, storm events), with few documented invertebrate species. Round gobies are an invasive species. Footprint of cooling/service intake and discharge structures is small, and habitat loss is not significant relative to entire area.

TABLE 9.3-1 (Cont'd)
Determination of Significance of Residual Adverse Effects

Likely Residual Adverse Effect (After Mitigation)	Valued Ecosystem Component Affected	Evaluation: Rating of Criteria	Evaluation: Assessment of Significance	Significance Result and Comments from Technical Specialists
AQUATIC ENVIRONMENT (Cont'd)				
		Effect on Physical Human Health: LOW No Effect. **Effect on Psycho-social Human Health: LOW** No Effect. **Ecological Importance (of VEC): LOW** Affected species are common. **Societal Value (of VEC): LOW** Effect involves primarily species of no direct importance to human users. **Sustainability: LOW** Affected species will persist in abundance in extensive remaining similar habitats adjacent to affected areas.	**Step 2:** Not needed.	
Impingement and entrainment losses associated with operation of the once-through lakewater cooling option, and to a lesser degree, with the cooling tower option.	Benthic Invertebrates, VEC Fish Species	**Magnitude: LOW** Small proportion of populations affected. **Spatial Extent: LOW** Small proportion of range of species affected. **Duration / Timing: MEDIUM** Effect occurs throughout the Operation and Maintenance phase. **Frequency (or Probability): HIGH** Occurs continuously with seasonal fluctuations. **Reversibility: HIGH** Affected organisms are permanently lost.	**Step 1:** At least one is low; therefore, not significant and Step 2 not needed.	**Minor Adverse Effect (Not significant)** Once-through-cooling porous veneer intake has been designed specifically for reducing entrainment and impingement of fish. The intake incorporates design features based on fish behavioural principles, and is also located offshore at depths which are less productive than inshore locations. The expected losses will be low relative to Lake Ontario populations. The cooling tower option will also incorporate features, such as reduced flow to reduce entrainment and impingement.

TABLE 9.3-1 (Cont'd)
Determination of Significance of Residual Adverse Effects

Likely Residual Adverse Effect (After Mitigation)	Valued Ecosystem Component Affected	Evaluation: Rating of Criteria	Evaluation: Assessment of Significance	Significance Result and Comments from Technical Specialists
AQUATIC ENVIRONMENT (Cont'd)				
		Effect on Physical Human Health: LOW No Effect.	**Step 2:** Not needed.	
		Effect on Psycho-social Human Health: LOW No Effect.		
		Ecological Importance (of VEC): LOW Affected species are common.		
		Societal Value (of VEC): LOW Effect involves primarily species of no direct importance to human users.		
		Sustainability: LOW Affected species will persist in abundance despite the losses; populations are expected to compensate for losses of such low magnitude.		
Loss of approximately 40 ha of Lake Ontario nearshore aquatic habitat as a result of lake infilling and construction of cooling water intake and discharge structures.	Aquatic Habitat	**Magnitude: LOW** Fish habitat loss is not unique to nearshore environment of Lake Ontario. Similar habitat in RSA.	**Step 1:** At least one is low, therefore not significant and Step 2 not needed.	**Minor Adverse Effect (Not significant)** There is nothing distinctive about the DN site nearshore habitat as a spawning or feeding area that is not shared by adjacent areas for many kilometers east and west of the site, influenced to a limited extent by the seasonal presence of warmwater fish from nearby tributaries, bays and coastal marshes. The nearshore in this area is a high energy environment. Its ecology is heavily skewed toward the seasonal and intermittent presence of migratory Lake Ontario fish species.
		Spatial Extent: LOW Effect limited to SSA		
		Duration / Timing: HIGH Effect occurs during the Site Preparation and Construction phase.		
		Frequency (or Probability): MEDIUM Occurs once.		

TABLE 9.3-1 (Cont'd)
Determination of Significance of Residual Adverse Effects

Likely Residual Adverse Effect (After Mitigation)	Valued Ecosystem Component Affected	Evaluation		Significance Result and Comments from Technical Specialists
		Rating of Criteria	Assessment of Significance	
AQUATIC ENVIRONMENT (Cont'd)				
Continued from Previous Page		**Reversibility: LOW** Habitat is permanently lost but replaceable with on-shore and offshore shoals, restoration, and/or diversifying the forage base through replacement of stock (Fish Habitat Compensation Plan).		Preliminary results of the HAAT model also suggested the low productivity of the proposed lake infill area, and areas affected by the construction of the cooling water intake and discharge structures. The Project will not result in a residual adverse effect on Aquatic Habitat because of the mitigation measures that will be implemented (notably, the Fish Habitat Compensation Plan).
		Effect on Physical Human Health: LOW No Effect	**Step 2:** Not needed	
		Effect on Psycho-social Human Health: LOW No Effect		
		Ecological Importance (of VEC): LOW Nearshore habitat is common to north shore of Lake Ontario.		
		Societal Value (of VEC): LOW Of limited interest; commonly found in RSA.		
		Sustainability: LOW Effect is persistent but limited to common habitat in RSA. Compensation will address loss of habitat.		

TABLE 9.3-1 (Cont'd)
Determination of Significance of Residual Adverse Effects

Likely Residual Adverse Effect (After Mitigation)	Valued Ecosystem Component Affected	Evaluation: Rating of Criteria	Evaluation: Assessment of Significance	Significance Result and Comments from Technical Specialists
TERRESTRIAL ENVIRONMENT				
Loss of approximately 50 ha of terrestrial habitat on the DN site.	Cultural Meadow and Thicket Ecosystem Winter Raptor Feeding and Roosting Area Breeding Mammals Migrant Butterfly Stopover Area Breeding Birds Migrant Songbirds and their Habitat	**Magnitude: LOW** Many other cultural meadows and other terrestrial habitat in the RSA.	**Step 1:** At least one is low; therefore, not significant and Step 2 not needed.	**Minor Adverse Effect (Not significant)** Cultural meadows and other terrestrial habitat of the types found at DN site are widespread in the environment in southern Ontario, and in the RSA and LSA. Many of those at the DN site are hydroseed mixture or otherwise of low ecological function. The effect is also confined to the DN site. The VECs will persist at the DN site as some habitat will remain where raptors can feed or roost. Breeding birds occupy almost all habitats, constructed and natural. None of the breeding bird habitats being reduced due to effects of the project are unique to the DN site and they occur commonly in the RSA and LSA, VECs will persist at the DN site as will most of the suite of breeding birds known to occur
		Spatial Extent: LOW Effect limited to the SSA.		
		Duration / Timing: HIGH Loss occurs early in Project and extends beyond the Decommissioning phase.		
		Frequency (or Probability): MEDIUM Occurs once, but effect is long-lasting.		
		Reversibility: HIGH Terrestrial habitat is permanently lost.		
		Effect on Physical Human Health: LOW No Effect.	**Step 2:** Not needed.	
		Effect on Psycho-social Human Health: LOW No Effect.		
		Ecological Importance (of VEC): MEDIUM Cultural meadows are common and anthropogenic in nature; winter raptor feeding area less common, breeding mammals are common species adapted to human altered landscapes.		
		Societal Value (of VEC): MEDIUM Limited role for Cultural Meadow and winter raptors, some mammals – e.g. deer, beaver have limited economic role.		
		Sustainability: LOW There are many other similar ecosystems in the RSA where no species will be lost.		

TABLE 9.3-1 (Cont'd)
Determination of Significance of Residual Adverse Effects

Likely Residual Adverse Effect (After Mitigation)	Valued Ecosystem Component Affected	Evaluation: Rating of Criteria	Evaluation: Assessment of Significance	Significance Result and Comments from Technical Specialists
TERRESTRIAL ENVIRONMENT (Cont'd)				
Loss of nesting habitat for up to 1,000 active Bank Swallows	Breeding Birds (Bank Swallows)	**Magnitude: MEDIUM** A portion of the nesting habitat in the Bank Swallow Evaluation Area (shoreline extending from Oshawa Creek to Wilmot Creek in the LSA) will be removed; creation of artificial colonies could further reduce loss. **Spatial (Geographic) Extent: LOW** Effect limited to the SSA. **Duration / Timing HIGH** Effect extends beyond the Decommissioning phase. **Frequency (or Probability): HIGH** Most of the habitat area lost once, early in Project. . **Reversibility: HIGH** Loss will be permanent. Only partially reversed through mitigation. **Effect on Physical Human Health: LOW** No Effect. **Effect on Psycho-social Human Health: LOW** No Effect. Not generally of concern to the public. **Ecological Importance (of VEC): MEDIUM** Although a common breeding species, breeding areas are less common and of limited abundance within the RSA. **Societal Value (of VEC): LOW** Plays a limited and direct role in terms of societal value. **Sustainability: MEDIUM** VEC indicator as a species will survive in the Bank Swallow Evaluation Area and the RSA, however, this may be one of a relatively few productive colonies.	**Step 1:** At least one is low; therefore, not significant and Step 2 not needed. **Step 2:** Not needed.	**Minor Adverse Effect (Not significant)** The mitigative options being advanced for consideration are innovative including the long-term protection of important nesting areas, design and construction of artificial Bank Swallow colonies, and research into declines in aerial foraging birds. These actions are expected to bring long-term tangible benefits to the species and perhaps others. The portions of the colony being removed are confined to the SSA, and a larger portion of the associated colony will still remain viable.

TABLE 9.3-1 (Cont'd)
Determination of Significance of Residual Adverse Effects

Likely Residual Adverse Effect (After Mitigation)	Valued Ecosystem Component Affected	Evaluation: Rating of Criteria	Evaluation: Assessment of Significance	Significance Result and Comments from Technical Specialists
TERRESTRIAL ENVIRONMENT (Cont'd)				
Bird strike mortalities associated only with natural draft cooling tower structures. (Estimated at <110 in the spring and <300 in the fall assuming natural draft cooling towers).	Migrant Songbirds and their Habitat	**Magnitude: LOW** Number of birds predicted to be struck is proportionally very small (<0.01% of total number of birds). **Spatial (Geographic) Extent: LOW** Effect limited to the SSA. **Duration / Timing: MEDIUM** Effect will extend throughout the Operation and Maintenance phase. **Frequency (or Probability): MEDIUM** Annually in Spring and Fall. **Reversibility: HIGH** Effect is not reversible.	**Step 1:** At least one is low; therefore, not significant and Step 2 not needed.	**Minor Adverse Effect (Not significant)** Compared to the large numbers of migrant birds passing over the DN site in spring and fall, or to the known level of mortalities at lit buildings in Toronto or due to other anthropogenic sources (e.g., residential windows, pet cats) these anticipated strike numbers are low. In addition, the effect will occur in a relatively small area associated with the tower structures in the SSA only. The effects are unlikely to result in measurable change to bird populations
		Effect on Physical Human Health: LOW No Effect. **Effect on Psycho-social Human Health: LOW** Effect not noticeable to public. **Ecological Importance (of VEC): MEDIUM** Struck species are primarily common or abundant, some will be less common. **Societal Value (of VEC): MEDIUM** Play an important but indirect role in people's sense of well-being. **Sustainability: LOW** Species will survive and exist elsewhere, including within the LSA and SSA.	**Step 2:** Not needed.	

TABLE 9.3-1 (Cont'd)
Determination of Significance of Residual Adverse Effects

Likely Residual Adverse Effect (After Mitigation)	Valued Ecosystem Component Affected	Evaluation: Rating of Criteria	Evaluation: Assessment of Significance	Significance Result and Comments from Technical Specialists
TERRESTRIAL ENVIRONMENT (Cont'd)				
Disruption to wildlife travel along the east-west wildlife corridor during Site Preparation and Construction phase.	Wildlife Corridors	**Magnitude: LOW** **Spatial (Geographic) Extent: LOW** Effect limited to Site Study Area. **Duration / Timing: LOW** Effect is limited to the Site Preparation and Construction phase **Frequency (or Probability): MEDIUM** Likely to occur periodically but only during the Site Preparation and Construction phase. **Reversibility: LOW** Reversible upon completion of construction activities.	<u>Step 1:</u> At least one is low; therefore, not significant and Step 2 not needed.	**Minor Adverse Effect (Not significant)** Although there is no major wildlife corridor on site, a corridor does exist. Wildlife using the east-west corridor through the DN site are already adapted to the road network and high levels of human disturbance that characterize both the LSA and SSA. The DN site remains permeable for many of these species and the period of disturbance will be relatively limited.
		Effect on Physical Human Health: LOW No Effect. **Effect on Psycho-social Human Health: LOW** No Effect. **Ecological Importance (of VEC): LOW** Not a regional or important corridor; local corridor functions for relatively adaptable species. **Societal Value (of VEC): LOW** Limited and indirect role for societal values. **Sustainability: LOW** Most species will still be able to traverse the DN site.	<u>Step 2:</u> Not needed	
GEOLOGICAL AND HYDROGEOLOGICAL ENVIRONMENT				
No residual adverse effects				
RADIATION AND RADIOACTIVITY ENVIRONMENT				
No residual adverse effects				

TABLE 9.3-1 (Cont'd)
Determination of Significance of Residual Adverse Effects

<table>
<tr><th rowspan="2">Likely Residual Adverse Effect (After Mitigation)</th><th rowspan="2">Valued Ecosystem Component Affected</th><th colspan="2">Evaluation</th><th rowspan="2">Significance Result and Comments from Technical Specialists</th></tr>
<tr><th>Rating of Criteria</th><th>Assessment of Significance</th></tr>
<tr><td colspan="5">LAND USE</td></tr>
<tr><td rowspan="10">Changes in the quality of existing views of the DN site throughout the operating life of the Project from viewing locations in the RSA and LSA as a result of the presence of the natural draft cooling tower structures and the associated plumes released from either natural draft or mechanical draft cooling towers.

(Residual Project effect considered in combination with the effects of other tall structures existing and foreseeable in the DN site vicinity).</td><td rowspan="10">Visual Aesthetics</td><td>Magnitude: HIGH
Towers will represent a "Strong" visual presence.</td><td rowspan="5"><u>Step 1:</u>
All are high or medium; therefore, proceed to Step 2</td><td rowspan="10">Minor Adverse Effect (Not Significant)

The combined residual adverse effect and likely cumulative effect will not likely preclude the use and enjoyment of private property in LSA communities. Although the conditions creating the effect will not be reversible, the magnitude of the effect is likely to further diminish over time as the structures become a familiar feature of the landscape.</td></tr>
<tr><td>Spatial (Geographic) Extent: HIGH
Towers and plumes will be visible from vantage points throughout the RSA.</td></tr>
<tr><td>Duration / Timing: MEDIUM
Effect will extend throughout the Operation and Maintenance phase.</td></tr>
<tr><td>Frequency (or Probability): HIGH
Conditions creating the effect will be ongoing throughout the Operation and Maintenance phase.</td></tr>
<tr><td>Reversibility: MEDIUM
Not reversible during Operations and Maintenance phase. Towers will be demolished during the Decommissioning phase.</td></tr>
<tr><td>Effect on Physical Human Health: LOW
No Effect.</td><td rowspan="5"><u>Step 2:</u>
No criteria are medium or high; therefore, the effect is not significant</td></tr>
<tr><td>Effect on Psycho-social Human Health: LOW
No Effect.</td></tr>
<tr><td>Ecological Importance (of VEC): LOW
No effect</td></tr>
<tr><td>Societal Value (of VEC): LOW
The community is accustomed to seeing industrial uses at and near DN. Such uses are also consistent with local and regional plans.</td></tr>
<tr><td>Sustainability: LOW
No Effect.</td></tr>
<tr><td colspan="5">TRAFFIC AND TRANSPORTATION</td></tr>
<tr><td>No residual adverse effects.</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="5">PHYSICAL AND CULTURAL HERITAGE</td></tr>
<tr><td>No residual adverse effects.</td><td></td><td></td><td></td><td></td></tr>
</table>

TABLE 9.3-1 (Cont'd)
Determination of Significance of Residual Adverse Effects

Likely Residual Adverse Effect (After Mitigation)	Valued Ecosystem Component Affected	Evaluation: Rating of Criteria	Evaluation: Assessment of Significance	Significance Result and Comments from Technical Specialists
SOCIO-ECONOMIC ENVIRONMENT				
Change in the character of communities in the RSA and LSA as a result of the presence of the natural draft cooling tower structures and the associated plumes released from either natural draft or mechanical draft cooling towers. (Residual Project effect considered in combination with the effects of other tall structures existing and foreseeable in the DN site vicinity).	Community Character	**Magnitude: LOW** The community is accustomed to seeing industrial uses at and near DN. Such uses are also consistent with local and regional plans. **Spatial (Geographic) Extent: MEDIUM** Even though visible from within the RSA the cooling tower structures are likely to be prominent features of the landscape within the LSA. **Duration / Timing: HIGH** Condition creating the effect will be permanent. **Frequency (or Probability): HIGH** Condition creating the effect will be a one-time event and continue until the Decommissioning phase. **Reversibility: MEDIUM** Effects on community character are likely to persist for some time after the cooling towers and their vapour plumes are no longer visible features on the landscape, but will eventually cease.	**Step 1:** At least one is low; therefore, not significant and Step 2 not needed.	**Minor Adverse Effect (Not significant)** Although there is likely to be a cumulative visual impact, the NND Project (in combination with other tall structures existing and foreseeable in the DN site vicinity) will not likely change the unique and distinctive qualities of LSA communities. The area in the immediate vicinity of the DN site is a mix of industrial, commercial and residential land uses. The presence of industrial and commercial land uses is increasing.

TABLE 9.3-1 (Cont'd)
Determination of Significance of Residual Adverse Effects

Likely Residual Adverse Effect (After Mitigation)	Valued Ecosystem Component Affected	Evaluation: Rating of Criteria	Evaluation: Assessment of Significance	Significance Result and Comments from Technical Specialists
SOCIO-ECONOMIC ENVIRONMENT (Cont'd)				
Continued from Previous Page		**Effect on Physical Human Health: LOW** No Effect.	**Step 2:** Not needed.	
		Effect on Psycho-social Human Health: MEDIUM A change in community character due to the presence of natural draft cooling tower structures may affect some people's, sense of health, safety and well-being.		
		Ecological Importance (of VEC): LOW No effect.		
		Societal Value (of VEC): MEDIUM Community character plays an important yet indirect role in maintaining the economic base, social structure, community stability, and the character of local communities or people's sense of satisfaction with their community.		
		Sustainability: LOW The NND Project will not fundamentally change the unique and distinctive qualities of the communities in the LSA.		

TABLE 9.3-1 (Cont'd)
Determination of Significance of Residual Adverse Effects

Likely Residual Adverse Effect (After Mitigation)	Valued Ecosystem Component Affected	Evaluation: Rating of Criteria	Evaluation: Assessment of Significance	Significance Result and Comments from Technical Specialists
SOCIO-ECONOMIC ENVIRONMENT (Cont'd)				
Reduced use and enjoyment of community and recreational features on the DN site during the Site Preparation and Construction phase	Community and Recreational Facilities and Services	**Magnitude: MEDIUM** Fewer users of the recreational features on the DN site will be evident compared to current levels. Enjoyment of the site will also be diminished. **Spatial (Geographic) Extent: MEDIUM** The vast majority of users of the DN site are from the LSA. **Duration / Timing: LOW** Effect will be limited to the Site Preparation and Construction phase. **Frequency (or Probability): HIGH** People use the DN site for recreational purposes frequently during the day and during each season of the year. **Reversibility: LOW** Effect will be reversible (i.e., ceases once nuisance effects diminish and the recreational features and biodiversity of the DN site is restored).	**Step 1:** At least one is low; therefore, not significant and Step 2 not needed.	**Minor Adverse Effect (Not significant)** The Project does not preclude the use of the DN site for recreational purposes. The reduced use and enjoyment of the DN site for recreational purposes will likely be experienced by a small number of users for a few years prior to its restoration.

TABLE 9.3-1 (Cont'd)
Determination of Significance of Residual Adverse Effects

Likely Residual Adverse Effect (After Mitigation)	Valued Ecosystem Component Affected	Evaluation: Rating of Criteria	Evaluation: Assessment of Significance	Significance Result and Comments from Technical Specialists
SOCIO-ECONOMIC ENVIRONMENT (Cont'd)				
Continued from Previous Page		**Effect on Physical Human Health: LOW** No Effect. **Effect on Psycho-social Human Health: LOW** Reduced use and enjoyment of these community and recreational features on the DN site may affect some people's feelings of health, safety and well-being. **Ecological Importance (of VEC): LOW** No Effect. **Societal Value (of VEC): LOW** The community and recreational features on the DN site play a limited and indirect role in maintaining the character of local communities or people's satisfaction with their community. **Sustainability: LOW** The effect does not affect the existence of the community and recreational features in the LSA or their continued use.	<u>**Step 2:**</u> Not needed.	
Disruption to use and enjoyment of property because of nuisance-related effects (e.g., dust, noise, traffic), during the Site Preparation and Construction phase for some residents living along the truck haul routes.	Use and Enjoyment of Private Property	**Magnitude: MEDIUM** Conditions creating the effect will be evident above current levels.	<u>**Step 1:**</u> At least one is low; therefore, not significant and Step 2 not needed.	**Minor Adverse Effect (Not significant)** Although those affected will likely notice increased traffic, noise and dust, these effects are not anticipated to be of sufficient magnitude to preclude continued use of private property. Effects will also be limited to a few properties along the haul route within the LSA during the Site Preparation and Construction phase.

TABLE 9.3-1 (Cont'd)
Determination of Significance of Residual Adverse Effects

Likely Residual Adverse Effect (After Mitigation)	Valued Ecosystem Component Affected	Evaluation: Rating of Criteria	Evaluation: Assessment of Significance	Significance Result and Comments from Technical Specialists
SOCIO-ECONOMIC ENVIRONMENT (Cont'd)				
Continued from Previous Page		**Spatial (Geographic) Extent: MEDIUM** Effect will be limited to a truck haul route and a soil storage area likely within the LSA.		
		Duration / Timing: MEDIUM Effect will be limited to the Site Preparation and Construction phase		
		Frequency (or Probability): MEDIUM Condition creating the effect will occur on more than one occasion, but only during the Site Preparation and Construction phase.		
		Reversibility: LOW Effect will be reversible following the Site Preparation and Construction phase.		
		Effect on Physical Human Health: LOW No Effect.	**Step 2:** Not needed.	
		Effect on Psycho-social Human Health: MEDIUM Disruption to people's use and enjoyment of private property may affect some people's feelings of health, safety and sense of well-being.		
		Ecological Importance (of VEC): LOW No effect.		
		Societal Value (of VEC): LOW The use and enjoyment of private property plays a limited and indirect role in maintaining the economic base, social structure, community stability and the character of local communities or people's satisfaction with their community.		
		Sustainability: LOW The effect does not preclude continued use of private property.		

TABLE 9.3-1 (Cont'd)
Determination of Significance of Residual Adverse Effects

Likely Residual Adverse Effect (After Mitigation)	Valued Ecosystem Component Affected	Evaluation: Rating of Criteria	Evaluation: Assessment of Significance	Significance Result and Comments from Technical Specialists
SOCIO-ECONOMIC ENVIRONMENT (Cont'd)				
Reduced enjoyment of private property in the RSA and LSA as a result of the visual dominance of the natural draft cooling tower structures and the associated vapour plumes released from either the natural draft or mechanical draft cooling towers. (Residual Project effect considered in combination with the effects of other tall structures existing and foreseeable in the DN site vicinity).	Use and Enjoyment of Property	**Magnitude : LOW** Although there is a strong visual impact, the NND Project will not preclude the use and enjoyment of private property in LSA communities. **Spatial (Geographic) Extent: MEDIUM** Even though visible from within the Regional Study Area, the cooling towers are likely to be prominent features of the landscape within the LSA. **Duration / Timing: MEDIUM** Effects on use and enjoyment of private property will cease after the cooling tower structures and their vapour plumes are no longer visible features on the landscape. **Frequency (or Probability): HIGH** The cooling tower structures and their vapour plumes will likely be visible from private property often and at regular and frequent intervals. Their presence on the landscape may result in people thinking more frequently about living near the DN site, thereby affecting people's use and enjoyment of private property more frequently. **Reversibility: MEDIUM** Effects are likely to cease after the cooling tower structures and their vapour plumes are no longer visible features on the landscape.	<u>**Step 1:**</u> At least one is low; therefore, not significant and Step 2 not needed.	**Minor Adverse Effect** **(Not significant)** Although there is likely to be a cumulative visual impact, the NND Project (in combination with other tall structures existing and foreseeable in the DN site vicinity) will not likely preclude the use and enjoyment of private property in LSA communities. Although the conditions creating the effect will not be reversible, the magnitude of the effect is likely to further diminish over time as the structures become a familiar feature of the landscape and the Project establishes a positive track record.

TABLE 9.3-1 (Cont'd)
Determination of Significance of Residual Adverse Effects

Likely Residual Adverse Effect (After Mitigation)	Valued Ecosystem Component Affected	Evaluation		Significance Result and Comments from Technical Specialists
		Rating of Criteria	Assessment of Significance	
SOCIO-ECONOMIC ENVIRONMENT (Cont'd)				
		Effect on Physical Human Health: LOW No Effect. **Effect on Psycho-social Human Health: MEDIUM** Disruption to people's use and enjoyment of private property may affect some people's feelings of health, safety and well-being. **Ecological Importance (of VEC):LOW** No Effect. **Societal Value (of VEC): LOW** The use and enjoyment of private property plays a limited and indirect role in maintaining the economic base, social structure, community stability and the character of local communities or people's satisfaction with their community. **Sustainability: LOW** The effect does not preclude continued use of private property.	**<u>Step 2:</u>** Not needed.	
ABORIGINAL INTERESTS				
No residual adverse effects				

TABLE 9.3-1 (Cont'd)
Determination of Significance of Residual Adverse Effects

Likely Residual Adverse Effect (After Mitigation)	Valued Ecosystem Component Affected	Evaluation		Significance Result and Comments from Technical Specialists
		Rating of Criteria	Assessment of Significance	
HEALTH-HUMAN				
The three residual adverse effects for Human Health are common with similar residual adverse effects discussed in Socio-Economic Environment and have not been included here to avoid duplication.				
HEALTH- NON-HUMAN BIOTA				
No residual adverse effects				
MALFUNCTIONS, ACCIDENTS AND MALEVOLENT ACTS				
No residual adverse effects				

9.4 Summary of Significance Evaluation

Based on the detailed analysis in the table above, the significance evaluation considered 12 likely residual adverse effects. Of these, 11 were eliminated in Step 1 due to the limited nature and extent of the effects. The remaining residual adverse effect was eliminated in Step 2 of the analysis, because of the low environmental or social implications of the effect. Therefore, the NND Project will not result in any significant residual adverse effects.

10. COMMUNICATIONS AND CONSULTATION PROGRAM

This Chapter describes the communications and consultation program developed for the NND Project from its commencement in September 2006 through to May 2009. The program is consistent with OPG's practices on public consultation and is intended to fulfill all of the requirements for consultation under the *CEAA* and the *NSCA*. The program will continue throughout the regulatory approvals process and beyond.

Section 10.1 describes the community context, outlines the requirements for communications and consultation as defined in various regulatory documents, and summarizes the Communications and Consultation Program developed for the new nuclear project, given the community context and requirements. Section 10.2 reports on the activities, events and methods used to inform and involve the community and stakeholders throughout the EA. Section 10.3 describes the stakeholder and public feedback received, Section 10.4 provides an evaluation of the program delivered to date and Section 10.5 describes the EIS and Licence to Prepare Site post-submission communications program.

Aboriginal Engagement is described in 10.6. Section 10.6.1 describes the regulatory requirements; 10.6.2 the engagement and information sharing that was undertaken and 10.6.3 the results, feedback and insights from the dialogue OPG had with Aboriginal communities and organizations. Section 10.6.4 describes the post-submission engagement and information sharing program.

10.1 Community Context, Requirements and Program

The Communications and Consultation Plan for the Project identified the host and adjacent communities, including the Municipality of Clarington and the City of Oshawa as the area of focus for communications. These communities are described below.

10.1.1 Municipality of Clarington

The Municipality of Clarington is the host municipality for the existing DNGS and the proposed NND Project. According to Statistics Canada, in 2006, the population of the Municipality of Clarington was approximately 78,000. In 2007, Clarington reported a population of 80,440, with 28,000 households. Clarington is comprised of a collection of four urban communities, and more than a dozen rural settlements and hamlets.

Bowmanville, located approximately 5 km northeast of the DN site, is the largest urban community in Clarington with a population of approximately 32,000. Courtice (pop. 22,000) located approximately 4 km northwest of the DN site, Newcastle (pop. 7,540) approximately 10 km to the east of the DN site, and Orono (pop. 1,670) approximately 13 km to the northeast of the DN site make up the remaining urban communities. Bowmanville is home to the municipal offices and central library, the Bowmanville Hospital, the Bowmanville Museum, and the Visual Arts Centre.

Clarington is governed by an elected municipal Council consisting of a Mayor, two Regional Councillors each representing two local wards and four local Councillors representing each of the Municipality's four wards. The Mayor and the Regional Councillors sit on both Clarington Council and Regional Municipality of Durham Council.

Clarington's vision is to be:

- a place where each community can build on its individual character but shares a common economic base and a distinct collective vision;
- a place for people to live, work and play in a safe, vibrant, healthy and prosperous environment; and
- a place where people, businesses and governments balance structured growth with the protection, management and enhancements of rural landscapes, cultural heritage, natural resources and the natural environment (Municipality of Clarington, 2007).

10.1.2 City of Oshawa

The City of Oshawa (2006 pop. 142,000) is located immediately to the west of Clarington and is Durham Region's most populated municipality. Oshawa's land use structure is a mix of urban and rural areas.

The Council of the City of Oshawa is made up of 11 members - one Mayor, seven Regional Councillors and three City Councillors. The Mayor is elected at large by electors throughout the City, heads the Council of the City of Oshawa and is also a representative of the City on the Council of the Regional Municipality of Durham. Seven Regional Councillors are elected, one from each of City's seven Wards to represent those Wards on both City of Oshawa Council and Regional Municipality of Durham Council. Three City Councillors are elected, one from each combined Wards One and Three, Two and Four and Five and Six, to represent those Wards on the Council of the City of Oshawa.

Oshawa is developing into a balanced city of residential, commercial, industrial, social and recreational facilities. Notable facilities in Oshawa include the University of Ontario Institute of Technology, the General Motors Centre, and the soon to be completed Regional Municipality of Durham Courthouse. With the recent changes in the North American automobile sector, the City of Oshawa has been proactive in identifying opportunities to diversify its economic base.

10.1.3 Regional Municipality of Durham

The regional system of municipal government consists of two tiers. The Regional Municipality of Durham is an upper-tier municipality and operates at a broader scale to provide planning, servicing and financing for the Region. The Region is made up of eight area municipalities: Ajax, Brock, Clarington, Oshawa, Pickering, Scugog, Uxbridge and Whitby.

In 2006, the Regional Municipality of Durham's population was 561,258 as reported by Statistics Canada. Major employers in Durham include General Motors of Canada, OPG (which owns and operates both the DNGS and PNGS), Lakeridge Health System, the Durham District School Board, Durham College, and the University of Ontario Institute of Technology.

Durham Region Council is comprised of 29 members, including the Regional Chair and 28 Regional Councillors from the eight area municipalities. Oshawa is represented by eight members, Whitby and Pickering with four members each, Ajax and Clarington each with three members, and Brock, Uxbridge and Scugog with two members apiece.

The Durham Nuclear Health Committee (DNHC) was established by Durham Region Council in the fall of 1995 as a forum for discussing and addressing radiological emissions from nuclear facilities in Durham and to assess the potential environmental and human health impacts of the nuclear industry on the Region.

In recent years, the Municipality of Clarington, the City of Oshawa and the Region of Durham have formally demonstrated interest and support in hosting new nuclear development at the DN site, including Council resolutions, letters of support, and statements (Refer to Section 2.1.4.1 of the *Communications and Consultation TSD*),

10.1.4 Darlington Nuclear Generating Station – Historical Context

In the late 1960s and early 1970s the DN site was identified by Ontario Hydro as a future electricity generation centre, with an ultimate generation capacity of up to 12,000 MW. Between 1974 and 1976 Ontario Hydro undertook a public consultation program to ensure that all concerns were identified and taken into account. In 1975, a preliminary environmental assessment was distributed to the community and a series of meetings were held with interested groups and individuals. In total, 17 meetings were held between 1974 and 1976, 12 with interest groups and five with local officials.

In November 1976 Ontario Hydro submitted a proposal to the provincial government for the development of the Darlington Nuclear Generating Station, which considered the impact of construction and operation on both the environment and the community and included a summary of the government review and public participation process (Ontario Hydro, 1976). The submission was supported by a separate Community Impact Study commissioned by Ontario Hydro undertaken by James F. MacLaren Limited (MacLaren, 1976). Both studies identified a need for additional infrastructure to facilitate the project. To address this need, Ontario Hydro entered into community impact agreements with the Town of Newcastle and the Regional Municipality of Durham in 1977.

Site approval was granted by the then Atomic Energy Control Board (AECB) on June 29, 1977 and in July 1977, the Province approved Ontario Hydro's proposal for the DNGS. The AECB approved Ontario Hydro's construction license in June 1981. During this time, public confidence in nuclear power was challenged by two high-profile international events: Three Mile Island in 1979, which inspired protests in Durham Region and a severe event at the nuclear station in Chernobyl in 1986 prompting worldwide debate about nuclear power.

In Ontario public activism regarding the potential shipment of tritium from the then-proposed Tritium Removal Facility at the Darlington site; and concern about cost overruns and work delays on the Darlington project also challenged public support for nuclear power in Ontario. The Town of Newcastle raised concerns over payments for building permits and fire protection at the site.

In October 1990, Ontario Hydro obtained its operating licence and the first unit (Unit 2) came into service. All four units were in service by June 1993. At the time the DNGS was providing 3,400 MW of power to the provincial grid. Appendix 2A of the *Communications and Consultation TSD* provides details of this time period.

10.1.5 Demand for Additional Generating Capacity – Darlington B

In the late 1980's Ontario Hydro initiated a 25-year electricity demand-supply planning exercise. In 1989 Ontario Hydro released the Balance of Power, which among other things, identified that the DN site was one of many existing sites that could accommodate up to four additional 881 MW CANDU reactors (then called "Darlington B"). The demand-supply plan did not proceed.

10.1.6 The DN Site Today

The DNGS is a top performing station in the nuclear industry recognized by a unit capability factor of 99.9% in the first quarter of 2009. The electricity output of the DNGS provides approximately 20% of Ontario's electricity needs, enough to serve approximately two million people. In 2008, the CNSC granted the DNGS a five-year operating licence renewal, which is the maximum length of time allowable and affirms the safe and effective operation of the station. There is public confidence in the safety of the DNGS. Residents within 10 km (LSA) and 50 km (RSA) were asked about their confidence in the safety of the existing station and over 80% of residents within 50 km feel confident about the station's safety (refer to Table 4.4-1 of the *Socio-Economic Existing Conditions TSD*).

In 2008, there were 2,819 workers at the DN site making OPG the largest single employer in the Municipality of Clarington. The majority (63%) of workers reside within the Regional Municipality of Durham. Within Durham, the majority of workers reside within Clarington (32%) and Oshawa (14%). (*Socio-economic Environment Existing Environmental Conditions TSD*)

The DN site offers several recreational amenities, including eight soccer fields, a baseball diamond, the Waterfront Trail, four fitness stations with educational signage, a playground, several picnic areas, and public parking lots for use by residents. The Waterfront Trail, developed in partnership with the Municipality of Clarington, the Region of Durham, and community partners, extends through the DN site and measures over seven kilometres.

OPG has been recognized for its contributions to the community. Over the years, the DNGS has earned many distinctions and awards including the "Corporate Citizen of the Year" award from the Clarington Board of Trade in 2002 and 2003; the "Jessica Markland Partnership Award" from the Durham Environmental Advisory Committee which recognizes the co-operative efforts of those who enhance Durham Region's environment by building partnerships with public, community and private organizations (2007); and the 2008 "Corporate Habitat of the Year" and "Wings over Wetlands" awards from the Wildlife Habitat Council.

OPG also maintains an existing community relations and public information program at the DNGS, which is described in detail in Section 2.1 of the *Communications and Consultation TSD*.

10.1.7 Communications and Consultation Requirements

The federal requirements for communications and consultation are articulated in the *CEAA*; *NSCA*; and the EIS Guidelines. For a comprehensive EA, or an EA under mediation or a review panel, the legislation requires that the study include consideration of comments from the public that are received. It acknowledges that community knowledge and Aboriginal Peoples traditional knowledge may be considered in conducting an EA.

The *NSCA* requires a public information program to "inform persons living in the vicinity of the site of the general nature and characteristics of the anticipated effects on the environmental and the health and safety of persons that may results from the activity to be licensed".

The EIS Guidelines require the EIS to include notification of, and consultation with, the potentially affected stakeholders, including the public. The Guidelines require that the EIS summarize the public and stakeholder comments received during the EIS and indicate how issues have been considered in the completion of the study, or how they may be addressed in any subsequent regulatory licensing and compliance process.

The Guidelines require the proponent to address concerns of the general public regarding the anticipated or potential environmental effects of the project. In preparing the EIS, the proponent is required to engage residents and organizations in all potentially affected communities, other interested organizations, and relevant government agencies. The proponent must provide in the EIS the highlights of this engagement, including the methods used, the results, and the ways in which the proponent intends to address the concerns identified.

Meaningful involvement in the environmental assessment is seen to take place when all parties involved have a clear understanding of the proposed project as early as possible in the review process. The proponent is required to:

- Continue to provide up-to-date information describing the project to the public and especially to the communities likely to be most affected by the project;
- Involve Aboriginal Peoples in determining how best to deliver that information, e.g., the types of information required, translation needs, different formats, the possible need for community meetings; and

- Explain the results of the EIS in a clear direct manner to make the issues comprehensible to as wide an audience as possible.

Additional requirements include:

- In preparing the EIS, the proponent must demonstrate how it has engaged interested parties that may be affected or have an interest in the project. The key issues identified by Aboriginal Peoples and the non-Aboriginal public must be identified and summarized in the EIS;
- The EIS must describe the proponent's engagement with provincial and federal government agencies and local governments. The EIS must describe the objectives of such engagement, the methods used, issues raised during such engagement and the ways in which the proponent has addressed these issues;
- The EIS must describe the proponent's engagement with stakeholders (e.g. local businesses, neighbouring residences, cottagers, and outdoor recreational interests). The EIS must describe the objectives of such engagement, the methods used, issues raised during such consultations and the ways in which the proponent has addressed these issues; and
- The EIS must describe any other public engagement undertaken by the proponent prior to submitting the EIS. This description must identify the objectives of such engagement, outline the methods used, and summarize the issues raised by the public, and the ways in which the proponent has addressed these issues.

10.1.8 Communications and Consultation Plan

This Section describes the communications and consultation program developed for the NND Project from its commencement in September 2006 through to June 2009. The program is consistent with OPG's practice on public consultation and is intended to fulfill all of the requirements for consultation under the *CEAA* and the *NSCA.* Communications and consultation will continue throughout the regulatory approvals process and beyond.

At the outset of the Project, a communications and consultation plan was prepared to guide the Communications and Consultation Program. This plan reflected a commitment to conform with and to exceed the consultation requirements of the *CEAA* and the EIS Guidelines as well as the *NSCA* and the CNSC Regulatory Requirements for new nuclear power plants. The Communications and Consultation Program provided a broad range of opportunities for stakeholders to obtain information, ask questions, provide comments, data and input to the EA Study, and to identify and discuss any concerns they had with the Project. It also included a process to identify, document and address stakeholder issues as they arose during the EA.

The following principles were developed for the Communications and Consultation Program:

- Integration of the program with OPG's communication activities, particularly those related to the Darlington Nuclear site, while maintaining a Project focus;
- Inclusion of all interested stakeholders and members of the public at a level of involvement suitable to their needs and interests;
- Flexibility to respond and adapt to unanticipated issues and stakeholder input throughout the study period; and
- Incorporation of the issues, concerns, comments and perspectives brought forward in planning the Project and carrying out the EA Study in an open and transparent manner.

The objectives of the Communications and Consultation Program were to:

- Communicate plans to, and share information with, the public and stakeholders in a timely and accessible manner;
- Seek informed views, perspectives, issues and concerns;
- Respond to and incorporate feedback and input, in a reasonable amount of time; and
- Meet the requirements of the CNSC and the CEA Agency to document activities undertaken, comments and issues received, and how they have been addressed in the EIS.

Stakeholder groups and individuals included, but were not limited to, the following stakeholder categories (in no particular order), as required in the EIS Guidelines:

- Federal government – departmental and agency staff responsible for review and with a role in the approval of the Project (CNSC, Fisheries and Oceans, Natural Resources, Environment, Health, Transport Canada);
- Canadian Environmental Assessment Agency;
- Aboriginal communities (Aboriginal Peoples and Métis Organizations);
- provincial government – ministry and agency staff likely to play a role in the approval of the Project (Energy & Infrastructure, Transportation, Community Safety and Correctional Services);
- Regional and local municipal government agencies and staff likely to play a role in the approval of the Project (Works, Health, Emergency Services, Planning, Parks & Recreation, Economic Development);
- Conservation Authorities;
- Elected officials – MPs, MPPs, and regional and local municipal councils;

- Local, regional and national non-governmental organizations and organizations of civil society, such as, ratepayers, park user groups, environmental organizations (local, provincial and regional), educational institutions and school boards, business associations, and suppliers;
- Residents/general public;
- OPG employees; and
- Print and broadcast media in the area of focus.

An initial listing of stakeholders was assembled in the stakeholder database for the Project. Additions were made to the list as the Project progressed. The list of stakeholders recorded in categories by position and/or group is provided in Appendix 3D of the *Communications and Consultation TSD.*

10.1.9 Communications and Consultation Support

OPG provided support to communities, organizations and individuals to ensure involvement in the public participation process and to remove any barriers to participation. This included:

- Financial support to individuals and organizations to attend consultation events (details in the *Aboriginal Interests TSD*);
- Holding additional sessions or events when requested (further discussed in Section 3.5.0);
- Providing translation services in communities with a high proportion of multiple languages; and
- Establishing a participant funding program (discussed below).

In March 2008, OPG established the NND EA Participant Funding Program to financially support individuals, community groups and/or organizations wishing to participate in the EA for the Project. The goals of the program are to ensure:

- That the EA is fulsome in its analysis;
- That the EA is based on a process that recognizes public interest, knowledge and concern; and
- That new information or findings that arise and are of relevance and value to the Project, are incorporated into the EA.

This program is intended to complement participant funding provided by the federal government, not duplicate it. The program offers two forms of funding:

New Knowledge Funding

New knowledge funding was made available to eligible individuals, groups and organizations to support the contribution of new information and/or research findings that are of relevance and value to the NND EA. Key stakeholders were notified in April 14, 2008 about the funding program and information was available on the Project website. As of May 2009 no applications have been received for the funding program.

Municipal Peer Review Funding

Municipal peer review funding was offered to the communities in the LSA. The objective is to enable Municipalities to undertake independent technical peer reviews of the EIS, and to ensure that potential effects on the municipality are addressed. Both the Municipality of Clarington and the City of Oshawa participated under this form of funding.

The complete Communications and Consultation Plan is provided in Appendix 2B in the *Communications and Consultation TSD.*

10.2 Communications and Consultation Program

This Section reports on the activities, events and methods used to inform and involve the community and stakeholders throughout the EA, from commencement in September 2006 through to May 2009. It begins with a description of the Project announcement and initial notifications (10.2.1); and discusses the range of engagement activities with government departments and agencies (10.2.2); stakeholders (10.2.3) and the public (10.2.4). This is followed by a description of the range of general public communications (10.2.5), media coverage (10.2.6) and employee engagement (10.2.7).

10.2.1 Project Announcement and Initial Notifications

In response to a directive from the Ontario Government (its sole shareholder) to begin the federal approvals process, including an environmental assessment for new nuclear generation at an existing site, OPG initiated the NND Project in September 2006 by submitting an application for a site preparation license to the CNSC.

OPG issued a press release on September 22, 2006 notifying the public of the application and indicating that the CNSC would review the application and determine the environmental assessment requirements. At that time OPG also ran advertisements in local newspapers (Whitby This Week, Clarington This Week, Oshawa This Week on September 24, 2006 and Orono Times on September 27, 2006) to inform the local community. A copy of the press release is in Appendix 3A, and a copy of the advertisement is in Appendix 3B in the Communications and Consultation TSD. In response to the release, several newspapers published articles and the listing is provided in Appendix 3C in the *Communications and Consultation TSD.*

Also on September 22, 2006, OPG notified key stakeholders including federal, provincial and municipal agencies, the CNSC and members of local municipal councils that OPG submitted an Application for a Licence to Prepare Site at the DN site and indicating that OPG would keep them informed and consult them throughout the process.

10.2.2 Government Agency and Department Engagement

Federal, provincial and municipal government agencies and departments consulted throughout the Project commencement and received Project newsletters and invitations to EA consultation events. The notification list expanded as the Project progressed and more key stakeholders became aware of the Project and OPG identified more government agencies and departments to include in consultation activities. At all times OPG offered to meet and discuss the Project. Table 10.2-1 identifies the nature of the information provided to government agencies and departments consulted throughout the Project.

TABLE 10.2-1
Communication with Government Agencies and Departments

Materials Sent	Date of Release
Project Commencement Notification Email	22-September-06
Project Commencement Notification Letter & Community Information Session #1 Invitation Letter	07-November-06
Community Information Session #2 Invitation and Project Update Letter	22-October-07
Community Information Session #3 Invitation and Project Update Letter	04-April-08
Community Information Session #4 Invitation and Project Update Letter	15-September-08
Community Information Session #5 Invitation and Project Update Letter	18-March-09

In addition, OPG has held two rounds of dialogue with government agencies and departments to share information and receive feedback at key stages in the study process (see Section 3.2 in *Communication and Consultation TSD* for details). OPG has also met with several agencies and departments to discuss specific topics of interest to that department/agency.

10.2.2.1 Federal and Provincial Departments and Agencies Engagement

OPG met with the following federal and provincial government agencies and departments, on the dates indicated (Table 10.2-2). Feedback and results from the discussions are in Section 10.3.1.

TABLE 10.2-2
Government Agency Engagement

Federal Department/Agency	Date of Meeting
Canadian Environmental Assessment Agency	28-February-07
	20-February-08
	11-June-08
	10-September-08
	15-October-08
	22-October-08
	29-October-08
	31-October-08
	26-November-08
	26-January-09
	04-February-09
	11-February-09
	23-February-09
	25-February-09
	26-February-09
	25-March-09
	22-April-09
Canadian Nuclear Safety Commission	28-February-07
	20-February-08
	11-June-08
	10-September-08
	15- October-08
	22- October-08
	29-October-08
	31-October-08
	26-November-08
	26-January-09
	04-February-09
	11-February-09
	23-February-09
	25-February-09
	26-February-09
	25-March-09
	02-April-09
	22-April-09
Canadian Standards Association	24-March-09
Citizenship and Immigration Canada	21-May-08
Environment Canada	15-March-07
	21-May-08
	25-March-09
Fisheries and Oceans	28-February-07
	02-March-09
Health Canada	15-March-07
	20-February-08

TABLE 10.2-2 (Cont'd)
Government Agency Engagement

Federal Department/Agency	Date of Meeting
Industry Canada	20-February-08
Major Project Management Office	23-February-09
Natural Resources Canada	28-February-07
	20-February-08
	05-March-09
Nuclear Waste Management Organization	16-April-08
	13-November-08
Privy Council Office	28-February-07
	20-February-08
Provincial Department/Organization	**Date of Meeting**
Central Lake Ontario Conservation Authority	08-February-08
	04-November-08
	07-May-09
Emergency Measures Ontario	01-March-07
Hydro One	10-March-08
	27-May-08
Independent Electricity System Operator	25-April-08
Ministry of Energy and Infrastructure	01-March-07
	08-February-08
Ministry of Transportation	09-May-08
	17-February-09
	17-March-09
	27-March-09
	07-April-09
Ontario Finance Authority	01-March-07
	08-February-08
Ontario Ministry of Health	01-March-07
Ontario Ministry of Natural Resources	05-March-09
Ministry of Culture	27-April-09
Ontario Power Authority	01-March-07
	08-February-08

10.2.2.2 Municipal Departments and Agencies Engagement

OPG met with the following municipal government agencies and departments, on the dates indicated (Table 10.2-3). Feedback and results from the discussions are in Section 10.3.1.

TABLE 10.2-3
Municipal Departments and Agencies Engagement

Municipality	Department	Date of Meeting
City of Oshawa	• City Manager's Office • Corporate Services • Finance Services • Corporate Services • Development Services • Emergency and Fire Services • Works	07-March-07
	• Community Services • City Manager's Office • Development Services Depart. • Office of the Auditor General	13-February-08
	• Planning Services	13-November-08
	• Development Services • Planning Services	28-May-09
Municipality of Clarington	• Building Services • Finance • Municipal Clerk's Office • Planning Services	06-March-07
	• Corporate Services • Emergency and Fire Services • Finance • Planning Services	07-February-08
	• Special Projects • Engineering Services • Infrastructure	22-April-09
Region of Durham	• Planning • Technical Support	08-March-07
	• Planning • Works	05-February-08
	• Planning	11-August-08
	• Environmental Services	31-March-09

10.2.2.2.1 Municipal Peer Review

The purpose of the municipal peer reviews is to ensure that the EA is undertaken according to current EA standards and practices and to ensure that the views and perspectives of the local municipality are addressed in the EIS. OPG has found that past peer reviews by municipalities have improved the quality of the EA.

The Municipality of Clarington is the host community and a key stakeholder. They are an important voice for the community residents and businesses. The Municipality of Clarington selected and retained Morrison Hershfield, a qualified consultant, to undertake an independent technical peer review of an early draft version of the NND Project EIS and related draft TSDs.

The Municipality of Clarington and OPG formed a Municipal Peer Review Management Team (MPRMT). Several meetings were held to discuss the review scope and schedule. Clarington provided a list of technical review comments to OPG in May 2009. OPG addressed each of the technical review comments, incorporated necessary changes in the EIS and TSDs and provided a table summarizing the disposition of the comments in writing to Clarington in early June 2009.

The City of Oshawa is a key stakeholder and an important voice for the community residents and businesses. The City retained a team of qualified consultants to undertake an independent technical peer review of an early draft version of the NND EIS and selected draft TSDs. At the time of writing, the review is not complete, however OPG has committed to working though any issued identified by the municipality.

10.2.2.3 Darlington Planning & Infrastructure Information Sharing Committee

In November 2007, OPG established the Darlington Planning and Infrastructure Information Sharing Committee (DPIISC). DPIISC is a working group comprised of representatives from the Ministry of Transportation (MTO), the Region of Durham, the Municipality of Clarington and OPG. The Committee is responsible for the mutual sharing of information and advice relating to planning, infrastructure and transportation matters, and their potential interrelationships, as they relate to lands in the former Township of Darlington in south Clarington. Particular focus for discussion is related to ongoing EAs for major Projects in the south Clarington area, including MTO's Highway 407 East EA Study, Durham Region's Energy from Waste EA, and the NND EA. DPIISC has met seven times from November 2007 until May 2009.

Areas of discussion have included the scope of work for the various EAs, including purpose of work, locations and methods of data collection, Project assumptions, Project timeframes, and any issues and/or risks associated with the work programs. These discussions have provided greater clarity in the environmental studies undertaken, potential Project interactions and cumulative effects of the different Projects. In June 2008, OPG held an intensive two-day workshop with EA specialists to share technical information related to studies undertaken for the EAs for Highway 407 East, Energy from Waste and the NND Project. On November 6, 2008, OPG held another workshop to discuss cumulative effects with the DPIISC members and GO Transit staff. The workshop is discussed in more detail in Sections 3.3 and 4.1 in the *Communication and Consultation TSD.*

10.2.3 Stakeholder Engagement

10.2.3.1 Elected Officials (MPs, MPPs and Municipal Councils)

Members of Parliament (MPs), Members of Provincial Parliament (MPPs) and members of municipal councils were notified of the Project commencement and were given study updates, Project newsletters and invitations to all of the EA consultation events. The *Communication and Consultation TSD* Table 3.2-1 identifies the dates information was provided to MPs, MPPs and municipal councillors throughout the Project.

In addition, OPG regularly briefed local and regional municipal governments to share information about the Project and the EA studies, explain the EA process and answer any questions elected officials may have. The presentations provide a public forum for elected officials to learn more about and discuss the Project and EA. Presentations were provided to the host Municipality of Clarington, the City of Oshawa, and the Regional Municipality of Durham. OPG also consulted with the City of Pickering, the Town of Ajax, the Town of Whitby, and the City of Toronto. These municipalities were engaged through the EA for Pickering B Refurbishment and Continued Operation and OPG sought to keep them informed on the NND EA. OPG also provided briefings to municipal councils when a Community Information Session was held in their communities (e.g. Town of Cobourg), and /or when a council requests to be updated (e.g. Municipality of Port Hope and City of Kawartha Lakes). OPG provided many presentations to municipal councils and committees during the Environmental Assessment process (Table 10.2.4).

TABLE 10.2-4
Presentations to Study Area Municipalities

Study Area	Municipality	Spring 2007	Fall 2007	Spring 2008	Fall 2008	Spring 2009
LSA	Municipality of Clarington Council	x	x	x	x	x
	City of Oshawa Council	x	x	x	x	x
	Regional Municipality of Durham Council		x	x	x	x
	Regional Municipality Finance Committee		x	x	x	x
RSA - North	City of Kawartha Lakes Council			x	x	x
	City of Peterborough Council					x
RSA - East	Town of Cobourg Council			x		x
	Town of Port Hope Council		x	x	x	x
RSA – West	Town of Ajax Council		x	x	x	x
	Town of Markham Council				x	x
	City of Pickering Council		x	x	x	x
	City of Toronto Mayor’s Office and East Toronto Councillors		x	x	x	x
	Town of Whitby Council		x	x	x	x

Following the presentations, attendees asked various questions about the Project and its potential effects on the environment. Overall, the councils welcomed the presentations and expressed interest in being kept informed as the Project progressed. All of the councils were interested in the nature of the public consultation program (e.g. what, where and how activities would be undertaken; attendance; questions asked, etc.). Almost all Councils expressed interest in the reactor technology and vendor selection process.

The host and adjacent municipalities (Municipality of Clarington, City of Oshawa) and Regional Municipality of Durham were particularly interested in:

- The reactor technologies under consideration;
- The number and size of the reactors that may be constructed;
- The operating experience of the non-CANDU technologies;
- The details of the EA studies;
- Employment opportunities that may arise; and
- Condenser cooling options and visual impact of the cooling towers.

Municipal governments further from the site asked a broader set of questions, inquiring about the nature of the electricity system in Ontario, how used fuel is managed and financial considerations.

In addition, OPG offered to meet with Municipal leaders, MPs and MPPs to update them on the project and EA. The Mayor of Oshawa, Whitby-Oshawa MPP and Durham MP and staff met with OPG to discuss the Project and EA.

10.2.3.2 Established Community Committees

Three community committees were identified for ongoing communication and consultation throughout the EA: the Durham Nuclear Health Committee (DNHC); the Darlington Site Planning Committee; and the Community Advisory Council (CAC). Throughout the EA study, OPG informed these community committees of the progress of the studies, and sought their advice, guidance and input. OPG had 12 meetings with the DNHC, eight meetings with the DSPC and five meetings with the CAC.

Overall, established community committees are knowledgeable about nuclear operations and expressed interest in learning more details about the Project and in being kept informed as the EA progressed.

The committees were interested in the responsibilities of OPG, Ontario Power Authority (OPA), CNSC and who was involved in the vendor selection process. Overall members asked for more details about the public consultation process, reactor technologies, vendor selection decision making responsibilities, reactor and EA process.

The DNHC was interested in the vendor and reactor technology selection, the differences between the technologies, who makes the decisions and when they were being made. They were also interested in the requirements and responsibilities of the regulatory approvals process and the joint review process. Throughout the meetings, members expressed interest in the effects of the Project on human health, lake infill, safety and security and a couple of members asked how uranium enrichment was considered. Some meetings, members expressed interest in the exclusion zones, how condenser cooling options and waste management were considered. In addition, members were interested in the relationship of the EA and OPG business plans.

The DSPC was particularly interested in discussions that pertained to the site, such as effects on the site recreational facilities, where the public can get information on employment; the effect of additional staff on road transportation and how it was being managed; affect of Project on human health, safety and security; how climate change would affect the Project; as well as, what effects of the Project on atmosphere and how other projects would be affected. They were also interested in the how OPG was consulting with the public and recognized of OPG efforts in consultation with community. Members were interested in the vendor and reactor technology selection, the differences between the technologies, who makes the decisions and when they were being made. Questions on the management and used fuel and the differences of condenser cooling were asked by members. A few members indicated that they would prefer not to have cooling towers and expressed concern about the towers. In addition, members asked questions to better understand the federal approvals process and roles and responsibilities.

The CAC was particularly interested in the vendor and reactor technology selection, the differences between the technologies, who makes the decisions and when they were being made. Members asked questions about the public consultation program and public comments received by OPG. They were equally interested in OPG studies on safety and security, the effect of the Energy from Waste project and St. Mary Cement, where employees would be coming from, and the cost of the Project and EA.

10.2.3.3 Key Stakeholder Engagement

OPG staff executed a Key Stakeholder Engagement Program to inform, and solicit feedback from, a variety of stakeholder groups identified as having a potential interest or responsibility in the Project. The objective of the sessions was to facilitate dialogue and information exchange at key points during the EA Study namely: prior to OPG's submission of the Project Description; during OPG's assessment of multiple reactor technologies and site layout options; and while OPG continued to refine its work on Valued Ecosystem Components, potential environmental effects and mitigation measures. OPG has completed two rounds of briefing sessions and is planning a third round. Of those sessions completed to date, each ran approximately two hours in duration. Participants were provided project-related information materials at all sessions.

Key Stakeholder Engagement Round One: Pre-Submission Engagement on the NND Project Description

In February and March 2007, OPG undertook its first round of Key Stakeholder Engagement on the Project Description for NND prior to its submission to the CNSC in April 2007. Pre-submission engagement focused on obtaining feedback on this document as it was a CNSC requirement enabling federal authorities to evaluate the scope of the Project by including an overview of major works and activities required and potential project-environment interactions. Participants were requested to provide feedback on these items as well as alternative means to the Project (i.e. nuclear waste management, condenser cooling and reactor technologies).

Approximately 70 stakeholders were invited, representing a range of organizations and authorities with different expertise and areas of interests. These groups included authorities at the federal, provincial and municipal level, labour organizations, business groups, educational institutions, and non-government organizations.

Key Stakeholder Engagement Round Two: Plant Parameter Envelope Approach, Site Option Studies and Site Preparation License Activities

From February to April 2008, OPG undertook its second round of Key Stakeholder Engagement on the Plant Parameter Envelope Approach (i.e. approach used to consider multiple reactor technologies), Site Option Studies, and proposed work activities considered within the scope of OPG's Site Preparation License Application. These topics pertained to work representing key components to the EA study and methodology. The briefings also included discussion on other aspects of EA work that had progressed since the initial round of briefings in 2007. These included: project scope (e.g. temporal and spatial boundaries); status of baseline environmental studies; and the work required to support different stages of the federal approvals process.

As with the first round of Key Stakeholder Engagement, OPG invited a range of stakeholder groups to participate. The number of invitees for the second round grew to approximately 110; this increase reflects the growing number of organizations and authorities identified as having a potential interest in, or responsibility for, in the Project.

Stakeholders provided a variety of feedback from the first and second rounds. This feedback is discussed in Section 10.3.1. Please see the *Aboriginal Interests TSD* for feedback received from Aboriginal groups and Métis organizations.

10.2.3.4 Neighbouring Residents

Four EA newsletters were developed to update local residents of Municipality of Clarington and City of Oshawa of the Project and EA. The newsletter was distributed to over 95,000 Municipality of Clarington and City of Oshawa residents and businesses. Newsletters were issued October 2007, March 2008, September 2008 and March 2009. Newsletters provided an update on the NND Project including articles on:

- Federal and licensing approvals process:
  - Draft and final EIS Guidelines;
  - Definition of review panel and draft terms of reference for panel;
- EA:
  - Process and updates;
  - EA schedule and bounding timelines;
  - Public consultation program;
  - Studies:
    - Transportation;
    - Heritage resource;
    - Socio-economic;
    - Cumulative effects;
  - Alternatives considered:
    - Nuclear waste and used fuel (topic included at request from the public);
    - Condenser cooling systems;
    - Approach to determine significance;
- Project:
- Site layout options:
    - Soil management and lake infill;
    - Recycling or reusing waste heat (in response to public interest).

In addition, invitations to upcoming public consultation programs, such as the Community Information Sessions and updates on the provincial reactor and vendor selection process were included.

In September 2008, the newsletter featured the new look of the Project and Project name "OPG New Nuclear at Darlington". Copies of the EA newsletters are included as Appendix 3H in the *Communications and Consultation TSD*.

Specifically for this EA, local residents were informed of the EA and Project through EA Newsletters, participation in the Darlington Site Planning Committee, Kitchen Table Meetings, presentations and survey. Approximately 45 of the closest site neighbours were surveyed (by phone and/or mail back survey) and Kitchen Table Meetings were held with 18 neighbours who reside within three km of the Project site. In addition, presentations were made to local residents and community organizations.

10.2.3.5 Business and Industry Organizations

Many business groups and organizations expressed an interest in learning more about the Project. OPG participated in trade shows with booths to provide information and provided presentations to these groups and organizations. Table 10.2-5 lists the presentations and events attended.

TABLE 10.2-5
Business and Industry Organizations

Organization/Group	Meeting Date
Canadian Manufacturers and Exporters	20-February-08
Canadian Nuclear Association	01-March-07
	29 February-08
	25-27-February-09
Bowmanville Rotary Club	17-February-09
Clarington Board of Trade	13-September-07
	18-October-07
	29-July-08
	30-September-08
Ontario Chamber of Commerce	02-May-08
Port Hope Chamber of Commerce	20-November-08
Whitby Rotary Club	30-January-07

Overall the local business groups and other organizations who attended these presentations and events showed great interest in reactor technologies and vendor selection. Many participants were specifically interested in the vendor decision process and the timelines that are associated with the process. People also expressed their views and asked questions on the EA studies particularly on employment, public consultation, EA process and methodology, safety and security and cumulative effects

10.2.3.6 Project Update Letters

In addition to notification letters that announced the start of the EA and Project, update letters were distributed to federal, provincial and municipal government agencies, community councils, Aboriginal Peoples, public libraries, business groups, non-governmental organizations, and other identified stakeholders at key stages in the EA, prior to Community Information Sessions. The notification list expanded as the Project progressed and more key stakeholders became aware of the Project and OPG identified more government agencies and departments to include in public consultation activities. A copy of the key stakeholder distribution list is in Appendix 3D and a copies of the update letters is in Appendix 3I in the *Communication and Consultation TSD*. Correspondence with Aboriginal communities, organizations and councils is in the Aboriginal Interests TSD

Letters included updates on the Project, EA and public consultation activities. An offer to discuss the EA and invitations to upcoming Community Information Sessions were included. Additional topics covered in the notification letters are listed in Table 10-2.6.

TABLE 10.2-6
Notification Letter Key Topics

Date	Distribution (approx.)	Key Topics
00-November-06	150	• Announcing the commencement of the site preparation licensing activities
22-October-07	230	• update on EA studies and consultation activities
04-April-08	400	• a brief listing of the EA baseline studies being conducted • consideration of Project alternatives • announcement of OPG's New Knowledge Funding Program
15-September-08	500	• brief description of the work activities through Project phases • announcement by the Province confirming OPG as the operator and Darlington Nuclear site as the location for two nuclear reactors
18-March-09	540	• brief description of Project activities • update on the vendor selection process • description of the Federal Approval process
14-July-09	560	• announcement by the Province suspending request for proposals for vendor and technology • confirmation of OPG's commitment to submit EIS and LTPS

10.2.3.7 Workshops

Cumulative Effects

OPG sponsored two workshops with a focus on cumulative effects. In June 2008, OPG held an intensive two-day workshop for EA specialists to share technical information related to studies undertaken for the EAs for Highway 407 East Extension, Energy from Waste and the NND Project. At that time it was recognized that these projects, all of which are located in proximity to the DN site, had the potential to have environmental effects in the same spatial and/or temporal bounds. The initial work shop was an exercise in understanding the methodology and approach each group was taking in their environmental assessments. The purpose of the session was to understand the major project assumptions, and range and status of studies for each.

OPG then held a cumulative effects workshop on November 6, 2008 with proponents of planned and future projects within a few kilometres of the DN site. This included the following projects:

- Highway 407 East Extension;
- York/Durham Residual Waste Study/Energy from Waste Proposal;
- GO Transit Service Expansion Project; and
- New Nuclear Darlington.

The Municipality of Clarington was included in the workshop. The purpose of the workshop was to understand the assumptions and potential residual environmental effects from the various projects, and to determine whether any cumulative effects may exist. The focus was on atmospheric, traffic and transportation, land use and visual, as well as, socio-economic comments. The workshop participants shared information on the timing, works and activities for each project and what environmental effect may overlap in time and space. Participants completed a matrix of potential effects. The information was used to determine what projects are likely to have a cumulative effect, and if so, the nature of it. Results of the workshop are discussed in Section 10.3.2.

Human Health

On April 30, 2009, OPG hosted a workshop for the DNHC on the assessment of human health effects for the NND Project.

The objective of the workshop was three-fold:

- Solicit feedback and advice on aspects of human health as assessed by OPG;
- Review OPG's proposed approach to assessing human health effects; and
- Provide an opportunity for DNHC members to comment on whether OPG's approach to human health assessment is adequately comprehensive.

OPG staff began the workshop by presenting an overview of the EIS Guidelines as they pertain to human health, radiation and radioactivity, and malfunctions and accidents. The presentation also included a review of Project roles and responsibilities, major milestones, Project assumptions and the nature of questions posed by members of the public to date.

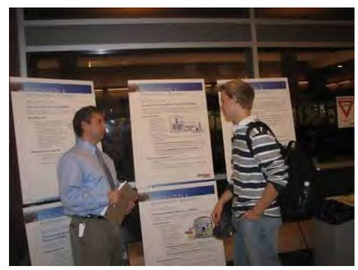
Following the overview, OPG then reviewed work undertaken to meet the EIS Guidelines in the areas of human health, radiation and radioactivity, malfunctions and accidents, and follow up programs. Also discussed was OPG's proposed approach to human health effects assessment in consideration for physical, mental and social well being. Members of the DNHC were led through different work programs which provided details regarding the VECs, potential interactions and preliminary findings for each.

The DNHC provided feedback in three major areas:

- OPG's framework for human health assessment;
- Conventional accidents; and
- Radiation and radioactivity.

See Section 4.1.7 for details regarding feedback provided at this workshop.

10.2.4 Community Information Sessions



Five rounds of Community Information Sessions (CISs) were undertaken for the EA. All rounds of Community Information Session have been held in the Municipality of Clarington and the City of Oshawa (highlighted in Table 10.2-7). Subsequent rounds included locations in the RSA. OPG also accommodated requests from community stakeholders to host sessions in their community (Port Hope, Cobourg, City of Toronto, Ajax, Markham and Peterborough). Table 10.2-7 lists the communities where CISs were held.

TABLE 10.2-7
Community Information Sessions

Study Area	Community	Round 1 Fall 2006	Round 2 Fall 2007	Round 3 Spring 2008	Round 4 Fall 2008	Round 5 Spring 2009
LSA	Bowmanville	x	x	x	x	x
	Courtice	x	x	x	x	x
	Newcastle	x	x	x	x	x
	Orono	x	x	x	x	x
	Oshawa	x	x	x	x	x
RSA - North	Kawartha Lakes				x	
	Peterborough			x		x
	Port Perry		x			
RSA - East	Cobourg			x		x
	Port Hope		x		x	
RSA –West	Ajax				x	
	Markham					x
	Pickering		x			
	Toronto			x		
	Whitby					x

The CISs were held to provide opportunities for local residents, officials, stakeholders and the public to obtain information about the NND Project, learn about the EA and License to Prepare Site application, as well as, provide input and feedback to the EA study. In addition, specific objectives for each CIS round are in Table 10.2-8.

TABLE 10.2-8
Community Information Sessions Objectives

Date	Objectives
Fall 2006	• Introduce the Project, approvals process and EA requirements • Obtain public input on proposed activities
Fall 2007	• Introduce the Ecosystem Components • Obtain public input on Project, the EA and environmental components
Spring 2008	• Identify preliminary VECs • Obtain public input on preliminary list of VECs and environmental baseline studies
Fall 2008	• Provide VECs, potential environmental effects and potential mitigation • Obtain public input on potential mitigation measures, projects to be considered in a cumulative effects assessment and criteria to be used in significance assessment
Spring 2009	• Provide preliminary results, in particular, significance of environmental effects • Obtain input on preliminary results, approach to determination of significance and approach to sustainability

Typically the CISs were held from late afternoon to 9 p.m. with a presentation at 7 p.m. All rounds of CISs were advertised with invitation letters sent to the mailing list, and invitation cards and Project newsletters sent to almost 95,000 homes and businesses. The CISs were also advertised in community newspapers. Invitations were mailed to local elected officials, interested agencies and key stakeholders. A personal invitation to the second, third, fourth and fifth rounds of CISs was mailed to all previous CIS visitors who requested to be added to the mailing list.

Each CIS consisted of a sign-in registration table, panel boards describing the NND Project and the EA process; a power point presentation given by OPG staff describing the Project; information/handouts including copies of the panels, the Project newsletter; fact sheets, invitation card; and questionnaire/comment forms. OPG provided aerial photos of the site and maps of the area at each session. Panels and information materials of the Project and EA were developed using non technical and plain language. CIS information was posted on the website (discussed in section 3.6.8 of the *Communications and Consultation TSD*) the first day of the sessions and the presentation within the first week.

OPG staff notes taken at the CISs together with the comment forms from each Information Session were used to identify public issues, concerns and questions that needed to be addressed. Participants were encouraged to fill in comment forms or to take them home and mail completed forms to OPG. In addition, comment forms were available on the website to be completed and mailed to OPG.

A report of each round of CISs was prepared, including notifications, and information shared at the sessions and a summary of the input from questionnaire and comment forms. A copy of each report is included in Appendices 3F, 3G, 3J, 3K and 3L of the *Communications and Consultation TSD*. Written responses were provided to any outstanding questions or concerns raised at the CIS or on the comment forms.

10.2.4.1 Community Information Sessions Discussions

More than 1000 local residents, officials, stakeholders and public participated in the five rounds of CISs. Participants were consistently interested in:

- Condenser Cooling Options – Participants wanted to know about the effects and how the options are assessed, whether cooling systems are specific to particular reactor designs, how to utilize waste heat;
- Vendor and Technology Selection – Participants were interested in the difference between designs, preference for a particular technology, use of enriched fuel and how OPG was assessing different reactor designs in EA;
- EA Studies – Participants wanted to know more about the EA studies and what role EA plays in the Project;
- EA Process and Decision Making – Participants sought to gain a better understanding of the type of planning and decision-making required and inquired about the different roles and responsibilities of those involved in the study;
- Management of nuclear waste and used fuel – Participants expressed an interest in discussing how nuclear waste is to be managed and the future location of storage facilities, ensuring safe management of used fuel and nuclear waste. Participants also wanted to know what future plans exist for the management and long term storage of used fuel, the fuel types for the different reactors and the possibility of reusing or recycling the fuel.; and
- Public Consultation – Participants wanted to know what opportunities for involvement and how they can influence decision- making processes.

Participants were also interested in:

- Ontario's Electricity System – Participants were interested in further information on the role nuclear will play in Ontario's overall energy plan, specifically the role it will play to meet

- Base load and if there is competition between OPG and Bruce Power. Participants were also interested in Ontario's investment of alternative energy sources such as wind turbines and farms and current status of PNGS B. Participants were interested in the gaps in future supply, need for nuclear energy and how the new plant would fill the gap;
- EA timelines – Participants were interested in the length of time required to complete all the approvals. Participants were interested in the start date for the Project, whether the Project was on schedule and the how the coordination amongst the various levels of government would affect the timeline;
- Site considerations – Participants were interested in the reasons for DN site, considerations for land availability and type of infrastructure required for Project;
- EA scope – There were suggestions that the uranium fuel cycle, particularly the front end of uranium mining should be included in the EA scope; and
- Financial considerations of the Project and EA – Participants were interested in the cost associated with the Project. Concern about cost overruns and wanted to understand measures the OPG would take to ensure the budget is managed effectively.

Additional specific topics discussed in the rounds are:

- First round of CISs - There was interest in the matters that were considered in selecting the DN site;
- Second round of CISs - Participants wanted to know more about the physical environment, the human and social environment, and what role the EA plays in the Project as a whole. Participants expressed a general interest in potential health effects associated with nuclear generation and asked questions regarding how potential health effects will be assessed. Some participants also wanted to discuss how OPG manages tritium emissions and management strategies to be used for the Project. There was an interest among some participants to gain a greater understanding of how a nuclear generating station produces electricity. Some participants requested a more detailed explanation of how OPG ensures that its operations are conducted safely and what procedures the public should follow in the unlikely event of a nuclear emergency;
- Third round of CISs - Participants raised questions in almost all of the areas of study underway for the EA. There was an interest in understanding whether and how these items will be examined as part of the EA, and how they may be potentially affected by the Project, should it proceed. Questions pertaining to human health were raised most frequently. Participants also wanted to understand how the EA measures the significance of potential environmental effects. Interest was also expressed in identifying future opportunities to provide input to OPG's assessment of Valued Ecosystem Components. Some participants wanted to understand who is involved in conducting the various environmental studies for this EA and whether there is bias to the work. Questions were raised among participants

who wished to clarify where OPG is in the licensing process for the project. Interest was also expressed in understanding the difference between the regulatory requirements OPG is subject to and those practiced in the United States;

- Fourth round of CISs – There was interest among many participants regarding the amount of soil that may need to be excavated and whether it could be subsequently used for other purposes. Participants were interested in the effects on lake water quality from potential erosion. A recurring area of discussion included the potential socio-economic effects, including effects on property values, economic benefits that may arise, impacts to local community services (e.g. fire) and hiring and training. A number of participants were interested in understanding the potential effects on lake water quality, particularly the effects of once through lake water cooling and the thermal discharge; and
- Fifth round of CISs – The results of the EA studies (particularly regarding malfunctions and accidents/emergency response, human health and recreational use of the Darlington site). Participants were also interested in understanding the potential effects of condenser cooling alternatives, the distinctions between the different reactor technologies, and EA process and methodology. Ontario's electricity system, nuclear waste and used fuel management, and financial considerations were also areas of interest. In the fifth round, Safe and Green Energy (SAGE) contacted OPG and indicated that they would be attending the CISs. OPG offered a table for SAGE materials and provided an opportunity for SAGE to present their point of view at each CIS. A primary concern raised was that the EA does not include the life cycle matters of uranium mining and milling.

More information about each session is in the *Communication and Consultation TSD*.

10.2.5 Public Communications

Communication materials were developed to help explain the Project, the EA process and technology alternatives. These materials were used as handouts to the public at community information sessions, events, and at OPG's Community Kiosk at the Bowmanville Mall.

After submitting an Application for a Licence to Prepare Site, a four page brochure introducing the Project was produced which included a description of the five licensing steps, why Darlington was selected, why an EA is being conducted and a commitment to keep the public informed and seek their views at key stages was made. One thousand copies of The First Step brochure were distributed at community events and information sessions throughout 2006 and 2007. A copy of The First Step brochure is provided in Appendix 3M in the *Communications and Consultation TSD.*

To provide a handout for the public to access more information, a website card was developed. The card has a close up aerial photo of the DNGS and the website address for the Project on one side and on the other side a photo of PNGS and the website address for the PNGS B Refurbishment Project. More than 2,000 cards were distributed throughout 2006 to 2008 at community events and information sessions. A copy of the website card is provided in Appendix 3N in the *Communications and Consultation TSD*.

To help the public understand technical aspects and provide more details of the EA and Project, fact sheets were developed. Two thousand copies of each Fact Sheet were distributed at information sessions and events, referenced at local libraries and were posted on the Project website. Fact sheets were developed providing information on the Project, federal EA process, environmental effects, reactor technologies, alternatives to the Project (condenser cooling, used fuel management, low and intermediate waste management), human health, site layout, and malfunctions, accidents and malevolent acts. Copies of the final Fact Sheets are provided in Appendix 3O in the *Communications and Consultation TSD*.

10.2.6 Public Libraries

In November 2007, OPG requested local public libraries to start a reference file for the EA and updates were sent in September 2008 and April 2009. OPG subsequently followed up with the libraries to ensure that a reference file on the Project was in the library. Whitby Public Library, Scugog Memorial Public Library, Oshawa Public Library, Clarington Public Library and Pickering had reference files on the Project. Libraries who had Project reference files were listed on the OPG's Project web site.

10.2.7 Community Events

OPG recognizes that not all publics have had the time or are available to attend scheduled CISs and looked at ways to meet the community. Local community events (such as fall fairs, home and garden shows, shopping mall) are popular places for residents to learn more about their community and provided the opportunity for OPG to meet the public and have face to face discussions on the Project. OPG staff attended a number of community events at which OPG provided copies of the current CIS panels, CIS reports, FAQs, Project Description and invitation cards for upcoming CISs. Through OPG's participation in these types of community events OPG has engaged over 6,500 people directly in discussions about the Project. Table 10.2-9 lists the events attended, the dates and visitors.

TABLE 10.2-9
Community Events Venue, Dates and Number of Visitors

Community	Venue	Date	# of Visitors
Ajax	Family Festival and Trade Fair	09-September-06	200
Whitby	Durham Region Economic Prosperity Conference	11-October-06	75
Pickering	Pickering Town Centre Display	19-22-October-06	150
Pickering	Pickering Ajax Uxbridge, Energy Forum	24-February-07	150
Pickering	Metro East Home & Garden Show	02-04-March-07	180
Pickering	Pickering Town Centre Display	08-11-March-07	330
Ajax	Ajax Public Library	31-March-07	18
Scarborough	Scarborough Town Centre	14-15-March-07	230
Whitby	Home & Garden Show	20-22-April-07	54
Oshawa	Spring and Garden Show	16-18-March-07	210
Bowmanville	Home Show	20 – 22-April-07	183
Bowmanville	Canada Day	01- July-07	200
Uxbridge	Fall Fair	07-08-September-07	100
Ajax	Family Festival	08-September-07	141
Orono	Durham Central Fair	09-September-07	152
Port Hope	Fall Fair	15-September-07	142
Whitby	Heritage Festival	15-September-07	323
Peterborough	Peterborough Public Library	22-September-07	22
Bowmanville	Clarington Family Safety Day	29-September-07	100
Scarborough	Scarborough Town Centre	11-12-October-07	46
Oshawa	Home and Décor Show	19-21-October-07	152
Cobourg	Cobourg Library	27-October-07	21
Oshawa	Home & Garden Show	07-09-March-08	156
Pickering	Metro East Spring Home & Garden Show	28-30-March-08	411
Bowmanville	Kinsmen Sports & Leisure Home Show	18-20-April-08	214
Whitby	Durham Home Show	25-27-April-08	393
Lindsay	Lindsay Public Library	24-May-08	5
Toronto	Waterpark Festival	21- June -08	400
Whitby	Whitby Town Carnival	28- June -08	432
Bowmanville	Canada Day	01- July -08	250
Peterborough	Peterborough Exhibition	2-3 - August - 08	63
Fenelon Falls	Fenelon Falls Fair	9-10 - August - 08	14
Oshawa	Jazz and Blues Festival	09- August - 08	30
Whitby	Heritage Day	20- September -08	278
Markham	Pedestrian Day	05 - October - 08	36
Markham	Markham Spring Home Show	06-08-March-09	265
Pickering	2009 Spring Metro East Home & Garden Show	27-29-March-09	450
	Total	39	6576

Overall, people who attended these displays showed great interest in learning about the Project and obtaining literature. Many visitors wished to engage in discussion about the nature of the works and activities associated with the Project. All comments or questions were answered by OPG staff at events, and most were recorded. The most frequently discussed areas were:

- Employment opportunities the Project may bring;
- Current station operations;
- Support for nuclear power;
- Ontario's electricity system;
- Public consultation and OPG's efforts to engage the public;
- Project timing;
- Emergency planning; and
- Long term plans for used nuclear fuel.

In addition people expressed interest in the reactor technologies, including the decision making process, reactor design consideration, how the ACR-1000 compared with other reactors and timelines. A few visitors indicated that alternative and renewable energy sources should be further pursued. Others noted that OPG makes a positive contribution to the economy, are excellent corporate citizens, and that the energy sector is an important contributor to the region.

10.2.8 Community Kiosk

OPG recognizes that not all publics have had the time or are available to attend scheduled CISs or local community events. OPG looked at additional ways for the community to learn more about the Project and EA on their time. OPG opened a publicly accessible, Project resource centre located in the Bowmanville Mall in Bowmanville, Ontario. The purpose of this leased facility (referred to as OPG's "Community Kiosk") was to provide local residents of the host community a place where they could access Project information, obtain literature on the EA, and have their questions answered by OPG staff. The Community Kiosk commenced operation on May 13, 2008. From May 2008 to May 2009, OPG staff met with over 1,800 community members at this facility.

OPG recorded all comments and questions raised by visitors. Thirty percent of the comments were related to employment at OPG, specifically where and how to apply for a job, the types of jobs that were currently available, and the skill sets required. Approximately 5% of the inquiries were from OPG employees (current and past) interested in viewing the kiosk and learning about the Project, and another 5% were inquiries about the existing operations at the DNGS and DNGSs.

The majority of the comments were on the Project and the EA (see *Communication and Consultation TSD* for a full list of comments):

- Visitors appreciated the opportunity to visit the community kiosk, acknowledged its importance to the community and were interested in the other public consultation activities for the NND Project (13%);
- Visitors were interested in the full breadth of environmental components under study, with a specific interest in the economic benefits the Project might bring to the local area, and potential adverse effects on recreation, property values and local traffic (11%);
- Visitors were interested in when construction would commence, the time it would take to build the new plant, and when the reactors would be operational (9%);
- Visitors were interested in Project and site considerations, seeking to know how many units would be constructed, the site layout (where on the site the reactors would physically go) and how materials would be brought to the site (9%);
- Reactor technology, vendor and site selection considerations were also of interest, particularly how decisions would be made and whether it would be CANDU (7%);
- A few offered their comments in support of the Project (3%); and
- Some offered views on the use of nuclear power (2%) and alternative energy forms (2%).

10.2.9 Information Line

A toll free information telephone line (1-866-487-6006) was established to provide an opportunity for individuals in the community and other stakeholders to contact the EA study team to obtain information, ask questions and voice their comments or concerns. All telephone calls are returned and questions responded to by the OPG staff and recorded in the EA Stakeholder Comment Database (SCD) which is discussed in Section 10.3.2. The toll-free information line became operational in September 2006 and was advertised on all invitation cards, newsletters, print advertising and at all community information sessions. Seventy-three (73) phone calls have been received (September 2006 to May 15, 2009). Most callers were interested in clarification about the upcoming CISs and other OPG related subjects such as employment opportunities. Others sought information about the Project or provided comments on materials received in the mail.

10.2.10 Project Website and Internet Consultations

A Project website (www.opg.com/newbuild) was established in September 2006 and linked to the OPG website. The Project website was established to provide information to the public and interested persons and to receive input from interested persons as an enhancement of the public consultation program. This website continues to provide stakeholders and interested members of the public with information about the Project. The website consists of an overview of the federal approvals process and status of the Project, a description of the EA process and Project, a listing of Frequently Asked Questions, ways for the public to get involved and contact the Project, a repository of information and reports on the Project and EA. Also on the website was a page for the public to contact the Project.

The material on the website is updated on a regular basis to remain current and reflect the progress of the EA and Project. The website was advertised in all issues of the Project newsletter, invitation cards, fact sheets and letters as well as at the CISs ads. In addition, a special card was created with the website address to distribute at public consultation activities. From September 2006 to May 15, 2009 the Project website has had more than 40,000 visitors with an average of about 1,500 visitors per month to www.opg.com/newbuild.

An e-mail address (newbuild@opg.com) was created to provide the public with a way to contact the EA study team electronically with any questions, comments or requests for information regarding the EA. Since its inception, 112 emails were received asking questions about the Project, requesting more information and inquiring about employment opportunities. All emails were replied to by OPG staff. Requests were recorded and tracked in the SCD and appropriate action was taken for all requests.

10.2.11 Public Inquiry and Response

Documentation, tracking and follow-up of stakeholder contacts, comments and questions are an important aspect of the consultation program for the EA. The SCD was developed and maintained throughout the Project to keep track of all stakeholder comments and issues that arose, as well as the responses provided.

Three hundred and forty-one (341) emails, letters, comment sheets and telephone calls were registered between September 2006 and May 15, 2009. The 341 inquiries included emails and toll free calls discussed in the previous sections. Stakeholder contacts and comments received were documented on a Stakeholder Comment form. The form included the name of the person and organization, where applicable, a contact telephone number and address, a description of the comment or discussion and any response or action taken or required. This information was then added to the SCD. Responses were provided to all comments received, as required.

Appropriate action and responses were provided to all comments received. Comments and questions were carefully reviewed to identify any issues that required consideration in the EA report. These issues were reviewed and referred to the EA discipline or area of concern to which they applied, such as air quality, surface water, nuclear waste, human health, etc.

10.2.12 Media Analysis

The news media may reflect and influence public opinion, and as such it is helpful to know how much media coverage there has been about the Project; which mediums have been involved; and what issues have been covered. Further it is helpful to know what views and perspectives have been expressed in relation to the Project.

As might be expected, there has been considerable media attention around the prospect of new nuclear facilities being built in Ontario. The majority of media attention specifically about Darlington has been experienced at key milestones such as the announcement that OPG had submitted a site preparation licence application (September 2006); and a project description (April 2007). The provincial vendor selection process attracted much attention (October 2007) as did a series of provincial decisions in June 2008 (the site for the new reactors; the operator of the new reactors; the short list of vendors entering the next phase of procurement). From September 2006 to May 15, 2009 there were about 280 published articles.

The media coverage has been centered in the Greater Toronto Area as the major dailies and broadcasters located in Toronto all have covered this issue. Media in Regional Municipality of Durham have also followed the progress of the new build project while media in locations such as Kitchener-Waterloo or Peterborough have covered the new build project potentially because of the prospects for local employment.

Media coverage to date has, with some exceptions, been balanced and factual, with the media attempting to provide all sides of the matter. Media coverage has not focused on any one issue in particular, but the political debates over the need for a new nuclear facility have been a common theme. A subtext of this coverage has been the potential cost of a new facility. It should be noted that this is most often in the context of any nuclear project, the type of technology that might be selected and not specifically Darlington as a site.

In terms of the project itself, the media have discussed how new nuclear facilities will assure a cleaner energy supply, as well as increase reliability once Ontario's fossil fuelled stations cease burning coal in 2014. There has also been a focus on local employment, especially in the Durham Region area.

A few (approximately 10) letters to the editor raised concerns about the cost, nuclear waste, safety and whether conservation and renewable energy would be a better way to meet future energy needs. There were an equal number of articles (10) that were supportive of the Project. The rest were neutral, or reporting on straight factual issues.

Following the announcement in June 2008 that Darlington had been selected as the site of a new nuclear site, the Toronto Star, Toronto Sun (also in Osprey Media papers in North Bay and Kingston) and Metroland Newspapers all ran editorials applauding the decision. Only one paper, The Orangeville Banner, posted an editorial in support of nuclear power, and stated that Bruce Power would have been a better choice.

In the spring of 2009, the media coverage centred on a few major themes:

- The process, and timing, for selecting a vendor, with a side issue being the impact the decision will have on the future of AECL; and
- The need for building new facilities when demand for power has declined because of the economic downturn.

OPG has briefed a number of journalists on the EA and has held media tours at the Darlington station and site of the new build. A summary of headlines is listed in Appendix 3C in the *Communications and Consultation TSD*.

10.2.13 OPG Employee Communications & Engagement

OPG provided opportunities for employees to learn about and discuss the EA and the NND Project through a number of forums, including:

- Employee Lunch and Learn sessions were held on a monthly basis on topics related to NND – lunch and learn sessions include a 30 minute presentation on a current topic or area of study, followed by a 30 minute Q&A session. About 250 employees attended the Employee Lunch and Learn sessions. Discussions largely focused on the technical aspects of the Project with participants seeking more specific information or clarification on the Project, EA process and methodology and vendor selection process. Participants were interested in particular on technology not in practice at OPG (cooling towers, reactor differences). Discussions on Cooling Towers in a couple sessions focused on the difference, effects and comparison of construction and operating costs. A few participants wanted to learn more about how Bruce A is conducting their EA process and if there is any lessons learned from Bruce's refurbishment and expansion plans; and
- Employee Information Sessions were held at various locations throughout OPG including the DN site in Clarington, the PN site and 777/889 Brock Road (for employees working on new nuclear generation projects) in Pickering and OPG Head Office. Over

1,000 employees attended the sessions and expressed interest in learning more about the Project and EA. Employees expressed support for the Project. Employees were particularly interested in:

  - Timelines to bring the new station into service, particularly the time to complete approvals. Some employees indicated that the approvals process takes too long and a few employees indicated that the timeline for site prep and construction was tight;
  - Technology considerations for the reactors and cooling options. Some employees indicated a preference for the CANDU technology citing advantages of on-line fuelling, buying Canadian and the CANDU performance track record. Many employees wanted to learn more about the differences in reactors. Some employees expressed a preference for lake water cooling instead of cooling towers;
  - Site layouts and clarification of what facilities may be located and where on site. Employees expressed the need for additional parking and road access on the existing site. Employees were also interested to learn whether and how the layout for the new facilities would impact existing operations and how the different cooling options impacted layouts;
  - Vendor selection process. Employees wanted to learn more about who makes the decision on the technology, the roles and responsibilities of OPG and Infrastructure Ontario, and the timing of decisions;
  - EA studies being conducted and by who. Employees were also interested in the employment opportunities and many employees expressed interest in working at the new station. Employees expressed a concern about transportation of employees and materials on and off site; and
  - Public opinion about nuclear and the position of the host municipality.

- Employee Articles: OPG has a number of employee newspapers, electronic and hard copy, corporate and site specific. Between September 2006 and May 15, 2009, 33 Project related articles were published in a variety of these publications; and
- Project Website: An internal intranet site dedicated to the Project was established in August 2007, as a mechanism for employees to quickly determine the status of the work and update themselves about the project. From August 2007 to May 2009 there were approximately 3,300 visitors to the site.

10.3 Public and Stakeholder Feedback, Questions and Issues

A comprehensive stakeholder comment and issue management program was initiated as part in the Communications and Consultation Program, including the development of a Stakeholder

Comment Database (SCD) and an Issue Database. This section describes the nature of the input and feedback received and how OPG responded to that input.

10.3.1 Public and Stakeholder Feedback and Input

OPG sought to ensure that the EA study approach was grounded in the perspectives, views and values of the community within which the Project would be operating. Throughout the EA, OPG sought community confirmation of the work undertaken to date, and community direction for the next steps in the EA. Specifically, OPG sought input on the:

- Project Description;
- Use of plant parameter envelopes;
- Valued Ecosystem Components (VECs);
- Potential effects and possible mitigations;
- Significance criteria;
- Projects to considered for the cumulative effects assessment; and
- Sustainability.

10.3.1.1 Pre-Submission Consultation on the Project Description

Prior to submission of the Project Description in the spring of 2007, OPG sought the views of approximately 70 key stakeholders on the proposed nature of the Project and related works and activities, including the approach to consideration of alternative means, and preliminary identification of potential Project-environment interactions. Participants expressed interest and sought clarification in:

- Project works and activities;
- EA requirements, scope and process;
- Public consultation and communications;
- Community participation in assessment of significance;
- Environmental considerations (e.g. white fish spawning beds, maintaining a green corridor through the DN site);
- Considerations for the management of waste and transportation;
- Residential development;
- Condenser cooling alternatives;
- Wharf construction;
- Project timeline;
- Aboriginal interests;

- Interactions matrix; and
- Funding and peer review.

Clarification and additional information was provided to stakeholders where requested. Follow up was provided for any questions that could not be addressed in person at the briefing. Stakeholders provided feedback on what areas of the Project they felt required greater detail, explanation or continued investigation. Table 10.3-1 indicates the feedback from stakeholders and where in the EIS or TSDs this information can be found.

TABLE 10.3-1
Pre-submission Feedback

Details Regarding	Stakeholder Feedback	Further Described In EIS Section
Project Description	Ensure federal authorities understand the Project and requirements for their involvement (including activities such as blasting, excavation, dredging and wharf construction).	2.0
Reactor Technologies	Note that the results of an assessment of potential environmental effects will depend on the information (i.e. generation of technology) used	2.0
Applicable Laws re: Migratory Birds and Species at Risk	Ensure section on applicable laws includes a reference to these Acts	4.5
Municipal Approvals that May be Required	Ensure the scope of jurisdictional involvement is clear.	Clarification of jurisdiction has been requested from the CNSC
Population Growth	Ensure risks associated with urbanization are mitigated	4.8
Aboriginal Engagement	Federal authorities need to be aware of the importance of early engagement.	10.6
Transmission	Explain why transmission system upgrades are not considered in the Project scope	1.1
Phased Approach to Capacity for the Site	Explain timing of development and potential for the refurbishment of other nuclear stations, as this could change the nature of potential effects on the Darlington site	1.1
Relationship to Electricity System and Integrated Power System Plan	Explain government decision making process and how the Project relates to the IPSP	10.3

10.3.1.2 EA Methodology: Plant Parameter Envelopes & Site Layout Considerations

In the spring of 2008, OPG conducted its second round of key stakeholder dialogue sessions. OPG sought to share information with, and solicit the views of approximately 110 key stakeholders who were identified as having a potential interest in, or responsibility for, certain aspects of the Project. The primary objective of the sessions was to build on the discussion from the first round and solicit input on the Multiple Technology Approach, Site Option Studies and Site Preparation Licence activities (key components to the EA study and methodology). Each briefing also included discussion of the following:

- Project scope (including the purpose; project phases; temporal and spatial boundaries and alternative means);
- Status of the EA baseline studies (including a discussion of the approach to determining Valued Ecosystem Components); and
- Upcoming work OPG planned to undertake to support different stages of the federal approvals process.

Feedback on the primary areas of discussion included:

Multiple Technology Approach

Participants posed a range of questions about the Multiple Technology Approach and, while this approach was unfamiliar to most individuals, they sought to gain a better understanding of its role and how it would be used within the context of the EA. Some questioned whether it would include all reactor technologies and how it would be used following the selection of a technology. Participants expressed interest in any preliminary findings or results that OPG has acquired in employing this method of assessment.

Site Option Studies

Participants wanted to know how the property at the DN site would change as a result of the Project. A range of questions were posed regarding the size of the site and how OPG would evaluate its ability to accommodate the work activities required for the Project. Specifically, participants wanted to know where the new units would be located on the site and how the site option studies would consider the need for additional workers and on-site logistics to allow for the delivery of materials. Participants also wanted to better understand how the site option studies would assess the site's ability to satisfy the additional room required for daily operations and the ability of workers to safely evacuate the property. Participants also inquired how these studies will include consideration for the CN rail line and St. Marys Cement property.

Licence to Prepare Site Activities

Generally, participants commented and asked questions about the regulatory requirements for the Site Preparation phase and the allowable scope of work permitted under this license if obtained. Participants expressed interest in knowing what stage OPG is at in attaining the Licence to

Prepare Site and whether such work could begin before the completion of the EA and the selection of a reactor technology.

Other Areas of Discussion

Throughout the sessions, OPG staff received questions and input on a range of other project-related matters including: the EA process; EA methodology and scope; transmission infrastructure; financial considerations; nuclear waste management; and public consultation. In addition to the feedback received on the primary discussion areas, each stakeholder group noted particular aspects of the Project that they were interested in, wanted to continue to receive information about, and/or discuss with OPG staff. Each group contributed feedback unique to their interests and organizational function.

10.3.1.3 Valued Ecosystem Components

Valued Ecosystem Components (VECs) are features of the environment selected to be the focus of an EA because of their ecological, social, and economical value, and their potential vulnerability to effects of a Project.

A preliminary list of 11 environmental components was presented to the public in the fall of 2007. The public were asked to rate each environmental component on a scale of 1 to 5, with 1 being "least important" and 5 being "most important". Results from the VEC form are in Appendix 3F (CIS Report Round 2 Table 7). The most important environmental component was human health. Sixty-seven percent (67%) of respondents rated this component as "most important". The atmospheric environment and sustainable development were also rated as "most important" by a majority (60% and 58% respectively).

In the spring of 2008, OPG presented 22 environmental sub-components and 100 environmental features (preliminary VECs and VEC indicators) for public discussion and feedback. These were identified through the following mechanisms:

- Compilation of a list of candidate VECs based on previous and ongoing work undertaken for the DN site, including the Darlington Used Fuel Waste Management Facility EA;
- Existing environment information compiled for this Project;
- Feedback from the public during the second round of consultations;
- Identification of, and consideration for potential Project-environment interactions; and
- The professional opinion of technical specialists on the EA team.

Results indicated that:

- All environmental features were identified as being important by at least 15% of respondents at the Community Information Sessions. Over 50% of the environmental features were identified by at least 50% of respondents as being "most important";
- Six environmental features were identified as being most important by at least 80% of respondents. These features included:
  - Source drinking water and lake water quality;
  - Atmospheric features (i.e. air particulates and chemicals); and
  - Human health considerations (i.e. for public members and nuclear workers).
- Eight additional environmental features were identified as being most important by at least 70% of respondents. These features included:
  - Human health (i.e. for non-nuclear workers, off-site nuclear energy workers, residents and users of the Waterfront Trail);
  - Nuclear emergency infrastructure and preparedness;
  - Transportation system safety and road traffic volumes and safety; and
  - Lake water (i.e. temperature).
- Thirteen additional environmental features were identified as being most important by at least 60% of respondents. These features included:
  - Human health considerations (i.e. recreational users of nearby water, the Darlington Provincial Park and the soccer fields);
  - Socio-economic considerations including community services (i.e. health care facilities and educational opportunities and services), population and economic considerations (i.e. employment, overall population levels and demographics, and taxes), community infrastructure considerations (i.e. property values and housing), and nuisance effects on residents and communities (i.e. noise, dust, traffic); and
  - Agriculture (i.e. farming activity and availability of agricultural lands).

The public was invited to identify specific species that they would like studied in the EA. Specific bird species identified for additional study included songbirds, shorebirds, Herring Gulls and waterfowl. Deer and frogs were also recommended as species for further study. Lake trout and lake salmon were specifically mentioned, while a few suggested that all fish species should be studied.

In addition to the OPG program to solicit feedback on ecosystem components and VECs, a draft list of VECs was included in the Draft EIS Guidelines issued in September 2008. A number of individuals and organizations provided comment to the VECs to the CNSC and CEA Agency. OPG reviewed these and are included in Table 4.1-2 in the *Communication and Consultation*

TSD for completeness. The individual subsections of Chapter 4.0 of identify the VECs selected for the EA.

10.3.1.4 Potential Environmental Effects

To provide the public with an opportunity for input in the early identification of effects, OPG shared the potential environmental effects list in the fall of 2008 for public comment. The list was revised, incorporating public comment and further study, and a listing of the likely environmental effects was provided to the public for comment in the spring 2009. At that time, CIS participants were asked whether they had confidence that all of the potential effects had been considered. The majority (almost 70%) of respondents indicated they had confidence that all of the potential effects had been considered. Of those who indicated not all effects had been considered, four suggested that the full effects of uranium life cycle be included; two that human health effects be included and two that costs of power and spent fuel storage be included. A few also indicated that it was not possible that all the potential effects could have been considered since the reactor technology had not been selected (and each has different fuel cycles), and further that it was difficult to consider the impact from the fuel for 150 years.

Given the importance the public placed on human health, a workshop was held with the DNHC to solicit feedback on the aspects of human health (see Section 3.4.7.2). Workshop participants discussed the need to assess human health from a holistic perspective, the importance of having sound measurement strategies for accurate assessment, the relevance of malfunction and accidents to human health effects assessment, and the importance of public education regarding OPG's work and on nuclear technology more generally. Members of the DNHC concurred that it is important to conceptualize human health as being comprised of different systems that are interrelated in function and effect.

Participants advised that while the human health framework is well done, it could be modified to more accurately capture the breadth of human health considerations to be made. They questioned whether malfunctions and accidents were considered part of human health effects, and whether considerations regarding the ecosystem and community played a role in the assessment of human health. Participants noted that it is important to consider that radiation dose affects people's sense of personal safety.

Specifically they advised that:

- Under physical well being, activities such as commissioning, refurbishment, the changing of fuel and outages are associated with ongoing operation and should be reflected in the framework; and

- Stress associated with nuclear accidents and malevolent acts should be acknowledged within the framework.

Workshop participants further advised that the higher potential for conventional accidents during construction would require co-ordination with local hospitals and other health care providers. It would be informative to examine any historical data regarding accidents during the construction phase from the building of the first plant, to assist in the planning for this.

From a radiation and radioactivity perspective, participants noted that the most important aspect from a human health perspective is measurement of radiation dose, including dose to critical groups; the design standards and requirements for measurements of emissions; the ability to distinguish between emissions from the existing facilities (the power plant and tritium removal facility) and the new plant; and public and community reporting of findings. The participants noted that that there is a great potential for more health effects and potential harm during reactor commissioning. They also questioned whether internal emissions of acrolein could affect people with respiratory problems.

Participants also noted the importance of implementing a condenser cooling system that is not visually noticeable or distracting and that there is the possibility of creating a module within Regional Municipality of Durham's ongoing health survey that addresses nuclear power and public safety. The human health assessment framework is further addressed in the *Human Health TSD*.

10.3.1.5 Mitigation Measures

Mitigation measures are potential technically and economically feasible means to mitigate (i.e. to eliminate, reduce or control) a potential adverse effect. Mitigations are identified for all known adverse effects of the Project. Each likely adverse effect is examined to identify whether or not it remains after mitigation has been put into place, and whether it is measurable or observable. All measurable, adverse residual effects are carried forward in the assessment. Effects that are not likely, or not measurable, are not considered further.

OPG identified 35 potential mitigation measures as a starting point for public discussion. These were identified through the following mechanisms:

- The compilation of a list based on previous and on-going work undertaken for the DN site (including the Darlington Used Fuel Dry Storage EA);
- Existing information compiled for this Project; and

- The professional opinion of technical specialists on the Project team from both SENES and OPG.

The preliminary list of mitigation measures was presented to the public during the fall of 2008. The public were asked to rate each potential mitigation measure on a scale of low, medium and high importance. Key findings included:

- All mitigation measures were identified as being "high in importance" by at least 29% of respondents;
- At least 60% of respondents indicated that mitigation measures for the following environmental components were of high importance:
  - Human health – radiation and radioactivity;
  - Surface water environment;
  - Aquatic environment; and
  - Geology, hydrogeology and seismic environment.

Human Health - Radiation and Radioactivity

Seventy-eight percent (78%) of respondents identified mitigation measures in the area of human health as high in importance. Of these respondents, the following measures were rated:

- Continued on-site and off-site worker and environmental monitoring programs - 82%;
- Extensive regulatory oversight and management - 79%;
- Ongoing research, education and training for workers - 79%; and
- Use of the "As Low As Reasonably Achievable (ALARA)" principle for design, operation and maintenance - 71%.

Surface Water Environment

Seventy percent (70%) of respondents identified mitigation measures for the surface water environment as high in importance. Of these respondents, the following measures were rated:

- Treat water discharges from the site to ensure water quality meets appropriate quality standards - 89%;
- Develop secondary containment for above ground storage tanks to limit potential for spills - 82%;
- Implement good on-site storm water management practices - 71%;

- Limit near shore temperature effects with design and location of discharge diffuser - 71%;
- Employ environmental management plan to minimize effects during shoreline construction - 64%; and
- Limit extent of shoreline sediment transport and loading with design and location of lake infill - 39%.

Aquatic Environment

Sixty-six percent (66%) of respondents identified mitigation measures for the aquatic environment as highly important. Of these respondents, the following measures were rated:

- Protect Darlington Creek from construction effects - 79%;
- Employ environmental management plan to minimize effects during marine construction activities - 64%;
- Work with agencies to identify and implement appropriate means to compensate loss of aquatic habitat - 61%;
- Reduce extent of thermal effects with design and location of discharge diffuser - 57%; and,
- Reduce impingement and entrainment with design and location of intake structure - 57%.

Geological and Hydrogeological Environment

Sixty-one percent (61%) of respondents identified mitigation measures in the Geological and Hydrogeological Environment as high in importance. Of these respondents, the following measures were rated:

- Design graded site topography to optimize flows and recharge into Darlington Creek and nearby groundwater discharge - 64%; and
- Develop ongoing groundwater monitoring to measure quality and flow - 57%.

Respondents also identified an interest in mitigations measures pertaining to the Terrestrial, Atmospheric, and Socio-economic Environments, as well as, Land Use, Traffic and Transportation, and Aboriginal Interests.

10.3.1.6 Cumulative Effects Assessment

Residual effects of a Project also have the potential to combine and interact with effects from other projects and activities that exist, or are planned during the same time frame and that overlap geographically. These are potential cumulative effects and must also be assessed for significance. To act cumulatively, the effects of the Project on the selected VECs must overlap with the effects of other projects on those same VECs. Where there is a potential for a cumulative effect, it is evaluated. Where there is a likely adverse cumulative effect, mitigation measures are identified and a determination is made whether a residual cumulative effect is likely. A preliminary list of projects to be considered in the cumulative effects assessment was shared with the public in the fall of 2008. The public were asked to identify any potential projects (current or planned) that they felt were important to consider from a cumulative perspective. The list of projects presented to the public is noted in Table 10.3-2. OPG used this list in a preliminary screening of projects which may have a cumulative effect. This is further described in Chapter 8.

TABLE 10.3-2
Cumulative Effects Assessment – Projects for Public Consideration

Name of Project/Activity
Continued operation of the existing DNGS
407 East Extension
Energy from Waste Facility*
Development of Clarington Energy Park
Oshawa Ethanol Plant
Refurbishment of DNGS
Future 401 widening
Port Hope Area Project
Port Granby Area Projects
Pickering Airport
St. Marys Alternative Fuels Project
Regional Municipality of Durham Water and Wastewater Master Servicing Strategy
Planning and development applications in Clarington and Oshawa

- Energy from Waste Facility was referred to by different names including the "Regional Municipality of Durham Energy from Waste Project"'; "York/Durham Energy from Waste Facility"; the York/Durham Thermal Treatment Facility".

Other projects and/or supporting narrative included:

- SUNBAY Energy-from-Waste Project should be included, this project is in the Wesleyville area and construction begins in 2009;
- Housing projects in Bowmanville and Newcastle;
- Seaton Development in Pickering;
- Ajax Steam Plant redevelopment;

- Continued Operation of the Existing Pickering NGS; and
- The Port Granby Project.

Some participants commented on, or inquired about the cumulative effects being considered for this Project with other development such as Energy from Waste and relocation of the CN rail line. In addition, participants asked to ensure farm production in the area is maintained and supported.

OPG hosted cumulative effects workshops with proponents of planned and future projects within 10 km of the DN site (see Section 3.4.7). Workshop participants shared information on the timing, works and activities for each project and what environmental effect may overlap in time and space. Participants also shared indicative project schedules to assist in understanding the potential temporal overlap of the projects to document potential interactions and effects. Cumulative effects are further discussed in Chapter 8.

10.3.1.7 Significance Assessment

One of the final steps in an EA is to conduct an assessment of significance. This assessment is based on considerations that help determine the significance of residual adverse environmental effects. These considerations are derived from public input, professional expertise, and existing regulatory and industry standards. A preliminary list of criteria to assess significance was presented to the public in the fall of 2008. The following criteria were listed for public review and comment:

- Timing, Duration and Frequency of the Effect;
- Magnitude of the Effect;
- Geographic Extent of the Effect;
- Degree to which Effects are Reversible or Mitigable;
- Ecological and Social/Cultural Context;
- Measures of Human Health;
- Probability of Occurrence; and
- Sustainability.

Participants were encouraged to provide feedback on this area of study as local knowledge is key to the assessment of significance. In addition to the significance criteria noted above, respondents listed the following to be considered:

- Human Health (noted by participants despite already being presented as a criterion);

- Waste Disposal;
- Effects on Future Generations; and
- Cost Effectiveness and Sustainability of Other Options.

In the spring 2009, the public was asked if the approach used to determine the significance of remaining effects was fair and reasonable. This list included:

- Magnitude;
- Geographic Extent;
- Duration;
- Frequency and Probability;
- Reversibility;
- Physical Human Health;
- Psycho-social Human Health;
- Ecological Importance;
- Societal Value; and
- Sustainability.

Almost 80% of the respondents indicated that Societal (value to society), followed by Magnitude (77%) and Frequency and Probability (77%) criterion should be included in significance assessment. A few respondents (less than 6%) indicted that Reversibility, Human Health and Psycho-social Health should be removed.

In addition, respondents were asked to indicate if the two step approach was fair. Almost two thirds of the respondents (65%) indicated that the approach was fair. Respondents were also asked to indicate what criteria should be used in step 1 or 2. A few respondents indicated:

- Human health, ecological importance and sustainability should be used in step 1; and
- Frequency and probability, as well as, reversibility should be used in step 2 (currently considered in step 1).

A couple of respondents provided comments indicating the effects should not be considered in isolation of other effects. One respondent indicated that the approach to determination of significance is "fairly comprehensive". Significance is discussed in Section 9.2 of the EIS.

10.3.1.8 Sustainability

A project that is supportive of sustainability must strive to integrate the objective of net ecological, economic and social benefits to society in the planning and decision-making process and must incorporate citizen participation. OPG developed an approach to the consideration of sustainability that was grounded in the sustainable development goals and objectives of the local and regional municipalities in which the Project would be developed. This was shared with the public and stakeholders. Overall, 68% of respondents during Round 5 of the CISs indicated that it is reasonable to use local and regional objectives. Fourteen specific measures where identified, including:

- Society:
  - Balanced development;
  - Efficient use of infrastructure and access to services;
  - Live, work and play communities;
  - Community pride and identity; and
  - Personal well being.
- Ecology:
  - Green spaces in urban areas;
  - Biodiversity and ecosystem development;
  - Environmental stewardship; and
  - Energy conservation.
- Economy:
  - New job opportunities;
  - Business retention, expansion and creation;
  - Durham Energy Hub;
  - Diversification of skills base; and
  - Healthy municipal finance.

All of the measures were confirmed by at least 60% of respondents as measures to use in the sustainability assessment. Personal well-being and live, work and play communities were identified by less than 9% as measures that should not be included.

When asked whether or not there is other things that OPG should consider in our assessment of sustainability, respondents felt that the uranium fuel cycle as well as alternatives should be given more consideration, other comments included:

- Sustainable development means Canadian technology to me;

- Impact on environment and energy cost of not doing this Project and using other alternatives (coal etc);
- Has to mitigate the risks and environmental downfalls; identifying all these is just one fix they weren't presented throughout the session;
- I felt the sight of a cooling tower would be an "eye sore", visually unappealing;
- Can't think of anything else, doing a good job;
- The entire uranium fuel cycle;
- The entire uranium cycle from embedded in bedrock to end storage and monitoring;
- Yes, the desire of Ontarians to put public money into renewables;
- Carbon offsets of nuclear; and
- Appearance of plant most important! "Clean Looking", large cooling towers not desirable.

10.3.2 Stakeholder Comment Database and Issue Management Program

Documentation, tracking and follow-up of stakeholder contacts, comments and questions were an important aspect of the Communication and Consultation Program for the Project. The Stakeholder Comment Database (SCD) was developed and maintained throughout the Project to track all stakeholder comments and issues, as well as the responses provided. Stakeholder contacts and comments received were documented on a Stakeholder Comment Record (SCR) form. The SCR included the name of the person and organization (where applicable), contact information, a description of the comment or question and any response or action taken or required. This information was then added to the SCD. Responses were provided to all stakeholder comments received, as required. Comments and questions were carefully reviewed to identify any issues that required consideration in the EIS. These issues were catalogued in an issue database according to the EA discipline or area of concern to which they applied (e.g. air quality, surface water, nuclear waste, human health, etc.).

The objective of the Issue Management Program was to address and resolve those matters under discussion, in question or in dispute that may affect the overall quality and acceptability of the EA and subsequent approval of the EIS. By formally addressing all stakeholder comments and attempting to resolve issues, OPG gained a more comprehensive understanding of stakeholder issues and became better positioned to address those issues or concerns in the EA study and during the preparation of the EIS.

All comments received were documented in the SCD. Many of these were straightforward requests for information that could be readily acknowledged or answered with a letter or a

Project information package. Instances of correspondence (i.e. a question, comment or expressed concern) that fit one or more of the following criteria were defined as an "issue":

- Required consideration by the EA Team and discussion in the EIS;
- Potentially presented a risk to the EA study (i.e. called into question the accuracy or credibility of the EA study data, analysis or process);
- Required a change of scope in the EA study; and/or
- Mentioned frequently by the public or stakeholders.

Issues were identified from the following sources: the SCD; CISs and stakeholder workshop reports, and documents in the public registry maintained by the CEA Agency. All potential issues were reviewed to determine if the matter should be treated as an issue and whether it was an EA or Project issue or OPG issue. EA issues were those issues directly related to the Project. Those issues could relate to the CEA Agency process, the EA methodology, the technical work programs and results, OPG's consultation program, potential environmental effects, the follow-up and monitoring program or other matters related to the work and responsibilities of the EA Consultant Team. OPG, in consultation with the EA Consultant Team, determined the appropriate course of action to address these issues. OPG managed issues directly related to the Project, such as the Project schedule and description, and other matters that, while not considered directly related to the NND EA, were considered relevant to the Project by some stakeholders and needed to be addressed in the context of OPG's relationship with its stakeholders and host communities (e.g. long term disposal of used fuel, alternatives to nuclear power, nuclear plant security, deregulation of the Ontario electricity market).

10.3.3 NND Project Public Opinion Research

Ipsos Reid has maintained a research program that tracks overall support for/opposition to, and attitudes toward nuclear energy in Canada since February 2005 on behalf of the Canadian Nuclear Association. Recent (2009) public opinion research demonstrates support in the Province for nuclear generation.

Overall, the survey results reveal that 67% of Ontarians are supportive of nuclear energy (the trend has been upwards from 48% in 2005) including development of new nuclear stations and refurbishment of existing ones. Further, while there may be a growing sense of caution and a desire to confirm need, half of Ontarian's feel that government is moving slowly in building new nuclear power plants. This work is fully described in Section 4.3 in the *Communication and Consultation TSD*.

10.3.4 Public and Stakeholder Feedback, Interest and Discussion

OPG received questions and comments covering a wide range of matters throughout the EA Study process, these areas are presented in Tables 10.3-3 and 10.3-4. In this subsection we summarize those matters that were: i) of recurring interest among the public but which would generally be considered beyond the scope of the EA; ii) of interest and pertaining to the EA; and iii) raised by selected stakeholder groups. OPG's response is also provided.

10.3.4.1 Areas of General Interest

This section provides a summary overview of the questions, comments and issues that were raised by members of the public and stakeholders through the consultation program and describes how OPG responded to these matters in the EIS or elsewhere. Public comment on EA-related topics pertained to a wide variety of subject matter including those having to do with human health, social and community welfare, assessment scope and methodology, condenser cooling alternatives and nuclear waste management strategies (among others).

Throughout the communications and consultation program, there was a high degree of interest in a number of matters specific to the Project and the potential environmental effects. This included questions about overall Project effects on air quality, drinking and lake water quality, human health; questions about the potential environmental effects from alternative methods of condenser cooling and from traffic and transportation; specific questions regarding the DN site; the recognition of economic benefits that may arise; and waste heat utilization. These areas are described below, along with OPG responses. Table 10.3-3 provides a listing of frequently asked questions, OPG's response, and where additional information can be found in the EIS or TSD.

Air Quality

There was considerable interest in potential effects on air quality. Participants wanted to know about the methodology used to assess potential effects on air quality; sought assurance that the Project would not pose any threats to air quality issues in the Municipality of Clarington or the City of Oshawa; and expressed concerns about the potential cumulative effects on air quality from the NND Project and other planned projects in the area (particularly the York/Durham Energy from Waste Facility).

In response, OPG provided an overview of the key steps being used to assess air quality for this study, the standards that would be required and the mitigation measures that could be used to reduce any potential effects on air quality. OPG also ensured that the potential atmospheric effects from other projects were considered in the cumulative effects assessment.

Drinking and Lake Water Quality

There was considerable interest in potential effects on water quality, both from drinking water and lake water perspectives. Participants specifically wanted to know about the potential effects on drinking water quality from radiological contaminants, and the effects on water quality from lake infilling, and storm water management.

In response, OPG explained how the EA examined lake water quality from many perspectives: regional, local and site study area drainage; conventional chemical characteristics; radiological water quality parameters; and sediment quality are all assessed. The study also determined the effects on various water uses including drinking, recreational, industrial and use by fish and other biota. Finally, OPG explained about the annual REMP which, in support of our ongoing operations, drinking water samples are taken from three DN site-area water supply plants (which are sampled twice daily) and local wells. Monthly well water samples are also collected from farms and residents near the DN site.

Human Health

Participants consistently noted that human health was one of the most important areas to study, particularly the potential effects from a radiological perspective. Many sought to understand whether different reactor designs being considered have different radiological emissions, whether epidemiological studies were required, and whether there would be potential effects of leukemia in children.

In response, OPG noted that this EA includes an assessment of potential human health effects according to the World Health Organization's definition of health which is, "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity". We looked at conventional aspects (noise, air and water quality), as well as radiological aspects (from ionizing radiation). OPG examined various studies at a local, provincial, national and international level to ensure that health considerations are appropriately assessed and accounted for, including epidemiological studies where published. As an example, the Regional Municipality of Durham Health Department completed a study titled "Radiation and Health in Regional Municipality of Durham 2007" (Regional Municipality of Durham Health Department, 2007). The study included a review of the scientific literature on health effects of radiation, information on public radiation dose for people in Regional Municipality of Durham as based on OPG radiological environmental monitoring data, and a comparison of selected health indicators in Regional Municipality of Durham and municipalities within Regional Municipality of Durham. In general terms, the study concluded that "Most Category 2 indicators were significantly low or at provincial levels in Ajax-Pickering and Clarington, including childhood cancer, childhood leukemia, bladder cancer, colorectal cancer, stomach cancer and the congenital anomaly microcephay". Finally, OPG clarified that each reactor design has a specified anticipated radiological emission output based on its design and operation, as well as the design of the liquid waste clean up system. The CNSC establishes stringent requirements for public dose arising from plant operations for all nuclear reactors in Canada. The reactor technology to be selected by the Ontario Government will need to meet CNSC requirements in order to be licensed and will be regulated by the CNSC.

Project Considerations - Condenser Cooling

Participants asked a range of questions about condenser cooling but showed greatest interest in understanding whether certain condenser cooling systems are specific to particular reactor designs, and how the potential environmental effects of cooling towers and once through lake water cooling would be assessed. Participants specifically wanted to know more about the effects of thermal discharge to Lake Ontario and how that compared with the atmospheric and visual impacts of cooling towers. A number expressed concern over the potential use of natural draft cooling towers.

In response OPG explained that all nuclear reactors require condenser cooling and that all reactor designs can use their lake water cooling or atmospheric cooling (i.e. cooling towers) and that both options were being considered in this EA. With regards to how OPG assessed the environmental effects of these options, staff noted to public members that the assessment is conducted from a variety of perspectives including: visual effects, atmospheric emissions; water-related effects and land excavation. In addition, it was explained that the potential effects of thermal discharge were assessed by means of examining lake circulation, water temperature and the potential for fish impingement and entrainment. Noted was OPG's operating experience with once-through lakewater cooling systems and how this type of cooling system operates.

Site Considerations

Participants wanted to understand the reasons for selecting Darlington as the preferred site, the considerations given to land availability, and the type of infrastructure development that the Project may require. Participants expressed a general interest in understanding how the EA will assess different layout options for the reactors and what considerations have been made regarding the site's proximity to St. Marys Cement property.

In response, OPG explained that Darlington was the preferred site for several reasons including: availability of land; proximity to a major transmission corridor and load centre; history of local and regional support; and history of on-site operating experience. OPG also developed three conceptual plant layouts illustrating siting options. These layouts were shared with the public and provided the basis for more detailed discussion regarding options for situating the reactors and associated support structures and facilities.

Economic Benefits

Participants were interested in the social and economic effects of the Project. Many spoke about potential employment opportunities that may arise should the Project proceed and the benefit that employment would bring to the community. Others sought to secure employment with OPG and were interested in the types of jobs that may be available, the skills that would be required, and when and how they could apply for jobs. A number asked that the benefits of the Project be considered, not just the adverse effects, and wondered whether there would be a labour shortage and if so, how that would be managed.

In response, OPG indicated that the assessment included potential socio-economic effects, including the nature and types of jobs that may be required throughout all phases of the Project. The employment forecasts used in the environmental assessment are documented in the *Socio-Economic Environment Assessment of Effects TSD*. It was noted that projected labour data provides information to determine potential effects on related aspects such as housing, transportation and other infrastructure needs in the community.

OPG provided information on its current employment practices, including where to find job postings, information on specific job categories and how to apply on-line. OPG also noted that the construction phase would be contracted to a separate company, and that company would be responsible for all construction related hiring.

With respect to the need for skilled workers, OPG noted that there is sufficient lead time due to the hiring of new staff over the past number of years and working with the UOIT, Durham College and other post-secondary institutions to ensure educational programs are in place to prepare future nuclear energy workers. OPG has invested significantly in training through internal programs and through the University Network of Excellence in Nuclear Engineering (which includes other industry partners and several Ontario universities).

Traffic and Transportation Considerations

Many were interested in how the workforce would be brought on site, whether the existing transportation system could accommodate the additional workers or whether adjustments would need to be made, and if so of what nature. Many noted that Holt Road was already congested, and that during morning rush hour the traffic was backed up onto Highway 401. Concerns were raised regarding the amount of off-site trucking and the volume of traffic required for on-site shipments of aggregates. People asked if there was going to be a new GO train station in Bowmanville, or some other system of mass transit and whether OPG would encourage its use.

In response, OPG explained that, for the purposes of this EA, potential roadwork and related infrastructure was assessed to better understand site access and parking requirements for future workers. It also included an assessment of site access controls to help explain how the Project may potentially affect on-site road works such as parking and lay down areas. Off-site road works were also assessed to better understand how the Project may affect traffic patterns on public roads at shift changes and during peak construction periods. This is documented in the Traffic and Transportation TSD, and is summarized in Section 5.9 of the EIS.

In response to questions on a new GO train station in Bowmanville, OPG explained that Official Plans for Municipality of Clarington had identified future plans for a new GO station and GO Transit was currently (2008) undertaking a feasibility study on the extension of rail service from Oshawa to Bowmanville.

Waste Heat Utilization

A recurring area of discussion was whether the waste heat (that is the heat in the outflow of the condenser cooling system or steam that might be released) could be utilized. Many people felt that this would be an environmentally responsible practice.

Typically, condenser cooling systems in nuclear power plants produce a low-temperature waste heat stream, one that is very diffuse and only slightly warmer than the surrounding water temperature. To help put this into context, the temperature of the discharge, in absolutely terms, is no more than 5% warmer than the surrounding water.

There are very few efficient uses for low temperature heat and the economic benefits of waste heat recovery generally do not justify the cost of recovery systems. Having the ability to recover waste heat in an efficient and meaningful way would require a larger temperature difference than is generally produced by a nuclear power plant.

A recent article appearing in a Finnish newspaper reported efforts by the Mayor of Helsinki to investigate the use of a nuclear reactor to serve the district heating needs of Helsinki. The article noted that the ability to utilize reactors in this manner is difficult because steam is not produced at a temperature high enough to allow for a productive contribution to local area heating without compromising the electrical output of the plant.[10]

[10] Helsingin Sanomat, International Edition - Metro. February 2009.

Additionally, OPG noted that the Project was a commercial venture, and that provision for ancillary projects (such as waste heat capture systems) was not included in the project scope for tendering.

TABLE 10.3-3
Public Comments and Areas of Interest

#	Question and Answer	Further discussed in
ENVIRONMENTAL ASSESSMENT STUDIES		
Aboriginal Interests		
Q1	**Are Aboriginal interests being considered in this EA and if so, how?**	Aboriginal Interests Technical Support Document
A1	Yes, Aboriginal interests are being considered in the EA. OPG has sought to ensure that Aboriginal views and perspectives are integrated into the EA at the earliest possible stage. OPG has engaged approximately 15 communities that may have a current and/or historic interest in the areas around the DN site. This involves the following First Nations that are signatories to the Williams Treaty (1923): • The Alderville Ojibway First Nation; • The Chippewas of Georgina Island First Nation; • Curve Lake First Nation; • Hiawatha First Nation; and • Mississaugas of Scugog Island First Nation. In addition, OPG has sought the views and perspectives of other Aboriginal groups that may also have a current or historic interest in this area including: • Mississaugas of New Credit First Nation; • Métis Nation of Ontario; • Kawartha Nishnawbe; • The Oshawa Métis Council; • The Ontario Métis Aboriginal Association; • The Mohawks of the Bay of Quinte First Nation; • The Huron-Wendat First Nation; • The Chippewas of Rama First Nation; • The Six Nations of the Grand River; and • The Erie Indian Moundbuilders Tribal Nation. OPG continues throughout the EA process to create opportunities to share information and solicit dialogue on, among other things: • Whether the Project may have an environmental effect on any lands or resources currently used by Aboriginal Peoples for traditional purposes; • Whether the Project may have any perceived impacts on Aboriginal and Treaty Rights; • Whether local and traditional knowledge can assist in describing the existing environment; and • Proposed VECs that have been identified for the assessment.	
Agricultural Interests		
Q2	**How does the EA look at farming activity and agricultural use of lands surrounding the site?**	EIS Section 4.0 Land Use TSD Socio-Economic TSD
A2	The EA documents the current agricultural use of lands, including farming activity, in the LSA. The EA examined the extent to which Project works and activities may affect current farming activity. For example, the lands south of the 401 and north of the CN rail line could be potentially impacted by site preparation activities. The EA includes consideration for mitigation measures should it be determined that the Project would have an effect on surrounding agricultural uses and farming activity.	
Q3	**What's being done to look at agricultural produce outside of the direct fence area in terms of monitoring?**	EIS Section 5.0

TABLE 10.3-3 (Cont'd)
Public Comments and Areas of Interest

#	Question and Answer	Further discussed in
A3	OPG currently conducts radiological environmental monitoring programs in the vicinity of the DN site. These programs involve the sampling of air, precipitation, lake water, well water, soil, beach sand, lake sediment, local fruits, vegetables, milk, honey, fish and direct radiation exposure. Many of these samples are collected on the properties of local farms including milk, garden produce and silage. The results of the extensive monitoring programs are reported each year to the CNSC as part of a licensing requirement and are made available to the public. These results are also used to estimate the level of radioactivity received by the public (dose levels). Public dose levels from DNGS operations are typically less than 1/1,000 of the regulatory limit. For this EA, an assessment of potential effects from a new nuclear generating station to agricultural products was undertaken. Should the Project proceed, the radiological environmental monitoring program would account for the new station.	
Aquatic Biota/Surface Water		
Q4	**Does the EA look at the effects on drinking water quality?**	EIS Section 5.0
A4	Yes, the EA looks at the potential effects on drinking water. Lake Ontario serves as a source of drinking water and recreation for communities in the RSA and LSA. Surface water from water supply plants, lakes and streams, and the proposed discharge structure will be analyzed for contaminants as they represent potential exposure pathways to humans. As part of OPG's annual Radiological Environmental Monitoring Program (REMP) in support of our ongoing operations, drinking water samples are taken from three Darlington Nuclear-area water supply plants (which are sampled twice daily) and local wells. Monthly well water samples are also collected from farms and residents near the Darlington site. OPG's 2007 REMP can be viewed at www.opg.com/news/reports in "Nuclear Reports and Publications".	
Q5	**Does your EA assess lake water quality?**	EIS Section 5.0
A5	Yes. The EA examines lake water quality from many perspectives: Regional, Local and Site Study Area drainage; conventional chemical characteristics; radiological water quality parameters; and sediment quality are all assessed. The study also determines the effects on various water uses including drinking, recreational, industrial and use by fish and other biota.	
Q6	**Does your EA look at the effects on fish from potential lake infilling?**	EIS Section 5.0
A6	Yes. The EA examines potential effects on fish species and their habitat should the Project require lake infilling. VECs have been selected to assess potential effects on fish and fish habitat. These VECs consist of key fish species that represent the aquatic ecosystem as a whole.	
Q7	**What work is done to ensure that the near shore current patterns in Lake Ontario are not altered**?	
A7	Extensive work is done to describe and understand the potential effect of the Project on the Surface Water Environment, including Lake Circulation (such as lake-wide circulation characteristics; near-shore lake current direction and velocity; water velocities and directions in the vicinity of cooling water intakes and discharges; and cooling water withdrawal volumes and rates) and on Shoreline Processes, that is processes that affect the nearshore conditions in the vicinity of the DN site (e.g., geomorphic setting and bathymetry; sediments; Lake Ontario water levels; wave conditions; and ice behaviour); sediment transport and deposition).	
Atmospheric Considerations		
Q8	**How are you assessing air quality to ensure that the Project will not pose air quality issues in the Municipality of Clarington?**	Atmospheric Environment TSD
A8	Air quality assessment is an important part of this EA and is based on a standard approach. The key steps used to assess air quality for this study include:	

TABLE 10.3-3 (Cont'd)
Public Comments and Areas of Interest

#	Question and Answer	Further discussed in
	• The collection and review of data pertaining to baseline air quality, meteorology (i.e. temperature, precipitation and wind) and climate; • Estimating emissions based on data from OPG reports or standard methodologies; • Identifying sensitive receptors to include in the effects assessment; • Documenting weather data from the DN site meteorological station (and other local stations as required); • Use of atmospheric dispersion models to estimate downwind air concentrations from emissions to air resulting from Project works and activities; and • The comparison of predicted air concentrations to Canadian and Ontario regulatory criteria for air quality. This will help determine how the potential Project may impact air quality.	
Q9	**What effect would vehicle emissions have on the environment?**	Atmospheric Environment TSD
A9	OPG has conducted atmospheric studies which include consideration for vehicle emissions (e.g. road dust and tailpipe exhaust) from employee traffic and delivery vehicles. Various contaminants from on-going maintenance and operational activities at Darlington Nuclear Generating Station (e.g. laboratories, maintenance welding, painting etc.) have also been assessed. Most emissions, including those caused by the operation of ventilation systems, contribute only trace levels of substances to the local and regional study areas and did not require further study.	
Q10	**What noise effects will the project have?**	Atmospheric Environment TSD
A10	Noise conditions in the vicinity of the residential receptors are largely related to background traffic. A moderate increase in sound levels is predicted during site preparation activities at the closest residence west of the DN site. This will be of limited duration and only occur during the day. The predicted increases in sound levels at the other residential receptors are negligible during all phases of the Project, and are not considered an adverse environmental effect in the Atmospheric Environment.	
Climate Change		
Q11	**How does the EA consider global warming and its potential impact to the Project?**	EIS Section 8.0
A11	Studies by Environment Canada and the Intergovernmental Panel on Climate Change indicate that predicted increases in global mean temperatures could result in the following changes in Ontario over the next 100 years, among others: • Northward shifts in climatic zones; • Intensified droughts and flood due to El-Nino events; • Greater frequency of higher intensity precipitation events; and • Increases in Great Lake water temperatures. The EA studied the potential impact that climate change may have on the Project from these types of changes. The EA also examined the potential effects that the Project may have to climate, including the potential production of greenhouse gas emissions. Greenhouse gas (GHG) emissions are very limited at nuclear sites and do not result from regular station operations but primarily from auxiliary backup systems and from on-site vehicular traffic. During the construction of a new nuclear station, the operation of construction equipment will release small quantities of GHG in excess of existing operations at the site. Therefore, GHG emitted during construction represents a maximum scenario for the Project and were used to assess the potential impact of the Project in this regard.	
Human Health		
Q12	**Is there any health effects associated with living near a nuclear plant?**	Human Health TSD
A12	There are no health effects associated with living near OPG's nuclear power plants. OPG is committed to operating its facilities in a way that protects the health and safety of its employees and the public, in addition to protecting and improving the environment.	

TABLE 10.3-3 (Cont'd)
Public Comments and Areas of Interest

#	Question and Answer	Further discussed in
	High operating standards, robust plant designs built and operated with a conservative "defense-in-depth' safety philosophy, government and industry oversight of plant operations and the dedication of well-trained and experienced work force that recognizes that safety is the key to successful plant operations and are key to ensuring that health and safety are always protected. The data from routine testing and monitoring of plant operations, employee doses, plant emissions and environmental levels of radiation are compiled and provided to the public in annual reports. The preparation and public release of these annual reports is a regulatory requirement of the CNSC which must receive and agree to the contents of these reports. Copies of recent reports that have been released to the public are available on OPG's website, www.opg.com. *Radiation and Health in Regional Municipality of Durham 2007* is a descriptive study that was undertaken by the Regional Municipality of Durham Health Department. The study examines rates of various cancers and congenital anomalies and stillbirths in areas surrounding the Pickering and DNGSs. The study concluded that rates of cancer, congenital anomalies and stillbirths in Ajax-Pickering and Clarington did not indicate a pattern to suggest that the Pickering and DNGSs were causing health effects in the population. The study concluded that given the extremely low levels of radiation exposure from the nuclear stations, it would be unlikely that any effects would occur.[11]	
Q13	**Do the different reactor designs being considered have different radiological emissions?**	Scope of Project TSD
A13	Yes, each reactor design has a specified anticipated radiological emission output based on its design and operation, as well as the design of the liquid waste clean up system. The CNSC establishes stringent requirements for public dose arising from plant operations for all nuclear reactors in Canada. The reactor technology to be selected by the Ontario Government will need to meet CNSC requirements in order to be licensed and will be regulated by the CNSC.	
Q14	**Are you conducting epidemiological studies as part of this EA?**	Human Health TSD
A14	This EA includes an assessment of potential human health effects according to the World Health Organization's definition of health which is, "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity".[12] We look at conventional aspects (i.e. noise, air and water quality), as well as radiological aspects (i.e. ionizing radiation). Community health profiles are included in the study and represent the current (or baseline) conditions affecting the physical, mental and social well-being of the general public within the Local Study Area and of workers on the Darlington site. OPG examines various studies at a local, provincial, national and international level to ensure that health considerations are appropriately assessed and accounted for, including epidemiological studies where published.	
Q15	**Will you look at the potential effects of leukemia in children?**	Human Health TSD
A15	OPG considered a wide range of studies in its assessment of potential human health effects. The Regional Municipality of Durham Health Department recently completed a study titled *Radiation and Health in Regional Municipality of Durham 2007*. The study included a review of the scientific literature on health effects of radiation, information on public radiation dose for people in Regional Municipality of Durham as based on OPG radiological environmental monitoring data, and a comparison of selected health indicators in Regional Municipality of	

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[11] Region of Durham 2007. *Radiation and Health in Regional Municipality of Durham 2007.*

[12] Preamble to the Constitution of the World Health Organization as adopted by the International Health Conference, New York, 19-22 June, 1946; signed on 22 July 1946 by the representatives of 61 States (Official Records of the World Health Organization, no. 2, p. 100) and entered into force on 7 April 1948.

TABLE 10.3-3 (Cont'd)
Public Comments and Areas of Interest

#	Question and Answer	Further discussed in
	Durham and municipalities within Regional Municipality of Durham. In general terms, the study concluded that "Most Category 2 indicators were significantly low or at provincial levels in Ajax-Pickering and Clarington, including childhood cancer, childhood leukemia, bladder cancer, colorectal cancer, stomach cancer and the congenital anomaly microcephaly".[13]	
Malfunctions and Accidents/Emergency Planning and Response		
Q16	**What would happen in an emergency? Does the EA look at evacuation?**	EIS Section 7.0 Malfunctions and Accidents TSD
A16	Yes, the EA includes consideration for evacuation that could occur as a result of credible malfunctions and accident scenarios. The Province of Ontario has overall responsibility for managing the off-site response to nuclear emergencies. OPG, Emergency Management Ontario and the regional and local governments all work together to protect the public. Each organization has responsibility for a distinct area of the emergency response: • OPG's first responsibility is to make sure its reactors are operated, maintained and designed in such a way that accidents will not occur. In the highly unlikely event of an accident, our responsibility is to ensure it is controlled and that radioactive emissions are minimized. OPG assists the Province and local municipalities with funding and planning support for their emergency programs. • Emergency Management Ontario, an agency of the Ontario Government, is responsible for the overall Provincial Nuclear Emergency Plan and public safety during nuclear emergencies. If a nuclear emergency were to occur, the Ontario Government would manage the off-site response. • Regional and local municipalities all have emergency plans in place. More importantly, it is their emergency responders who ensure that emergency plans are properly implemented. This includes police, fire and ambulance crews. Municipal agencies have been an important part of our EA process and have provided input and comment to our process. For the purposes of the EA, we included the unlikely scenario that an evacuation may be required. In the EA we looked at the potential environmental effects of a malfunction as well as an evacuation scenario, including the potential radiological effects on human health and biota.	
Q17	**What about transportation in a worst case scenario?**	EIS Section 7.0
A17	The EA includes an assessment of the effects of the Project on transportation, and the potential effects of Project-related transportation on the environment. As part of the EA, we also included the unlikely scenario that an evacuation may be required. A key consideration is the time required to evacuate a designated sector, referred to as "evacuation time estimates". Evacuation time estimates are determined by a number of factors, including the level of road congestion. OPG will include a discussion of evacuation time estimates in the EA for the Project. The Province of Ontario has the overall responsibility for managing the off-site response to nuclear emergencies. OPG, Emergency Management Ontario, and the regional and local governments work together to protect the public. Each organization has responsibility for a distinct area of the emergency response.	

[13] Region of Durham 2007. *Radiation and Health in Regional Municipality of Durham 2007*, p. 7.

TABLE 10.3-3 (Cont'd)
Public Comments and Areas of Interest

#	Question and Answer	Further discussed in
Physical and Cultural Heritage Resources		
Q18	**Are there any burial grounds on the site?**	EIS Section 4.0
A18	As part of the EA work, extensive surveys of any physical and cultural heritage resources were undertaken. This includes archaeological surveys to determine whether any cemeteries or burial grounds exist or potentially exist in areas that may be disturbed. To date, no Aboriginal burial grounds have been found on the DN site; however, two built heritage features remain on the northwest portion of the DN site. These include the Burk family cemetery which is commemorated by a large monument placed within the cemetery, and a historic cairn commemorating the opening of DNGS in 1989.	
Safety and Security		
Q19	**Is it true that the largest security vulnerability at the site would be the used fuel dry storage buildings?**	EIS Section
A19	Used fuel storage buildings are not considered to be highly vulnerable to security threats. However, as with all nuclear facilities, safety and security is extremely important. For the DNGS, once used fuel is removed from the reactor, it is first stored under water in irradiated fuel bays and is subject to continuous surveillance. Following a minimum period of 10 years, the fuel is transferred to dry storage at the Darlington Waste Management Facility and placed in robust, sealed containers made of 0.5 metre thick reinforced concrete and carbon steel inner and outer liners – this provides a very high degree of protection for the fuel. Each used fuel bundle must be accounted for by the station at all times. The Darlington Waste Management Facility has been designed, constructed and operates to meet all safety and security regulations as set out by the CNSC and has demonstrated to be robust to withstand all credible scenarios. Used fuel is stored within a security protected area and is monitored under programs specified by the CNSC. The International Atomic Energy Agency (IAEA) is responsible for the regular on-site monitoring of all fuel to ensure that it remains in its proper location. The IAEA affixes seals to each type of fuel storage container to ensure that no tampering occurs. OPG's on-site security program also ensures the safety of fuel. For EA planning purposes, two interim on-site storage options have been considered. This includes the expansion of the existing Darlington waste management storage structures and building an additional used fuel dry storage facility. Regardless of which alternative is chosen, it will satisfy all national and international safety and security regulations.	
Q20	**Do you study things like terrorist attacks?**	Malfunctions and Accidents TSD
A20	As part of the ongoing licensing of a nuclear power plant, safety and risk assessments are frequently undertaken. With respect to concerns about terrorism, the possibility of a deliberate aircraft crash into a nuclear power plant is the subject of studies that were performed collaboratively among all nuclear licensees in Canada (using similar studies conducted in the USA and Europe as benchmarks). While the worst-case aircraft crash would be expected to cause significant localized damage in the vicinity of the crash, it would not cause a release of radioactivity to the public. The analysis considered worst-case scenarios and assessed the consequences to the physical plant structures due to both aircraft impact and fires caused by resulting fuel explosions. The case of an aircraft packed with explosives was also assessed. All studies have been submitted to the CNSC. Specific conclusions are prescribed information and cannot be released. Accordingly, it is not deemed necessary to address the effects of a highly unlikely catastrophic accident in this EA. This work will be addressed in a Malfunctions and Accidents TSD. In addition, OPG will submit a Site Selection Threat and Risk Assessment as part of federal licensing requirements.	

TABLE 10.3-3 (Cont'd)
Public Comments and Areas of Interest

#	Question and Answer	Further discussed in
Seismicity		
Q21	**What is the potential for earthquakes? Does the EA include consideration for earthquakes?**	EIS Section 5.0
A21	Yes, the EA examined the potential for earthquakes in the area (referred to as "seismicity") and also the ability for a proposed station to withstand any such hazard. Research indicates that the Western Lake Ontario Region lies within the tectonically stable interior of the North American continent. This region is characterized by low rates of seismicity. In general, historical earthquakes in stable interior regions, such as the Lake Ontario region, occurred at depths of 5 km to 20 km on faults formed hundreds of millions of years ago during previous active tectonic episodes. These are widespread throughout the earth's crust. Nuclear stations must be seismically qualified in Canada, that is designed to withstand seismic activity. Reactor designs must comply with Canadian and International Atomic Energy Agency Standards for safety during the unlikely event of an earthquake. For example, selected plant structures, systems and components mush retain their integrity with no crackling, during and following an earthquake.	
Socio-Economic Considerations		
Q22	**How do you address jobs and the need for skilled workers?**	Socio-Economic Effects TSD
A22	As part of the EA, OPG looked at potential effects, including the nature and types of jobs that may be required throughout all phases of the Project. This provided us with the information to determine potential effects on related aspects such as housing, transportation and other infrastructure needs in the community. This will be addressed in detail in a separate TSD on the Socio- Economic Environment. With respect to the need for skilled workers, there is sufficient lead time due to the hiring of new staff over the past number of years. OPG is also working with the University of Ontario Institute Of Technology, Durham College and other post-secondary institutions to ensure educational programs are in place. OPG has invested significantly in training through internal programs and through the University Network of Excellence in Nuclear Engineering (which includes other industry partners and several Ontario universities).	
Q23	**What kind of employment will be required for this Project? How and when do I apply?**	Socio-Economic Effects TSD
A23	OPG is currently undertaking an environmental assessment for potential new nuclear units at the DN site. As well, OPG is part of a team, led by Infrastructure Ontario (IO), determining a vendor and technology for two new nuclear units at Darlington, to be operated by OPG. Current estimated timelines predict that the site preparation phase of the Project will start no earlier than 2010. For EA planning purposes, OPG has assumed it will take two years for site preparation. During that phase, we are estimating approximately 400 people would be employed on the Project. This would be followed by four to six years of construction with an estimated 3,500 jobs before the plant goes into service. During the operation phase, approximately 1,400 jobs could be created for operations related to the new units. However, until the vendor is selected through the IO process, OPG is using work force estimates for EA planning purposes and these are not finalized numbers. Once the project is approved, OPG would develop the capacity within its current operations to ensure it has a strong contingent of experienced nuclear operators and experienced nuclear engineers. This would allow us to move over experienced staff to the new station without impacting current operations.	

TABLE 10.3-3 (Cont'd)
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#	Question and Answer	Further discussed in
	Beyond the new nuclear activities, OPG is part of an industry experiencing attrition of workers due to retirements over the coming decade. OPG has been partnering with many organizations and institutions, including the University of Ontario Institute of Technology and Durham College, to ensure the company is well-prepared to meet staffing need. As well, OPG is a founding member of the Durham Strategic Energy Alliance which is committed to developing innovations and training in the energy sector.	
Q24	**What will be the effect on my property value?**	Socio-Economic Effects TSD
A24	OPG undertook a property valuation program to assess current residential property values within the Local Study Area (portions of Oshawa and Clarington). This enables OPG to compare and monitor, over time, whether property values change within the LSA and whether the change, if any, can be attributed to the NND Project. Other studies that have assessed residential property values, including a study for the Pickering B Refurbishment and Continued Operation Environmental Assessment, concluded that there is little potential for adverse effects on property values attributable to a nuclear facility. In the case of the Pickering B EA, local realtors indicated that the nuclear station had not influenced the number of sales as the turnover of properties nearest the station appeared comparable to other communities and neighbourhoods in the City of Pickering.	
Q25	**Does your EA examine the recreational usage of the Darlington Waterfront Trail?**	Socio-Economic Effects TSD
A25	Yes, the EA examines recreational use of the DN site including the waterfront trail, public walking paths, soccer and baseball fields, and related open space. OPG undertook seasonal user surveys to identify and understand the ways in which people use and enjoy the recreational resources on and in the vicinity of the DN site. The survey also identified specific factors affecting people's use and enjoyment of these recreational resources, any issues or concerns with respect to the DN site and those associated with the potential Project. The survey also quantified the number of users by season. This will be reported in the *Socio- Economic Environment Assessment of Environmental Effects TSD*. There may be a possible disruption of recreational usage at the Waterfront Trail during specific phases of the Project such as the Site Preparation and Construction phases. However, appropriate mitigation measures (i.e. measures to eliminate, reduce or control) would be identified and applied in such case to manage the disruption.	
Q26	**How do you quantify the socio-economic impact of cooling towers? Some people will associate the towers with Three Mile Island.**	Socio-Economic Effects TSD
A26	As part of socio-economic work program for the EA, OPG undertook public attitude research to assess what potential changes to community character and image may result from cooling towers on Local and Regional Study Area residents. The majority of respondents associated the potential for cooling towers as a negative change to community character and image in both the Local and Regional Study Areas.	
Q27	**How do you determine economic effect on the community, do you consider the payment of taxes?**	
A27	In the Socio-Economic Impact Assessment, we consider the many attributes that contribute to economic well-being, including the ability of a municipality to generate revenue (through the payment of taxes and other means) and its overall financial status because it has a direct bearing on the level and quality of facilities and services available to its residents and businesses	
Terrestrial Environment		
Q28	**How do you know what wildlife is already on the site? Do you take an inventory?**	Terrestrial Environment Baseline TSD
A28	Yes, OPG does take an inventory of the wildlife, as well as other flora and fauna on the site. OPG has an extensive biodiversity program at the Darlington Nuclear site which includes a comprehensive inventory of plants and animals. This program monitors and reports on breeding bird and amphibian inventories and new species (i.e. plants and animals) observed. Every five years, the Darlington site undergoes an Ecological Land Classification where the land is	

TABLE 10.3-3 (Cont'd)
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#	Question and Answer	Further discussed in
	extensively categorized based on different vegetation and soil types. For the EA, OPG added to this existing inventory database by conducting an updated and detailed assessment of current species on site. This is called "baseline characterization"; the existing environment is characterized by describing its features and characteristics.	
Q29	**Is OPG staff doing work on Bank Swallows?**	Terrestrial Environment Baseline TSD
A29	Yes, as part of the baseline data being collected for the terrestrial environment, OPG prepared an inventory of birds found on the DN site. Bank Swallows were included in this inventory. They nest in colonies in streamside, river or lake banks across much of North America. A Bank Swallow colony may range from 10 nests to nearly 2,000. OPG has documented the size of Bank Swallow colonies on the existing DN site (approximately 1,300 nests) and along the shorelines in Regional Municipality of Durham. OPG also assessed the potential for disruption the Project may cause and has identified mitigation measures.	
Transportation		
Q230	**I understand that there will be a GO Transit railway station through Bowmanville – would that help with transportation?**	Traffic and Transportation Effects TSD
A30	GO Transit intends to extend its commuter rail service from Oshawa eastward to Bowmanville, subject to the outcome of their ongoing feasibility study (expected to be completed in early 2009). While this GO rail service extension is intended to service existing and anticipated future population and other growth in the area, it could potentially attract or facilitate more growth, in turn leading to increased demand on community, recreational and other facilities and services. This will be described more fully in the *Traffic and Transportation TSD*. For the purposes of this EA, OPG assessed potential roadwork and related infrastructure to better understand site access and parking requirements for future workers. It also included an assessment of site access controls to help explain how the Project may potentially affect on-site road works such as parking and lay down areas. Off-site road works were also assessed to better understand how the Project may affect traffic patterns on public roads at shift changes and during peak construction periods. This will be documented in the Transportation TSD.	
ENVIRONMENTAL ASSESSMENT SCOPE		
EA Scope - General		
Q31	**Could the EA consider an alternative site or other technologies?**	EIS Section 1.0 and 2.0
A31	In this EA, we looked at alternative site layout options, as well as alternatives for used fuel management, low and intermediate waste management facilities and condenser cooling systems. The federal authorities provided additional direction in their Environmental Impact Statement guidelines on alternatives to be considered.	
Q32	**Will the EA assess the need for construction, demolition and abandonment of the reactors and the waste management facilities?**	EIS Section 2.0 and 13.0
A32	The EA considered three phases covering approximately 140 years including: a Site Preparation and Construction phase; an Operation and Maintenance phase; and a Decommissioning and Abandonment phase. The waste management facilities that are required to be built as part of this Project were also assessed right through to demolition and abandonment.	
EA Scope - Transmission		
Q33	**Will the EA include the effects on the transmission corridor?**	EIS Section 8.0
A33	Any potential changes to the bulk (500 kV) transmission corridor are the responsibility of Hydro One and any environmental assessment requirements would be carried out by that organization. However for this EA, OPG considered the cumulative effects of other planned or proposed projects in the area that might overlap in time or space. Potential upgrades to the existing 500 kV transmission line were included in the assessment of cumulative effects.	

TABLE 10.3-3 (Cont'd)
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#	Question and Answer	Further discussed in
EA Scope - Enriched Fuel		
Q34	**How and who will produce the enriched fuel?**	NA
A34	OPG buys fuel for its nuclear generating stations from commercial suppliers. OPG will purchase the fuel for the new reactors from commercial suppliers. There are many companies around the world that manufacture and supply enriched fuels.	
Q35	**How will enriched fuel be transported to Darlington?**	
A35	The transportation of fuel to nuclear reactors in Canada is strictly regulated by the two federal agencies, Transport Canada and the Canadian Nuclear Safety Commission. The transportation of fresh fuel to a nuclear reactor is the responsibility of the supplier. The carrier must adhere to Canadian legislation and regulations pertaining to the transportation of dangerous goods, under the federal Transportation of Dangerous Goods Act. In addition, the carrier will require a licence and will need to have an approved Transportation Security Plan from the Canadian Nuclear Safety Commission as per Packaging and Transport of Nuclear Substances Regulations and Nuclear Security Regulations. The shipment of fresh fuel (enriched or otherwise) is not within the scope of the NND EA.	EIS Section 2.0
EA Scope - Temporal Bounds		
Q36	**Why do you use 60 years as the operating life?**	EIS Section 2.0
A36	The nuclear industry has been developing and improving reactor technology for more than five decades. The next generation reactors currently under consideration for this Project have been designed for an operating life of typically 60 years (including refurbishment).	
Q37	**What is the start date for construction and how long will it take? When will the reactors be in-service?**	EIS Section 2.0
A37	Federal regulations require separate licenses for each of the five phases in the life cycle of a nuclear power plant including: site preparation; construction; operation; and decommissioning and abandonment. For EA planning purposes, it is assumed that site preparation and construction activities would not occur any earlier than 2010. It is anticipated that site preparation activities would require approximately two years and would be followed by four to six years of construction (per reactor). The EA assumes that reactor operation would occur no earlier than 2016 and would continue to 2100 (including refurbishment). The Ontario Government has indicated an approximate in-service date of July 2018.	
Q38	**Why does it take so long to complete the approvals for an existing site that already has a nuclear power plant on it?**	NA
A38	There is a comprehensive federal approvals process that must be followed prior to the construction and operation of a nuclear power plant. While environmental studies were undertaken in the 1970's during the planning of the existing DNGS, federal EA requirements were not established until 1995 under the *CEAA.* The CNSC is mandated, under the *NSCA* to regulate all nuclear facilities and nuclear-related activities in Canada. There are many stages in the life cycle of nuclear facilities; before any person or company can prepare a site for, construct, operate, decommission or abandon a nuclear facility - or possess, use, transport or store nuclear substances - they must obtain a corresponding licence from the CNSC. There are a number of steps in the licensing process which OPG must follow as part of this potential Project: submitting a license application to prepare a site for construction; a federal environmental assessment to ensure that the Project will not cause adverse effects to the environment; submitting applications for a construction licence, an operating licence, and ultimately decommissioning and abandonment licences.	
EA Scope - Uranium Fuel Cycle		
Q39	**Shouldn't this EA include consideration of the uranium fuel life cycle?**	EIS Section 2.0
A39	The CNSC guide on licensing processes for new nuclear power plants states that before a Licence to Prepare Site can be issued, an EA must be completed. The guide indicates that the EA must	

TABLE 10.3-3 (Cont'd)
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	examine the five phases in the life cycle of the plant (i.e. siting, construction, operation, decommissioning and abandonment). It does not include the uranium fuel life cycle. Secondly, the final EIS Guidelines were issued in March, 2009, following a public review process. The EIS Guidelines describe the scope of the Project to be assessed. The Guidelines do not include uranium mining or milling. Thirdly, the licensing process for new uranium mines is governed by the CNSC. The Uranium Mines and Mills Regulations set out the requirements for the following phases in the life-cycle of a uranium mine or mill: • A licence to prepare a site and to construct; • A licence to operate; • A licence to decommission; and • A licence to abandon. Prior to any such licence being granted, the *CEAA* stipulates that an environmental assessment (EA) must be carried out to identify whether a project is likely to cause significant adverse environmental effects, taking into account the appropriate mitigation measures. Only with a positive EA result can the licensing process continue.	
Q40	**Can you explain subsurface rights versus underground rights?**	NA
A40	For the purpose of mineral exploration in Ontario, the *Mining Act* defines two types of land rights and ownership. "Mining Rights" are the rights to minerals on, in or under any land; and "surface rights" are all other rights, besides mining rights, in land. These distinctive land rights may be held by the same person or could be held separately. If the Crown holds the mining rights on lands that are open for staking, any person with a prospector's licence may stake the land and attain the exclusive right to explore for minerals	
ENVIRONMENTAL ASSESSMENT PROCESS AND METHODOLOGY		
EA Process, Planning and Decision Making		
Q41	**Has a decision been made to proceed with this Project?**	EIS Section 1.0
A41	Final approval has not been received to construct a new nuclear power plant at the Darlington site. OPG is undertaking a federal environmental assessment to determine the environmental suitability of the site for this potential Project. The EA is an important piece of work required of the licensing process. A series of decisions will have to be made by OPG, the Province of Ontario, the federal Minister of Environment and the CNSC (among others) in order for the Project to proceed.	
Q42	**Why does this potential Project require a federal EA rather than a provincial EA?**	EIS Section 1.0
A42	Nuclear power plants are regulated by the federal government and therefore the federal EA process applies. The Canadian Transportation Agency, Fisheries and Oceans Canada and Transport Canada are also participating as they may have a regulatory role in the approvals process.	
Q43	**Is OPG conducting this EA itself or are independent studies being done?**	NA
A43	OPG is responsible for the conduct of the environmental assessment and the submission of the Environmental Impact Statement to the joint review panel. In doing its work, OPG relies on a team of over 10 consulting organizations with a team of more than 50 professionals. In addition, we draw on the expertise of numerous OPG employees and we hire specialists in most of the major technical areas, including human health. Our work is subject to peer review and will be reviewed by internal and external experts (some of which are hired by OPG and others to be hired by an independent review panel).	
Q44	**Does the EA look at the fact that the reactor technologies have never really been used before?**	EIS Section 1.0
A44	The reactor technologies being considered for this potential Project are evolutionary (i.e.	

TABLE 10.3-3 (Cont'd)
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	advanced) versions of existing reactor designs. Regardless of which technology is chosen by the Ontario Government, it must and will satisfy all regulations set out by the federal nuclear regulator – the CNSC.	
Q45	**How is the EA decision made?**	NA
A45	The major outcome of an EA is to determine whether or not a Project is likely to cause significant adverse environmental effects. The significance of potential environmental effects is determined by a combination of scientific data, regulated thresholds, standards, social values and professional judgment. In order for this Project to proceed for further review by OPG and the Province, the successful completion of a federal EA must be accomplished. The joint review panel will reach a conclusion on the significance of the environmental effects of the Project and will submit its report to the federal Minister of the Environment and the responsible authority (i.e. the CNSC). The federal Cabinet will approve the government's response to the panel's conclusions and recommendations.	
Q46	**How are Joint Review Panel members chosen?**	
A46	Under the *Canadian Environmental Assessment Act* and the *Nuclear Safety and Control Act*, a joint review panel is established to undertake an environmental assessment and regulatory review of Projects with higher potential for adverse environmental effects. The panel is comprised of subject matter experts selected by the federal Minister of the Environment on the basis of their knowledge and expertise.	
Q47	**Some people support nuclear power and others feel that it is too risky – how do you deal with that in the EA?**	EIS
A47	In the conduct of the EA we seek to determine what, if any, potential environmental effects may occur from the construction, operation and decommissioning of a proposed nuclear power plant. That involves a detailed assessment of the nature of the potential risks of nuclear generation and how they may be managed. Importantly, this EA is being undertaken in a way that encourages input and feedback from members of the public. Once OPG has completed its studies, an independent joint review panel will examine the work and determine if it is satisfactory.	
EA Significance		
Q48	**How does OPG determine the significance of an environmental impact?**	EIS Section 9.0
A48	Each potential project related work or activity is screened to identify those that might have an effect on the environment. The outcome of the screening will be a large table or matrix which will describe where a Project-environment interaction is likely to occur. These interactions are then further assessed to identify those that are likely to result in a measurable change on the environment, and if so, to determine the nature and magnitude of that effect. A measurable change is typically defined as a change in the environment that is real, observable, or detectable compared with existing conditions. In the final step, each residual adverse environmental effect is assessed to determine if it is significant. Significance criteria typically measure: • Magnitude or severity of the effect; • Geographic or spatial extent; • Duration of the effect; • Frequency and probability of the effect; • Reversibility of the effect; and • Ecological importance and societal value of the affected resource or attribute. As part of the EA, OPG provides opportunities for the public and key stakeholders to assist in identifying and determining significance criteria.	

TABLE 10.3-3 (Cont'd)
Public Comments and Areas of Interest

#	Question and Answer	Further discussed in
Q49	**Is the public involved in the determination of significance?**	EIS Section 10.4.
A49	OPG recognizes the public as an important source of local and traditional knowledge for both the Darlington site and the potential environmental effects of this Project. OPG continues to encourage members of the public to provide feedback on aspects of the environment they feel should be included in this environmental assessment. Such feedback helps OPG identify features of the environment to be considered in the effects assessment for the Project. The methodology of assessing significance and the results of the significance analysis are being discussed with the public at Community Information Sessions.	
EA Cumulative Effects		
Q50	**What are the cumulative effects associated with this Project?**	EIS Section 8.0
A50	The general conclusion is that the largest potential for cumulative effects may be in the area of transportation, on local roads, during the period 2010 – 2014, as a consequence of the currently planned projects in the area.	
Q51	**Regarding cumulative impacts to the lake and the potential increase in lake water temperature: when you consider the hardening of the shoreline and climate change, what impact is there? There will be a loss of green space.**	EIS Section 8.0
A51	In conducting the EA, OPG assessed the potential effects that the project may have on the environment with consideration for the potential effects of other projects in the vicinity that may occur at the same time or in the same geographic area. Shoreline hardening and climate change were not identified as potential cumulative effects of the project. Interactions between the NND Project and Lake Ontario effects were either low or negligible. Increased lake water temperatures could lead to warmer intake water temperature and increased algal and zebra mussel growth and alteration of fish communities. However, the deep water intake structure design minimizes these potential effects The EA does consider the effects of climate and climate change on the NND Project. The proposed NND Project may extend to approximately 2100 and therefore, may be subject to changes in climate. The climate change parameters that are considered to have a potential interaction with the NND physical structures and systems include Lake Ontario effects, including water temperature and water level. Surface layers of Lake Ontario are predicted to increase by approximately 3-5 degrees Celsius by 2050 due to warmer air temperatures and lake water levels are expected to decrease by as much as a metre.	
Q52	**Have you considered the development of Seaton and the Pickering airport?**	
A52	As part of the Cumulative Effects Assessment, we undertook a broad screening of projects and activities that might have the potential to cause adverse effects on the environment overlapping one or more of the identified residual effects of the proposed NND Project. this included, among other projects, the Pickering Airport and Growth and Development in Regional Communities	
EA - Process		
Q53	**What is the role and function of a joint review panel?**	EIS Section 1.0
A53	Under the *CEAA* and the *NSCA*, a joint review panel is established to undertake an environmental assessment and regulatory review of Projects with higher potential for adverse environmental effects. The panel is comprised of subject matter experts selected by the federal Minister of the Environment on the basis of their knowledge and expertise. Joint review panels have the capacity to encourage open discussion among large numbers of people by allowing individuals to present evidence, concerns and recommendations at public hearings. A panel allows the proponent (OPG) to present its potential project to the public and explain the projected environmental effects. It also provides an opportunity for the public to hear the views of government experts about the project.	

TABLE 10.3-3 (Cont'd)
Public Comments and Areas of Interest

#	Question and Answer	Further discussed in
	Following public hearings, a joint review panel prepares and submits a report that includes, but is not limited to, the rationale, conclusions and recommendations relating to the environmental assessment of a project, including any mitigation measures and follow-up program. Subsequently, the joint review panel makes its decision on whether to grant a Licence to Prepare a Site under the *NSCA*.	
Q54	**Will this Project be subject to a review panel? If so, when will this decision be made?**	NA
A54	In June 2007, the CNSC announced the start of the EA for this Project. In March 2008, the federal Minister of Environment announced that a review panel would be established for this Project. OPG will work to satisfy the requirements as laid out by the federal authorities and the Joint Review Panel. Updates to the JRP process is on the CEA Agency website darlington.review@ceaa-acee.gc.ca	
EA - Valued Ecosystem Components		
Q55	**What is a Valued Ecosystem Component (VEC)?**	EIS Section 4.0
A55	A VEC is a feature of the environment selected to be the focus of an environmental assessment because of its ecological, social and economical value, and its potential vulnerability to effects of a project. VECs can be individual species or important groups of species within a food chain. They can also be resources or features valued for their uniqueness or importance in maintaining the economic base, social structure and/or community stability. The potential effects of a project are predicted and evaluated for each VEC. This ensures that all likely effects can be measured and compared with existing conditions and environmental standards.	
Q56	**How can the public provide input on the Valued Ecosystem Components?**	EIS Section 10.4
A56	Public input is an important factor when selecting Valued Ecosystem Components (VECs) for assessment. OPG seeks public input on the selected areas of study, as well as the section of VECs. The preliminary list of environmental features was shared at OPG's spring 2008 Community Information Sessions and posted on the Project website for comment and feedback. A draft list of VECs was released for public review and comment during the fourth round of information sessions in fall 2008.	
PROJECT AND SITE CONSIDERATIONS		
Site and Layout Options		
Q57	**Why is Darlington the preferred site for the potential Project?**	EIS Section 2.0
A57	The Province directed OPG to consider new nuclear generation at an existing site. OPG considered its two existing nuclear sites and determined that Darlington was the best site for new nuclear generation for the following reasons: • There is room to build at the DN site; • The site is located beside a major transmission corridor and load centre; • OPG has extensive operating experience and knowledge of the site; and • There is a history of support from local and regional governments. The Pickering Nuclear site was the only other possible site and it does not offer the same opportunities as the DN site.	
Q58	**How many units can you fit on the site?**	EIS Section 2.0
A58	The three reactor types under consideration for this Project include: the ACR-1000 (AECL); the EPR (AREVA); and the AP1000 (Westinghouse). The EA considers all three of these reactor alternatives, and in the context of the number of units required to achieve the 4,800 MW electrical power generation objective (i.e. four ACR-1000s would be required to achieve 4,340 MW; three EPRs would be required to achieve 4,740 MW; four AP1000 reactors would be required to achieve 4,148 MW).	

TABLE 10.3-3 (Cont'd)
Public Comments and Areas of Interest

#	Question and Answer	Further discussed in
	The number of reactor units that can fit on the Darlington Nuclear site is primarily determined by the reactor technology and the condenser cooling system. The natural draft and fan assisted atmospheric towers require more surface land area on the site (and therefore restrict the amount of space for the reactor units).	
Q59	**Will you have enough land to construct everything you need for four new reactors?**	EIS Section 2.0
A59	OPG is conducting studies to determine how much additional nuclear power can be safely constructed and operated at the DN site. The purpose of the Project, if approved, is to construct and operate a nuclear power plant that generates up to 4,800 MW of base-load electricity from up to four nuclear reactors. The DN site is approximately 480 hectares in size and studies have been undertaken to determine all infrastructure requirements and how they can be accommodated on the site.	
Q60	**Are there any existing constraints (e.g. St. Marys Cement)?**	EIS Section 4.0
A60	There are no specific constraints on site layout from neighbouring properties. Potential effects on the LSA (including neighbouring properties) have been assessed as part of this EA. Mitigation measures have involved discussions and agreements with neighbouring property owners.	
Q61	**Will proximity to St. Marys affect your ability to operate safely?**	NA
A61	The existence of St. Marys cement, adjacent to the site, does not pose a problem for the existing nuclear power plant and would not interfere with the safety of OPG's operations should a new plant be constructed.	
Q62	**Will this Project require alteration to existing roads? Will the potential impacts be assessed?**	Traffic and Transportation TSD
A62	As part of the EA, OPG considered alternative site layouts. In developing alternative layouts, road infrastructure was assessed. The technical studies conducted for the EA considered changes that the Project may have on traffic patterns on Highway 401 and arterial roads. This will be described in full in the *Traffic and Transportation Assessment of Environmental Effects TSD*. OPG is the founding member of the Darlington Planning and Infrastructure Information Sharing Committee involving local and regional municipalities and the Ministry of Transportation. This Committee continues to meet regularly to discuss major development projects in Regional Municipality of Durham and helped identify and mitigate potential impacts of this potential Project, including those relating to transportation.	
Q63	**Where on the Darlington site will the proposed reactors be built?**	EIS Section 2.0
A63	The proposed Project area designated for new nuclear is approximately 180 hectares (445 acres) in size. There is enough undeveloped space to construct the proposed plant on the eastern portion of the site, south of the CN rail line. Although model plant layouts have been identified, the actual site layout will be determined by the reactor vendor chosen for this Project. The safe operation of Darlington's existing station and waste management facility would not be affected by site preparation and construction activities. The area for new build would be fenced off and a separate entrance would be constructed. Safe and responsible operation remains our priority at OPG.	
Q64	**Did you consider an alternative to lake infill?**	EIS Section 2.0
A64	The EIS Guidelines require that an EIS include a relative consideration of the environmental effects of alternative means of carrying out the Project that are technically and economically feasible. Technical and economic feasibility were determined on the basis of professional judgment by the Project team. The Project team relied on operating experience and precedents to determine whether the technical and economic feasibility of alternatives was reasonable. In the case of lake infill, it was determined early in the planning process that physical protection of the DN site would require some lake fill to restore shoreline stabilization. A variation that did not involve lake infill was screened out as not technically feasible. The extent of lake infill was maximized to allow for additional construction area. The extent is considered the bounding	

TABLE 10.3-3 (Cont'd)
Public Comments and Areas of Interest

#	Question and Answer	Further discussed in
	condition for lake infill and which would result in the greatest associated effect. As the Project design advances, the extent of lake infill may lessen.	
Lake Infill		
Q65	**What will be done with the excavated soil?**	EIS Section 2.0
A65	A soil management plan will be developed to ensure that the excavated soil and rock are managed appropriately. A number of options exist, including creating a new soil stockpile in the northeast corner of the site; potentially adding to the existing soil stockpile in the northwest corner; creating lake infill; and possibly moving some off site to an appropriate soil disposal area.	
Q66	**What are the potential environmental effects of soil excavation and lake fill?**	EIS Section 5.0 and 9.0
A66	The potential effects of soil excavation and lake infill are largely with respect to surface water and the aquatic environment. A cofferdam would be established and the enclosed area drained, any vegetative or aquatic species would be removed. The lake infill area would then be filled with the excavated soil. It is possible that there may be a loss of some aquatic species. These are considered residual effects and have been assessed as not significant.	
CONDENSER COOLING		
Relationship to Reactor Design		
Q67	**Are the condenser cooling alternatives specific to particular reactor designs?**	EIS Section 2.2.2
A67	All nuclear reactors require condenser cooling and all nuclear reactor designs can either use lake water cooling or atmospheric cooling (i.e. cooling towers). Both forms of cooling are considered in this EA. If cooling towers are to be used, the actual number required would depend on the number of reactor units, the size and capacity of the reactor units, and the type of cooling tower (i.e. natural draft or mechanical draft). A natural draft cooling tower may be up to 170 m in height and 100 m in diameter. A natural draft cooling tower (including support facilities such as equipment sheds, basins, canals or shoreline buffer areas) can require up to 8 ha of land. A minimum of one natural draft cooling tower is required for one reactor unit and a minimum of two cooling towers for two units. However one reactor unit may also have two towers for operational (backup) purposes. A mechanical draft cooling tower is typically 20 m in height and may require up to 20 ha of land (including support facilities such as equipment sheds, basins, canals or shoreline buffer areas). The configuration of the mechanical draft cooling towers, including how many would be required if built, has not yet been determined.	
Cooling Towers		
Q68	**What are the potential effects of the cooling towers?**	EIS Section 5.0
A68	There are a range of potential effects associated with cooling towers, including effects on visual effects, traffic and atmospheric emissions. These are discussed in item Q58 below.	
Q69	**Does the EA assess the potential effects of cooling towers specifically in terms of visual effects, traffic and atmospheric emissions?**	EIS Section 5.0

TABLE 10.3-3 (Cont'd)
Public Comments and Areas of Interest

#	Question and Answer	Further discussed in
A69	In the EA we studied the potential environmental effects of cooling towers from a number of perspectives: • Visual Effects: As part of the land use and visual environment we undertook an assessment of the view shed of the site. This involved an image of what the site would look like with a cooling tower and an assessment of the change in appearance and visibility of the site within the LSA. • Atmospheric Emissions: One particular area of interest was with respect to the atmospheric emissions from cooling towers. In addition to heat, cooling towers have chemical emissions that would need to be controlled. In winter conditions, atmospheric emissions may also contribute to fogging and icing in the surrounding areas. These types of considerations were assessed and will be discussed in the EIS. • Water-related Effects: We also examined lake circulation, water temperature, aquatic biota and water withdrawal from the lake. • Land Excavation: The land excavation required for the footprint of the cooling structures was also considered.	
Once Through Lake Water Cooling		
Q70	**How will the EA assess the potential effect that a once through cooling system may have on the lake?**	Surface Water Effects TSD
A70	In this EA we studied the potential environmental effects a once through cooling system may have on the lake by looking at: • Lake Circulation: Water velocities and directions near cooling water withdrawals and discharges, and cooling water withdrawal volumes and rates. • Water Temperature: Thermal plume behaviour, thermal plume locations and sizes, and cooling water discharge temperature. • The potential for fish impingement and entrainment were also assessed. OPG has many years of operating experience with once through lake water cooling systems. At the DNGS, lake water cooling involves bringing large volumes of lake water into the plant through a lake bottom intake tunnel located 700 m offshore at a depth of 10 m. The intake structure is designed to minimize potential adverse effects on fish and other organisms. The lake water is screened to remove debris, algae and other materials before use in cooling systems within the plant. Once used, the warmed water is returned to the lake through a discharge and diffuser pipe that runs approximately 1,560 m offshore. This minimizes the heat impact on the lake and the potential for the recirculation of heated water.	
Q71	**Does a once through lake water cooling system pose any danger to marine traffic?**	Traffic and Transportation Effects TSD
A71	OPG assessed the potential effects of this type of cooling system including whether it might pose any danger to marine traffic. OPG has been operating once through lake water cooling systems at its existing nuclear power plants and has not identified to date, any danger to marine traffic.	
Use of Waste Heat		
Q72	**Why not use the waste heat from the cooling water for other purposes?**	NA
A72	Typically, condenser cooling systems in nuclear power plants produce a low-temperature waste heat stream, one that is very diffuse and only slightly warmer than the surrounding water temperature. To help put this into context, the temperature of the discharge, in absolutely terms, is no more than 5% warmer than the surrounding water. There are very few efficient uses for low temperature heat and the economic benefits of waste heat recovery generally do not justify the cost of recovery systems. Having the ability to recover waste heat in an efficient and meaningful way would require a larger temperature difference than is generally produced by a nuclear power plant.	

TABLE 10.3-3 (Cont'd)
Public Comments and Areas of Interest

#	Question and Answer	Further discussed in
	A recent article appearing in a Finnish newspaper reported efforts by the Mayor of Helsinki to investigate the use of a nuclear reactor to serve the district heating needs of Helsinki. The article noted that the ability to utilize reactors in this manner is difficult because steam is not produced at a temperature high enough to allow for a productive contribution to local area heating without compromising the electrical output of the plant.[14]	
MANAGEMENT OF NUCLEAR WASTE AND USED FUEL		
Site Preparation and Construction Waste		
Q73	**How does the EA consider the management of waste produced during site preparation and construction?**	EIS Section 2.0
A73	The EA considers all waste streams produced during the life cycle of a nuclear power plant. This includes site preparation and construction wastes which will be re-used or recycled where feasible. Non-hazardous solid wastes meeting landfill requirements may be disposed of accordingly in a licensed landfill.	
Low and Intermediate Level Waste		
Q74	**Will OPG manage low-level radioactive waste on-site, or will it be transported to a new off-site facility?**	Nuclear Waste Management TSD
A74	Currently, low-level radioactive waste produced at OPG's nuclear stations is shipped by truck, via CNSC-licensed steel containers, to OPG's Western Waste Management Facility (Kincardine, Ontario) for processing and storage. Low-level waste includes items such as used mops, rags and protective clothing. Waste minimization programs are used to reduce the amount of waste sent for interim storage. The EA considered two alternative means for managing low-level radioactive waste including: transporting the waste offsite to be managed at an appropriately licensed nuclear waste management facility; or managing the waste in a new low and intermediate level radioactive waste management facility on the DN site.	
Q75	**What is in place for the long-term management of low and intermediate level radioactive waste?**	Nuclear Waste Management TSD
A75	The EA makes provision for the management of low and intermediate level waste from this Project (e.g. rags, used reactor components, etc.). The EA study indicates that the wastes will be managed at an appropriately licensed facility. No decision has been made regarding the final location for the long-term management of low and intermediate level wastes from this potential Project. OPG is conducting a separate EA on the potential construction and operation of a Deep Geologic Repository (DGR) for the long-term management of low and intermediate level nuclear waste on the OPG lands adjacent to the Western Waste Management Facility (WWMF) in Kincardine, Ontario. For more information about this Project, please visit www.opg.com/dgr. While the EA does not specifically address wastes from new reactors, the hosting agreement with the Municipality of Kincardine does not exclude these wastes from the Deep Geological Repository Project.	
Used Fuel		
Q76	**How do you ensure that used fuel managed on-site is safe?**	Nuclear Waste Management TSD
A76	OPG has been safely storing used nuclear fuel at reactor sites for nearly 40 years. Used fuel, after being removed from the reactor by remote control, is moved to water filled bays for a minimum of 10 years, to cool in temperature and to shield workers and the environment from radiation. The fuel is then transferred to CNSC-licensed dry storage containers on the reactor site. The dry storage containers are steel-encased concrete and welded shut to protect workers and the public.	

[14] Helsingin Sanomat, International Edition - Metro. February 2009.

TABLE 10.3-3 (Cont'd)
Public Comments and Areas of Interest

#	Question and Answer	Further discussed in
	These containers are kept in a separate facility on the station site which is licensed by the CNSC. The International Atomic Energy Agency affixes seals and monitors the containers throughout the entire storage period.	
Q77	**Do different reactor technologies require different methods for storing used fuel?**	Nuclear Waste Management TSD
A77	Used fuel consists of fuel that has been used by a nuclear power plant to generate electricity. Used fuel is managed in a two-stage process, regardless of which reactor technology is employed: 1. Wet storage which allows for initial cooling of the used fuel and shielding; followed by, 2. Dry storage for longer term interim storage. However, these facilities may differ to accommodate the different physical characteristics of different fuel bundles or assemblies. For example, the Advanced CANDU type reactor typically has 6,240 fuel bundles (12 bundles in each of the 520 fuel channels). Each bundle is approximately 0.5 m long. A typical PWR reactor has 150-260 fuel assemblies that contain 200-300 rods each. The fuel assembly is about 4 to 5 m long, so the containers would be sized differently to accommodate this. The containers would also be designed to handle the radiological properties of the PWR fuel. Dry storage of PWR fuel is common in many countries around the world including Germany, Switzerland and the United States.	
Q78	**Is there a plan for the long-term management of used nuclear fuel?**	Nuclear Waste Management TSD EIS Section 2.0
A78	The Nuclear Waste Management Organization (NWMO) was established in 2002 and is responsible for the long-term management of used nuclear fuel in Canada. The Government of Canada approved "Adaptive Phased Management" as Canada's approach to the long-term management of used nuclear fuel in 2007. This plan involves establishing a central repository for all used fuel (either above ground or slightly below ground) and eventually moving the used fuel into a deep geological repository where it will be continuously monitored and made retrievable. The NWMO is currently developing the siting process for the central repository. In June 2009, the NWMO published a "Draft Siting Process Plan" for public review and comment. For the EA, it is assumed that the used fuel from the new station will be stored in one of two interim on-site storage facilities until it is time to move it to a long-term waste management facility.	
Q79	**What if the long-term plan for used fuel doesn't go ahead? Does the EA account for this possibility?**	Nuclear Waste Management TSD
A79	Canada's plan for the long-term management of used nuclear fuel is Adaptive Phased Management. This plan was accepted by the Federal Government in 2007 and the NWMO is actively working to develop a site selection process for a centralized used fuel storage facility for all used fuel in Canada. The plan does not have defined timelines at this point. At the same time, the EA provides for the interim dry storage of over 50% of the used fuel that would be generated by the new nuclear reactors. This would follow a period of wet storage of approximately 10 years (which allows for initial cooling and shielding). An EA for additional storage space can be conducted in future years if required.	
Decommissioning		
Q80	**What happens to all of the waste produced during decommissioning? Isn't most of it toxic?**	EIS Section 12
A80	After a nuclear power plant is closed and removed from service, it must be decommissioned. The majority of the material, such as concrete rubble, is non-radioactive, non-hazardous and non-toxic. This material will be re-used or recycled where feasible. All waste material that cannot be re-used or recycled will be managed at an appropriately licensed facility.	

TABLE 10.3-3 (Cont'd)
Public Comments and Areas of Interest

#	Question and Answer	Further discussed in
	Decommissioning also entails the removal and disposal of radioactive components and materials, such as the reactor and associated piping, and the cleanup of radioactive or hazardous contamination that may remain in the buildings and on the site. However, the radioactive portion of the waste is a small percentage of the total amount of decommissioning waste (typically 10 to 20%).	
Q81	**What will the site look like after decommissioning?**	EIS Section 12.0
A81	After the plant is dismantled and all of the materials removed, the operating licence is terminated and the site will be restored to a brown field state which will be available for other industrial uses. This will be addressed in the *Nuclear Waste Management TSD*.	
LICENSING PROCESS		
Q82	**What is the status of the Site Preparation Licence?**	NA
A82	OPG submitted a preliminary Site Preparation Licence Application in September 2006 to begin the federal approvals process for this Project. Since then, OPG has been working to identify and complete the full range of additional studies that are required for this application and make sure they are completed on time. OPG will make a supplementary submission in support of this licence application to the CNSC in 2009 along with the submission of the EIS. This will be followed by a public hearing.	
Q83	**How do the regulatory requirements for this Project compare with those used in the United States?**	NA
A83	In Canada, separate licences are required from the CNSC to: • Prepare a site for a new nuclear power plant; • Construct a new nuclear power plant; and • Operate the plant once constructed. Before the licence to prepare a site is granted, the Project has to undergo an environmental assessment as required by the *CEAA*. Public involvement is built into both the environmental assessment process and the licensing process for both the construction and operating licences. In the United States, two alternative licensing processes are available under federal regulations. In one instance, an applicant requires a construction permit to build the plant and an operating licence to operate it. Alternatively, an applicant can obtain an Early Site Permit to obtain approval for a particular site and a combined construction permit and operating licence to build and operate the plant. As in Canada, an environmental review must be conducted before a construction permit is issued and there is opportunity for public involvement. However, in the U.S. a public hearing is not mandatory for an operating licence application.	
PUBLIC CONSULTATION		
Q84	**What ability does the public have to provide input and influence decisions that are made for this Project?**	EIS Section 10.0
A84	There are many opportunities for public input into the EA process. OPG (the Project proponent) has been providing opportunities for public input since the fall of 2006 and will continue to do so well into 2009. Input could be provided in a variety of ways including OPG's Project website, Project toll free information number and by mail. Input can also be provided in person at Community Information Sessions; OPG's Community Kiosk and at other community based events. In addition, the CEA Agency provides opportunities for public input into the EA guidelines for this Project, as well as for the panel agreement and terms. The joint review panel will provide opportunities for the public to review the adequacy of the studies and participate in public hearings on the EA. Once the joint review panel issues its report, the public may also provide comments to the federal Minister of the Environment.	

TABLE 10.3-3 (Cont'd)
Public Comments and Areas of Interest

#	Question and Answer	Further discussed in
Q85	**How many people attend OPG's Community Information Sessions?**	EIS Section 10.0
A85	On average, approximately 200 people attend each round of Community Information Sessions (there have been five rounds to date). OPG has also provided information on the Project and the EA Study to over 7,000 residents and the general public through participation at community events. We also have an information resource centre (referred to as the "OPG Community Kiosk") in the Bowmanville Mall. The Community Kiosk provides the community with easy access to information about the Project, a place to ask questions, speak to staff and learn about the Project and EA. There have been over 1,500 visitors to the Community Kiosk since it was opened.	
Q86	**What other communities are involved in this EA Study?**	EIS Section 10.0
A86	Historically, the focus of communications for EAs conducted at the Darlington Nuclear site has been with the Municipality of Clarington as the host community, adjacent communities within 10 kilometres of the Project (i.e. the City of Oshawa) and communities within the Regional Study Area. The RSA for the NND EA extends approximately from the Port Hope/Cobourg area in the east, to Toronto in the west (the eastern area, formerly Scarborough), and north to Port Perry in the Township of Scugog. The communication and consultation program seeks to involve the general public, potentially affected residents, local elected officials, government agencies with an interest in the project, established community committees and other local stakeholder groups. OPG also recognizes broader communities of interest, generally represented by regional and national groups with an interest in energy and environmental issues. To ensure that this broader community of interest has the opportunity to participate in the planning and conduct of the EA studies, a number of groups and organizations have been identified and included in Project notifications and invitations to participate.	
Q87	**Where can we talk about things like the ethics of nuclear power?**	EIS Section 10.0
A87	The EA for OPG NND includes consideration for human and social components as well as physical environmental components. From this perspective, ethical considerations, such as fairness, equity and intergenerational considerations are particularly important in a Project with a temporal scope of approximately 140 years. OPG welcomes input on these matters and will consider a potential dialogue forum on intergenerational considerations.	
Q88	**What is the purpose of the OPG's Bowmanville Community Kiosk? What can people learn at this facility?**	EIS Section 10.0
A88	OPG's Bowmanville Community Kiosk was established in May 2008 and is located in the Bowmanville Mall. The purpose of the Community Kiosk is to serve as a resource centre for local residents who wish to obtain information on the EA and/or speak directly with an OPG staff member about the Project. Visitors to the Community Kiosk can learn about the variety of environmental considerations included in this EA and are encouraged to provide feedback to OPG staff (e.g. regarding VECs, mitigation measures, cumulative effects, etc.). Information can be accessed at the Community Kiosk in multiple forms including: asking questions or engaging in discussion with an OPG staff member; using the public access computer terminal; viewing videos; obtaining project literature; and viewing the information wall displays.	
NUCLEAR TECHNOLOGY		
Q89	**How does a nuclear plant generate electricity?**	NA
A89	Nuclear reactors do the same job as conventional power plants in the generation of electricity by producing heat to convert water into steam. The steam then spins a turbine and a generator to make electricity. Instead of coal, oil or natural gas, nuclear reactors use uranium for fuel. Uranium atoms make heat by splitting; the technical term is "fissioning".	

TABLE 10.3-3 (Cont'd)
Public Comments and Areas of Interest

#	Question and Answer	Further discussed in
	When a neutron strikes an atom of uranium, the uranium atom splits into two lighter atoms (which are called fission products) and releases heat at the same time. The fissioning process also releases one to three additional neutrons that can split other uranium atoms. This is the beginning of a "chain reaction" in which more uranium atoms are split, releasing more neutrons and thus, heat. In a nuclear reactor, the chain reaction is tightly controlled to produce only the amount of heat needed to generate a specific amount of electricity.	
Q90	**What process is used to manage the emissions of tritium from a nuclear power plant?**	NA
A90	Safety is the key consideration at all OPG facilities. We are keenly aware of the need to protect our workers, the environment and the people who live and work near our facilities. Tritiated heavy water vapour is contained within the reactor building. Vapour recovery dryers remove a majority of tritium in the air within the reactor building. A small quantity of tritium is released to the atmosphere when dried air is vented from the reactor building and these amounts are kept well within regulatory limits. During the normal operation of OPG's CANDU nuclear reactors, a small amount of tritium is emitted from the reactor to the lake and atmosphere as a by-product of the nuclear process. Tritiated heavy water from the reactors is shipped to the Tritium Removal Facility at OPG's Darlington Nuclear site. The Tritium Removal Facility extracts tritium from heavy water and is safely stored in a concrete vault. Tritium that has been diluted by light water to a point, at which it cannot be reused, is processed by the Active Water Management System and released to the lake providing discharge limits are met. The rate and quantity of tritium emissions from airborne and waterborne effluents are continuously monitored to ensure that emissions do not exceed the CNSC's approved emission limit referred to as the Derived Release Limit. In addition, the proper control of tritium emissions is independently verified and confirmed by the Radiological Environment Monitoring Program. This program monitors tritium content in various environmental media in the vicinity of the reactor site. Sampling and measurements of tritium concentrations in the lake water, well water and drinking water from nearby water supply plants are routinely taken under this program.	

10.3.4.2 Electricity System Context

As OPG undertook its communications and consultation, there was a high degree of interest in a number of matters that set the context for the NND Project. This included discussions about Ontario's electricity system and the long term plan for energy (e.g. how it works, decision making responsibilities for long term planning, what forms of generation are being considered and why); the reactor technology and vendor selection process (initially, many people were surprised to learn that Ontario would consider a variety of reactor technologies in addition to CANDU technology); long term management of nuclear waste and used fuel; financial considerations; and, the relationship of the decision making processes for these matters. These areas are described below, along with OPG responses. Table 10.3-4 provides a listing of frequently asked questions and OPG's response.

Ontario's Electricity System

Many questions pertained to the structure of, and plan for Ontario's electricity system (present and future). Specifically, interest was expressed in how future demands and perceived gaps for electricity supply would be addressed, and whether alternative forms of electricity generation would be considered. Participants wanted to know how this Project would satisfy the government's goals for base-load nuclear capacity, and the operating status of OPG's existing nuclear generating stations. Participants also inquired whether additional transmission infrastructure would be required for the Project. Understanding was also sought on the type of EA required if additional transmission infrastructure was needed. It was also brought to OPG's attention that some members of the public feel that they lack the appropriate forum to discuss Ontario's electricity system and energy policy, and therefore raised their concerns to OPG at its public sessions.

In response, OPG noted that the roles and responsibilities for electricity system planning have changed over the years. At one time, Ontario Hydro (predecessor to OPG) was responsible for system planning, generation and transmission. However in 1999, Ontario Hydro was replaced by several successor companies. In turn, the responsibilities for establishing a provincial supply plan and pursuing alternative energy initiatives has been assigned to other organizations. Currently there exist a number of agencies involved in electricity supply, including:

- The OPA - responsible for long term supply planning for the Province of Ontario;
- The IESO - responsible for short term/daily market management;
- OPG - responsible for the operations of its fleet of generating stations;
- Bruce Power and other private companies – electricity generators;
- Hydro One - responsible for transmission system development and some aspects of distribution; and
- A number of smaller utilities and distribution companies that provide the wires to ensure delivery to homes.

OPG staff also informed public members of the OPA website, www.powerauthority.on.ca should they require more information on provincial plans for the generation and distribution of electricity.

Reactor Technology and Vendor Selection Considerations

Many questions were asked about the reactor technology and vendor selection process. Many people were initially surprised to learn that Ontario was considering alternative reactor technologies in addition to CANDU technology. This raised many questions specifically regarding: reactor technology selection (e.g. criteria for selection, fuel type considerations, whether AECL was a preferred vendor, whether other vendors and technologies were being considered, and reactor type considerations concerning cost, waste and environmental effects); and clarification of the decision making process (e.g. who will decide on technology and vendor choice – the government or OPG, whether it would it be a political decision, what skills the Province has to select a nuclear vendor, what role would the operator play in the decision process, etc.). Interest was also expressed in understanding what opportunities are available to public members who wish to participate in decision making processes.

In response, OPG staff explained that the vendor selection process was the responsibility of the Ontario Government agency, Infrastructure Ontario. OPG staff explained that the Infrastructure Ontario will make the decision regarding technology and vendor selection and that, the decision will be based on the best technology offered with appropriate consideration for costs, long-term benefits and lowest risk over the lifetime of the new facilities. It was explained to public members that OPG and Bruce Power (the two nuclear operators in the Province) provided technical input to the government.

Also shared with the public was an explanation of criteria used to assess the different reactor technologies including, amongst others: licensing confidence; design confidence; construction; operability and maintainability; fuel cycle; and environmental impact, waste management and decommissioning.

Transmission System Requirements

Often participants asked about the relationship of the potential generating station to the bulk transmission system and whether the current transmission system had the capacity to handle new generation. If upgrades were required, there was also much interest in whether the existing transmission right of way had sufficient space to accommodate upgrades, or if new land acquisition would be required. In conjunction, participants were very interested in the environmental assessment process for transmission system upgrades.

In response OPG noted that in the OPA's 2008 Integrated Power System Plan, 1,500 MW of additional generation at Darlington would require increased capacity on the 500 kV circuits from Bowmanville Transformer Station (TS) to Cherrywood TS. The bulk transmission system is the responsibility of Hydro One. Hydro One has indicated that the nature of the enhancements required to accommodate additional capacity would be determined once the number and size of units are known, once dates are more precise, and after consideration is made for other developments in the area. The EA requirements would depend on the type of enhancements required. Any changes to the bulk transmission corridor and environmental assessment requirements would be carried out by Hydro One.

Long Term Management of Nuclear Waste and Used Fuel

Many participants sought to gain a better understanding of the status of the long term programs for management of nuclear waste and used fuel. In response, OPG explained that for the purposes of the NND EA, alternative means of interim storage of nuclear waste and used fuel were being assessed as part of the EA studies, not the long term programs.

OPG also explained that with respect to the long term management of nuclear waste (i.e. low and intermediate radioactive waste) OPG was conducting a separate EA on the potential construction and operation of a Deep Geologic Repository (DGR) for the long-term management of low and intermediate level nuclear waste on the OPG lands adjacent to the Western Waste Management Facility (WWMF) in Kincardine, Ontario. While the EA does not specifically address wastes from new reactors, the hosting agreement with the Municipality of Kincardine does not exclude these wastes from the Deep Geological Repository Project.

The Nuclear Waste Management Organization (NWMO) was established in 2002 and is responsible for the long-term management of used nuclear fuel in Canada. In the summer of 2007, the Government of Canada approved the NWMO's "Adaptive Phased Management" approach as Canada's strategy for managing used fuel. The NWMO is now beginning the implementation of this approach. For EA planning purposes, it is assumed that the used fuel from the new station will be stored in one of two interim on-site storage facilities until it is time to move it to a long-term waste management facility.

Financial Considerations

The Project and the EA costs were recurring areas of interest among participants. A number of participants expressed concern for the potential of cost overruns and wanted to understand the measures that OPG would take to ensure that the budget is managed effectively. Participants were also interested in identifying the body responsible for bearing the ultimate cost of the Project, including any potential overruns if they were to occur.

In response, OPG indicated that it did not have a cost estimate for the Project. It was explained that no decision has been made with regard to technology or vendor and therefore costs for the Project are unclear. Total EA costs were explained as being approximately $20 - $25 million over a three to four year period. With regards to ensuring effective cost management, OPG indicated that if it is directed to proceed with new nuclear, schedule and cost performance commitments would be built into the contract and the builder would be required to provide things such as performance guarantees and a turnkey agreement to limit the risk of cost overruns.

Roles, Responsibilities and Decision Making

Many stakeholders sought to better understand the roles and responsibilities of the different government agencies involved in the Project and the relationship of the various decisions that needed to be made. Participants were interested in knowing who will be responsible for selecting the reactor technology and how the timelines for the EA and a decision on technology fit together. In the same vein, people sought to understand the relationship between the provincial long term supply plan (how it works, who decides what, what is being considered). Many individuals inquired about the time required to complete the approvals for a new nuclear power plant. Two commonly asked questions were “How can it take so long to go through the approvals, when you have an existing nuclear power plant, at an existing site?” and “If there were any environmental problems wouldn’t you know about them already?”.

In response, OPG created information materials to help explain the roles and responsibilities of the various organizations, agencies and the public in the federal approvals process which was provided at Community Information Sessions and posted on website.

TABLE 10.3-4
Other Public Comments and Areas of Interest

#	Question and Answer
ONTARIO’S ELECTRICITY SYSTEM	
Future Supply – Nuclear Base load	
Q91	**Why is the Province moving ahead with new nuclear plants?**
A91	Ontario currently has 30,000 MW of electricity generating capacity but many existing power facilities are approaching the end of their operating life (80% will need to be refurbished or replaced over the next 20 years). The Ontario Government and the Ontario Power Authority have developed a plan for Ontario’s long-term energy needs. The plan will double conservation and renewables, and maintain nuclear energy capacity for base-load operation up to its current level of 14,000 MW. Since replacement nuclear facilities have long lead times for approvals and construction, the Ontario Government directed OPG to begin the work needed to enter into an approvals process, including an environmental assessment for new units to be built at an existing site.
Q92	**How does this Project fit with the Government’s plan to meet nuclear base-load capacity?**
A92	The Ontario Power Authority (OPA) is responsible for conducting independent planning for electricity generation, demand management, conservation and transmission for the Province of Ontario. In 2007, the OPA produced the Integrated Power System Plan (IPSP) to address Ontario’s energy needs for the period 2008-2027. The IPSP recognizes a reduction in the energy contribution from existing base-load resources, largely as a result of declining nuclear capacity (most existing nuclear plants are projected to reach the end of service between 2013 and 2020). These factors will result in significant base-load energy shortfalls starting in 2015 which will increase to nearly 120 TWh by 2027 (120 TWh is 12,000,000 homes or enough electricity to meet over 75% of Ontario’s annual electricity consumption).

#	Question and Answer
	The Province has directed the OPA to "plan for nuclear capacity to meet base load electricity requirements but limit the installed in-service capacity of nuclear power over the life of the plan to 14,000 MW".[15] It will be necessary to add more than 10,000 MW of planned nuclear resources over the course of the IPSP to meet base-load requirements. The OPG NND Project is one of the initiatives underway to assist in meeting base-load requirements. Others include conservation and increased use of renewables. For more information, or to view a copy of the IPSP document, please visit www.powerauthority.on.ca.
Future Supply - Gaps	
Q93	**What will happen if the OPA's Integrated Power System Plan doesn't go ahead?**
A93	Under the *Electricity Act* (1998), the Ontario Power Authority (OPA) is responsible for developing an Integrated Power System Plan (IPSP). The OPA's IPSP must be submitted to the Ontario Energy Board for review and approval. Following review, the Board may approve a plan or refer it back with comments to the OPA for further consideration and resubmission to the Board. The need for the NND Project is premised on fulfilling the provincial government's 2006 directive. The NND Project would not be affected if the IPSP does not go ahead because it is not the basis for determining the need for the Project. On September 17, 2008, the OPA was directed to undertake revisions to the IPSP by the Ontario Government. One consideration to be included in the revision was (among others), the amount and diversity of renewable energy sources in the supply mix. The OPA was also asked to undertake an enhanced process of consultation with First Nations and Métis communities and consider the principle of Aboriginal partnership opportunities in both generation and transmission. On October 2, 2008, the Ontario Energy Board announced the adjournment of the current IPSP hearing, accepting the OPA's request that it not continue hearing witnesses until re-filing occurs. The OPA, in a letter to the OEB dated March 2009, indicated that it plans to submit a revised IPSP to the OEB in the summer of 2009.
Q94	**Why was it decided that Pickering A units 2 and 3 would not be refurbished?**
A94	OPG assessed the viability of restarting units 2 and 3 a few years ago. At that time, it was concluded that while it was technically feasible to return units 2 and 3 to service, there were considerable risks surrounding the projected remaining life, the associated operating costs, and plant performance. Given the large upfront investment required, this represented a significant financial risk that could not be justified on a commercial basis. The reactors are currently being defuelled in preparation for safe storage.
Q95	**What is happening with the Pickering plant? Will the Pickering B units be refurbished?**
A95	In June 2006, the Minister of Energy directed OPG to begin assessing the feasibility of refurbishing the Pickering B reactors for life extension. As part of the business case assessment, OPG has been conducting a number of studies, including an Integrated Safety Review (ISR), Plant Condition Assessments and a federal environmental assessment. Following a public hearing on December 10, 2008, the CNSC concluded that the refurbishment and continued operation of the PNGS B would have no significant residual adverse effects on the environment, taking into account mitigation and follow-up commitments. This decision is a key input into OPG's assessment of the feasibility of refurbishing Pickering B NGS. Once all studies are substantially complete, a recommendation will go to OPG's Board of Directors.
Q96	**What are you going to do in the gap between coal shutdown and nuclear start up?**
A96	The Ontario Power Authority (OPA) is responsible for developing a long term plan to ensure that Ontarians' ongoing and future electricity needs are met (which includes consideration for the time period between coal shutdown and nuclear start up). In 2006, the Ontario Government issued a Supply Mix Directive calling for the replacement of coal fired generation by 2014 and in turn, requiring the replacement of coal's existing capacity, energy production, and contribution to system reliability. The Directive also cites the need for an installed, in-service nuclear capacity of up to 14,000 MW.
Q97	**What is the Green Energy Act?**
A97	On February 23, 2009, the Ontario Government introduced the *Green Energy Act* in the provincial legislature. The objectives of this proposed Act are to (among others): • Encourage the growth of clean, renewable sources of energy;

[15] OPA. Integrated Power System Plan, Section B-1-1, 5.1

#	Question and Answer
	• Increase investment in renewable energy projects; • Increase conservation; and • Create the potential for savings and better managed household energy expenditures through a series of conservation measures.[16] After completing a series of public hearings in communities across the province, the Legislature's Standing Committee on General Government considered the proposed *Green Energy Act* in a detailed clause by clause review. The *Green Energy Act* received Royal Assent on May 14, 2009.
Alternative Energy	
Q98	**Why not pursue other methods of power production (e.g. wind power, solar power, etc.)?**
A98	OPG will seek to expand, develop and/or improve its hydroelectric generation capacity. OPG received direction from the Province in June 2006 to begin feasibility studies on refurbishing existing nuclear plants and to initiate the federal approvals process for new nuclear generation.
Q99	**Others have determined that we can meet all of our electricity needs without more nuclear power, why are you proceeding with this?**
A99	OPG was directed by the Province of Ontario to begin the federal approvals process for new nuclear. This in part, is to address the anticipated base-load future electricity requirements that may arise beginning in 2015.
REACTOR TECHNOLOGIES, VENDOR AND SITE SELECTION	
Decision Making Responsibilities	
Q100	**Is there a preferred reactor technology for this Project?**
A100	The Government of Ontario will make the decision on which reactor technology is selected for this Project. The decision will be based on best technology offered with appropriate consideration for costs, long-term benefits and lowest risks over the lifetime of the new facilities. OPG is providing technical input to the government and does not have a preferred reactor technology for this Project.
Q101	**Who is responsible for deciding which reactor technology is chosen for this Project?**
A101	The Ontario Government will make the decision regarding which technology is selected. On March 7, 2008, the Ontario Government announced a two-phase competitive procurement process to choose a preferred nuclear reactor vendor. Infrastructure Ontario is the organization responsible for managing the procurement process. Please visit www.infrastructureontario.ca for more information.
Decision Process - Timelines	
Q102	**How do the timelines for the EA and the reactor technology decision fit together?**
A102	The timelines for the two processes have been undertaking in parallel, however the EA is not dependent on a reactor technology decision.
Reactor Design Considerations	
Q103	**What criteria are being used to assess the different reactor classes?**
A103	The Ontario Government has indicated that it will make the final technology selection for Ontario. OPG and Bruce Power conducted a technology assessment to provide the government with a utility perspective of the technology alternatives. Criteria used to assess the different reactor technologies include, among others: • Lifetime cost of power; • Best meets schedule for in-service date; and • Level of investment in Ontario.
Q104	**What are the differences between the two reactor classes being considered for this Project?**
A104	The reactor technologies being considered have been grouped into two classes. These two classes are: • Pressurized Water Reactors; and • Pressurized Hybrid Light and Heavy Water Reactors. The differences in the two reactor classes being assessed are largely in the type of fuel used in the reactor systems. For example, Pressurized Water Reactors typically use low (4-5%) enriched fuel and Pressurized Hybrid Light and Heavy Water Reactors use slightly (2-3%) enriched fuel. Regardless of this difference, all nuclear power reactors produce heat as a result of a nuclear reaction. This reaction boils water, creates stream and turns a turbine and a generator to create electricity.

[16] Ontario Ministry of Energy and Infrastructure, "Ontario's Proposed Green Energy Act", http://www.mei.gov.on.ca.wsd6.korax.net/english/energy/gea/

#	Question and Answer
Q105	**Do the new reactor technologies need vacuum buildings?**
A105	The reactor designs under consideration for this Project do not include a vacuum building for their containment systems. The reactor technologies being considered for this Project utilize independent reactor buildings for each unit as part their containment design.
Q106	**Do the different reactor technologies produce different amounts of used fuel?**
A106	Yes, the different reactor technologies being considered produce different amounts of used fuel. The amount of used fuel that a reactor produces is dependent upon the rated power level of the reactor, the enrichment of the fuel (U-235) and the burn-up (which refers to the amount of energy that is extracted from the fuel while in the reactor). The higher the initial enrichment, the higher the potential burn-up. A high burn-up means that more energy is extracted from the fuel and consequently, less fuel is used to produce a megawatt-hour of electricity. Light water reactors will have higher enrichment and thus greater burn-up than CANDU reactors, so the used fuel will take up less storage space. However, the enrichment process adds cost to the front end of the fuel cycle, so overall the total fuel life cycle costs are comparable. Assuming a 60-year operating life at a 90% average capacity factor, the amount of used fuel per unit and per gigawatt-hour produced is anticipated to be 9.5 kg for the ACR-1000, 2.6 kg for the AP-1000 and 3.4 kg for the US-EPR.
REACTOR TECHNOLOGIES, VENDOR AND SITE SELECTION	
Reactor Design Considerations - Distinctions	
Q107	**What are the environmental impacts of the different reactor designs?**
A107	Because the EA was carried out as early as possible in the Darlington New Nuclear Project planning stage, the vendor had not yet been determined. Therefore, for purposes of the EA, the Project is defined and described in a manner that provides for an effective assessment of potential environmental effects that might result from the range of reactor types and number of units considered feasible for the DN site. Although only one of three potential reactor operating scenarios will ultimately be implemented, all three are considered in the EA. Where applicable, OPG used a bounding model plant approach for establishing an appropriate stand-in bounding parameter but where necessary, the unique features of the reactors are considered.
Q108	**How many years of operating experience does each reactor design have?**
A108	Each reactor under consideration is an evolutionary, Generation III+ reactor, designed to meet industry and public expectations for safe, reliable nuclear generation. The Generation III+ reactors have been developed as logical evolutionary steps from today's existing reactor technologies.
Q109	**Why are reactor technologies, other than CANDU, being considered?**
A109	On March 7 2008 the Ontario Government announced a two-phase competitive procurement process to choose a preferred nuclear reactor vendor. At that time four vendors identified in global market reviews as offering the latest generation technology were invited to participate. A commercial team, led by Infrastructure Ontario (IO) is managing the procurement process. In February 2009 Infrastructure Ontario received three proposal (bid) submissions from AREVA NP, Atomic Energy of Canada Limited and Westinghouse Electric Company to build a new, two-unit nuclear power plant at Ontario Power Generation's DN site. The reactor technologies include the AECL ACR1000 with a rated electrical power 1,085 MWe (net), the AREVA NP EPR has a rated electrical power of 1,580 MWe (net) and the Westinghouse AP1000 has a rated electrical power of 1,037 MWe (net).
Reactors Design Considerations – CANDU/AECL	
Q110	**Are there Canadian companies that can design and build these reactors?**
A110	There are a number of companies that design and build nuclear reactors. Atomic Energy of Canada Limited (AECL) is a Canadian-based company that designed the CANDU reactors currently in use at all Canadian nuclear facilities. While no other Canadian companies design reactors, many Canadian firms provide other major systems and components required for a complete nuclear reactor installation. Construction is undertaken by a number of different companies, and there are several Canadian companies capable of construction.
Q111	**Do we know much about the new AECL reactors, the ACR-1000s?**
A111	The Advanced CANDU Reactor (ACR-1000) is a new design developed from existing CANDU reactors that have been in safe operation for over 30 years. It has an approximate capacity of 1,200 MW. Two significant evolutions to the design include: • The use of slightly enriched uranium fuel (up to 2.5% uranium U-235) in place of natural uranium; and • The use of natural 'light' water in the heat transport fluid in place of heavy water. The resultant design is a light-water cooled, heavy-water moderated reactor with higher electrical output, while maintaining a high degree of proven CANDU design features.

#	Question and Answer
Q112	**Is it more likely that AECL will be selected because they are Canadian owned?**
A112	The decision will be based on the best technology offered at the best price and which provides the greatest benefits and lowest risk over the lifetime of the new facilities to the ratepayers of Ontario. Infrastructure Ontario has indicated that the technologies and vendors are being evaluated in three key areas: • Lifetime cost of power; • Best meets schedule for in-service date; and • Level of investment in Ontario.
FINANCIAL CONSIDERATIONS	
Project and EA Costs	
Q113	**What will the Project cost?**
A113	At this point OPG does not have a cost estimate for this potential Project. You will see various numbers in the media, generally in the range of \$3.5 - \$14 billion. However, we need to exercise caution; it is unclear what is included in these numbers. No decision has been made with regard to technology or a vendor, and therefore it is unclear what the costs for the Project will be. OPG will also incur costs associated with the Project oversight team and preparation to operate the plant.
Q114	**What will the EA cost?**
A114	The cost of this federal EA is estimated to be approximately \$20 - \$25 million from start to when a final decision is reached (i.e. over 3 - 4 years). This cost includes such things as OPG staff; technical studies (we have over 10 consulting firms conducting studies in various areas of expertise); and public consultation and communications activities. This excludes any regulatory fees (e.g. CNSC fees).
Q115	**Wasn't an EA conducted for the existing Darlington station? Is it necessary to conduct another?**
A115	In 1975, Ontario Hydro submitted a proposal and preliminary EA for the Darlington Nuclear Generating Station to the Province for approval. The EA submission preceded both the provincial EA legislation (which came into effect in 1976) and the federal EA Guidelines Order, predecessor to the current *Canadian Environmental Assessment Act* (the Guidelines Order stated that no federal EA was required for projects started before June 22, 1984). Today there is a comprehensive federal approvals process which must be followed prior to the construction and operation of a nuclear reactor in Canada. Before any licence can be issued, a federal EA must be completed to ensure that no significant adverse effects will arise if the plant is constructed and operated.
Q116	**Who controls the Project cost and budget?**
A116	OPG controls the cost and budget for those areas within its responsibility, including the cost and budget for the EA. the licenses and the regulatory fees. The vendor will be responsible for controlling the costs and budget of the construction activity and OPG will have an oversight role.
Q117	**How will the Project be financed?**
A117	OPG typically recovers the costs of operating and maintaining its current nuclear plants through a regulated rate process overseen by the Ontario Energy Board. The cost recovery options for new nuclear will be assessed as part of the financing strategy.
Q118	**Should a new station be built given the economic conditions of today?**
A118	Ontario currently has 30,000 MW of electricity generating capacity but many existing power facilities are approaching the end of their operating life (80% will need to be refurbished or replaced over the next 20 years). The Ontario Government and the Ontario Power Authority have developed a plan for Ontario's long-term energy needs. The plan will double conservation and renewables, and maintain nuclear energy capacity for base-load operation up to its current level of 14,000 MW. Since replacement nuclear facilities have long lead times for approvals and construction, the Ontario Government directed OPG to begin the work needed to enter into an approvals process, including an environmental assessment for new units to be built at an existing site.
Decommissioning and Nuclear Liability Costs	
Q119	**How will the costs for the Decommissioning Phase be covered?**
A119	OPG has an obligation to plan for, and fund, the eventual decommissioning of its nuclear facilities and the long-term management of the nuclear wastes. We believe it is important to ensure that future generations do not have to bear the cost of today's operations.

#	Question and Answer
	OPG is party to an agreement with the Ontario Government known as the Ontario Nuclear Funds Agreement (ONFA). Under ONFA, OPG makes quarterly contributions to segregated funds for the management of both its decommissioning and long-term nuclear waste management liabilities. OPG has been putting aside money in a segregated fund to fund the decommissioning of its existing nuclear plants. As of year-end 2007, OPG has accumulated a total of $9.3 billion in these funds which will continue to grow as annual contributions are made. The liabilities associated with nuclear decommissioning and nuclear waste management as of the end of 2007 were approximately $10.8 billion. Contributions are being made on a quarterly basis to the OPG funds to close the gap. The plan is for the liability to be fully funded at the projected end of life of OPG's stations. For a new nuclear power plant, OPG would expand existing segregated funds to cover the eventual decommissioning of the new nuclear facilities and the long-term management of the nuclear wastes arising from that plant. Funds associated with decommissioning are strictly controlled and subject to oversight by the Province. The federal *Nuclear Fuel Waste Act* also governs how the nuclear waste funds are established and governed.
Q120	**How will OPG avoid the cost overruns that occurred during the construction of the first four units in the 1980's and 1990's?**
A120	If OPG is directed by the Ontario Government to proceed with new nuclear units, our commitment is that the best project management processes will be applied. There will be schedule and cost performance commitments built into the contract with the contractor/builder. The Province has also indicated that the potential contractor/builder would need to provide a fixed price with performance guarantees and a turnkey agreement to limit the risk of cost overruns. Cost effectiveness over refurbishment must also be demonstrated. In the return to service of Pickering Unit 1, OPG applied the lessons of Pickering Unit 4 (the first unit to be returned to service) and brought Unit 1 back to service on time and on budget within 10 per cent of the original estimate. The Portland Generating Station, of which OPG is a principle partner, was also recently brought into service ahead of schedule and on budget.
TRANSMISSION INFRASTRUCTURE	
Q121	**What will determine if additional transmission infrastructure is required?**
A121	According to the Ontario Power Authority's Integrated Power System Plan, 1,500 MW of additional generation at Darlington would require increased capacity on the 500 kV circuits from Bowmanville to Cherrywood. Hydro One has indicated that the nature of the enhancements required to accommodate additional capacity will be determined once the number and size of units are known, once dates are more precise, and after consideration is made for other developments in the area.
Q122	**What kind of EA would be required for the transmission lines?**
A122	The EA requirements will depend on the type of enhancements required. Any changes to the bulk transmission corridor and environmental assessment requirements would be carried out by Hydro One.
OTHER APPROVALS	
Q123	**What Provincial or municipal approvals do you need?**
Q123	Over 50 different permits and approvals may be required over the course of the project. Examples of activities that may require provincial approvals include Shoreline Works – Work Permit Construction – Ontario Ministry of Natural Resources and Storm Water Management System – Ontario Ministry of Environment. Examples of activities that may require municipal approvals include Approvals to tie into municipal water supply and sanitary sewer services – Region of Durham and Municipality of Clarington; Upgrades to Regional/Municipal Roads – Region of Durham and Municipality of Clarington; and Dumping of fill, removal of fill, alteration of grades – Municipality of Clarington.
CURRENT NUCLEAR OPERATIONS	
Safety and Security	
Q124	**If there were a nuclear emergency, how would we know what to do?**
A124	The Province of Ontario has the overall responsibility for managing the off-site response to nuclear emergencies. OPG, Emergency Management Ontario (part of the Ontario Ministry of Community Safety and Correctional Services), and the regional and local governments work together to protect the public. Each organization has responsibility for a distinct aspect of emergency response. The people, plans and procedures that are put in place for a nuclear emergency response can also be called upon during more common emergencies like ice storms, train derailments or industrial accidents.

#	Question and Answer
	If an accident were to occur, reactor operators would act quickly to stop it from getting worse. They would then work on getting the situation under control so there is no impact on the public or employees. As mandated by the Provincial Nuclear Emergency Plan, within 15 minutes OPG would notify the Ontario Government and the local municipalities about the accident and the severity. We would also activate our on-site emergency response teams to conduct testing and to provide technical backup to the operators. We would act quickly to alert people in parks and other open areas adjacent to our facilities. Under most scenarios the accident would be quickly brought under control and the station would be put in a safe state. At this level, the Province and local municipality monitor the situation. Under rare circumstances (which have never happened in Canada), there may be the potential for some impact on the community. In this case, the Province would activate its emergency response. They would make decisions on what actions, if any should be taken. If action is warranted, the Province would alert people within 10 kilometres of the affected station through a series of designated media outlets. It is expected residents would have ample time to take proper action. The important thing is to listen to the radio or television and wait for instructions. OPG, regional and local governments work hand-in-hand with the province in planning, practicing, and providing public information on nuclear emergency preparedness. This will be addressed in the *Emergency Preparedness TSD* and in the EIS.
Q125	**What are KI pills?**
A125	During a nuclear emergency, Potassium Iodide (KI) pills can be taken to minimize the absorption of radioactive iodine by the thyroid gland. The thyroid gland absorbs iodine that is taken into the body as a normal part of its function. Following a postulated release of radioactivity, radioactive iodine (a radionuclide) could be absorbed by the thyroid gland. By loading the thyroid with non-radioactive iodine, the gland receives greater protection from any absorption of radioactive iodine that it would otherwise take in. Provincial officials will authorize the taking of KI pills, but only if necessary. KI pills would be available for the public at reception centers following an evacuation. Schools, daycare centers and hospitals would also have stockpiles of KI pills for their use during an emergency.
Q126	**How do you measure annual dose to the public?**
A126	Airborne and waterborne effluents from the Darlington Nuclear Station are routinely monitored. On an on-going basis, OPG conducts radiological environmental monitoring programs (REMP) in the vicinity of our nuclear power stations to determine the radiological impact to the public resulting from the operation of this station. The data from these tests is compiled and provided to the public in an annual report. These extensive monitoring programs include concentrations of radionuclides in the air, water, soil, sediments, vegetation and fish samples. OPG even samples the milk from local dairy cows. These samples are taken in the vicinity of Darlington and Pickering Generating Stations, and at provincial locations to determine naturally occurring radiation levels in areas away from the influence of nuclear stations. Preparation of the annual reports is a regulatory requirement of the Canadian Nuclear Safety Commission. Copies of recent reports that have been released to the public may be found on OPG's website, www.opg.com.
Q127	**Didn't Pickering have to shut down due to problems with the condenser cooling system?**
A127	In the past few years, there has been a rise in the amount of algae that lives in Lake Ontario. At the PNGS, the algae becomes entrapped in the once through lake water cooling system, restricting the amount of cooling water that is available to the plant. Consequently, the plant reduces power or, if needed, shuts down while the algae are cleaned out and then resumes normal operations. The plant does have measures in place to minimize the impact of algae.
Q128	**When is the Darlington A Nuclear Generating Station scheduled to reach its end-of-life?**
A128	The operating life of a reactor is determined by a number of factors, one of which is the anticipated life of major reactor components, as determined by the extent of degradation to the component. Major reactor components which can limit the operating life of a reactor include feeder tubes, fuel channels and/or steam generators. As such, reference is often made to the economic end of life of a plant, that is, when it is no longer economically prudent to continue to invest money in the plant. Should a decision be made to refurbish the reactors, major components would need to be changed in the DNGS over the course of the next 20 years. OPG has begun studies on the potential refurbishment and continued operation of the existing DNGS. This will include an environmental assessment and public consultation. If DNGS were to be refurbished, it would add approximately 25 - 30 years to the operating life of the station. If no refurbishment activities were done, the station could reach the end of its economic life around 2020.
Q129	**Didn't the existing Darlington station win some type of award?**
A129	In 2007, the Institute of Nuclear Power Operators (INPO) presented DNGS with the prestigious Performance Improvement Award. The award recognizes Darlington's strong performance among international nuclear plants and continued improvement at DNGS as the station strives for excellence

10.3.4.3 Areas of Recurring Discussion – Selected Stakeholder Groups

Some organizations raised specific concerns in their opposition to the Project or in opposition to continued investment in nuclear. These concerns included:

Uranium Fuel Life Cycle

Safe and Green Energy (SAGE), a sub-committee of the Ontario Public Interest Research Group at Lakehead University raised the concern that the EA scope should include the full life-cycle of uranium fuel, from mining and milling, through processing, and ultimately through to long term management. One concern was that, while OPG and the nuclear industry may operate at a high level of safety and environmental performance, other segments did not necessarily hold to such a standard of excellence. Two examples were cited – the uranium mining industry and the fuel processing industry. The concern was that by virtue of development of nuclear power generation in Ontario, other upstream activities (mining and fuel processing) would also be further developed and the potential negative environmental implications of these activities would thus be expanded.

In response, OPG noted that these other nuclear-related activities were also governed by the same legislation and agencies under which OPG was governed (i.e. *NSCA, CEAA*). OPG staff also encouraged members of SAGE (and others) to raise the matters to the CNSC and the CEA Agency as they could be addressed in the context of the EIS Guidelines.

Mineral Tenure, Mining and Surface Rights

A related concern has been that the OPG NND Project will renew interest in nuclear power, which in turn will revive interest in uranium mines in Ontario, which will drive claim staking, prospecting, mineral exploration and mine development. Recently these latter activities have been the source of conflict in Southern Ontario over mineral tenure, Aboriginal rights and private property rights.[17] A secondary matter of concern is the “the prospect of radioactive air and water pollution, as well as noise, from mines on Crown land near … homes and cottages”.

As indicated above uranium mine development is governed by the CNSC. The 2007 CNSC information document “Licensing Process for New Uranium Mines and Mills in Canada” provides an overview of the current process for licensing new uranium mines and mills in Canada, taking into consideration the requirements of the *NSCA*, associated regulations, and the

[17] *Why is someone digging in my backyard? Peter Gorrie, Toronto Star Saturday June 6 2009, Page IN3*

key prerequisite for a licence to be issued by the Commission, which is the completion with positive result of an EA pursuant to the *CEAA* [18]

Claim staking, prospecting, and mineral exploration and the issues of mineral tenure and conflict with Aboriginal and private property rights are matters of provincial responsibility, beyond the scope of this EA. However for purposes of completeness we provide an overview.

For the purpose of mineral exploration in Ontario, the *Mining Act* defines two types of land rights and ownership. "Mining Rights" are the rights to minerals on, in or under any land; and "surface rights" are all other rights, besides mining rights, in land. These distinctive land rights may be held by the same person or could be held separately. If the Crown holds the mining rights on lands that are open for staking, any person with a prospector's licence may stake the land and attain the exclusive right to explore for minerals.

In recent years, conflicts have arisen as a result of exploration companies or individuals entering private property, where mineral rights are owned by the Crown, to stake out mining claims or to undertake ground exploration work. Aboriginal communities have expressed concern about the way the *Mining Act* sets the rules for acquiring title to Crown-owned minerals. Surface rights holders, particularly those with rural vacation or retirement properties often find the act's approach completely at odds with their own enjoyment of their lands. At the same time, prospectors, mineral exploration companies and mining investors place a high value on the confidentiality, security and certainty provided by the current system. Mineral tenure is the only asset against which mineral companies can raise financing.[19]

The Ontario Ministry of Northern Development and Mines introduced the *Mining Amendment Act* on April 30th 2009, in part, to address the conflicts. The legislation is meant to modernize the mineral development process in Ontario. Key features include clarity and certainty for the mining industry; recognition of Aboriginal and treaty rights; a dispute resolution process; a new approach for mineral exploration on private surface rights; and prohibition on new mine openings in the Far North until there is a community-based land.

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[18] *Canadian Nuclear Safety Commission, Licensing Process for New Uranium Mines and Mills in Canada, Information Guide INFO-0759, March 2007*

[19] *Ontario Ministry of Northern Development and Mines, Modernizing Ontario's Mining Act: Finding A Balance, Discussion Paper, August 2008*

Greenhouse Gas and Nuclear Generation

Greenpeace, PEMBINA and others state that Ontario's integrated power system plan will prevent Ontario from reaching its greenhouse gas reduction targets, largely because it relies on nuclear generation. Specifically, the argument is that greenhouse gas emissions will increase, if a decision is made to refurbish and continue to operate the Pickering B reactors and/or Bruce B reactors (because fossil fuelled generation would be required during the refurbishment outages) and, during the time it takes for new nuclear reactors to come on line (because of a perceived gap in power supply over the 6 – 8 year construction period). A parallel argument is that due to the commitment to long lead–time nuclear projects, Ontario's long-term electricity plan caps the development of renewable power in the Province.

In response, OPG noted that greenhouse gas emissions that may arise as a direct consequence of this Project are considered minor. The use of fossil fuels is the main source of GHG emissions (methane CH_4), carbon dioxide (CO_2) or nitrous oxide (N_2O) related to this project. During the Site Preparation and Construction activities, GHG's will be emitted from fuel combustion associated with the construction equipment and construction related traffic. During the Operation and Maintenance phase, GHG emissions are primarily form the backup power equipment from on-site vehicular traffic. This is further discussed in Section 6.4, Climate Change Considerations.

Renewable Energy and Nuclear Generation

The Ontario Clean Air Alliance (OCAA) (a coalition of approximately 100 partner groups including organizations and associations) commissioned a report on "Ontario's Green Future" in October 2008. The report addresses the OPA's Integrated Power Supply Plan and perceived shortcomings including continued investment in nuclear generation. Nuclear baseload generation is perceived to be treated as a "must achieve" target rather than an "if necessary" target; and fails to protect Ontario's electricity consumers from nuclear reactor capital cost overruns.

To achieve a completely renewable electricity grid by 2027 the report states that the province must disallow nuclear power companies to win contracts by "low-balling cost estimates" and passing capital cost overruns to Ontario's electricity consumers. Such payments represent monies that could be used to support other public services (e.g. schools, hospitals and public transit).

The OCAA cites expense, inefficiency and competition between investment in nuclear and renewables as reasons why nuclear generation should not be pursued.

In response, OPG has noted that the Ontario Power Authority (OPA) is responsible for ensuring an adequate, long-term supply of electricity in Ontario. The OPA, under direction from the Provincial government, has developed an Integrated Power System Plan that identifies the conservation, generation and transmission investments needed to ensure reliable and sustainable energy. Further, the Provincial Government recently (May 2009) passed the *Green Energy and Economy Act*, intended to facilitate the development of a sustainable energy economy that protects the environment while streamlining the approvals process, mitigates climate change, engages communities and builds a world-class green industrial sector.

OPG's principal business is the generation and sale of electricity in Ontario. OPG's focus is on the efficient production and sale of electricity from our generation assets, while operating in a safe, open and environmentally responsible manner. At times OPG's shareholder may direct us to undertake special initiatives. Such directives are communicated as written declarations by way of a Unanimous Shareholder Agreement or Declaration in accordance with Section 108 of the *Ontario Business Corporations Act (OBCA).* OPG was directed in June 2006 to examine the feasibility of refurbishing Pickering B and to begin the federal approvals for new nuclear.

EIS Guidelines

The public comment period for the Draft EIS Guidelines was a two month period that commenced in September 2008 and closed in November 2008. Comments pertained to a variety of different subject matters, some of which are noted below. Although these comments were submitted to the CEA Agency (and not to OPG directly), OPG staff did document the nature of input provided by different public members and organizations (List included in *Communication and Consultation TSD* Section 4.4.3). Individuals and organizations expressed concerns in a variety of areas including:

- There is no known method for disposal of high level radioactive waste;
- Carbon emissions from construction should be accounted for;
- Need to evaluate if adequate protection against terrorism exists;
- Province must be part of review;
- Need for comprehensive epidemiological and gamma radiation health studies; and
- Failure to evaluate complete Uranium Fuel Cycle/mining.

OPG will continue to document areas of public interest and respond to public inquires as they are made throughout the EA Study.

10.4 Feedback and Evaluation

The OPG Project team implemented an extensive public consultation and communication program engaging a wide range of stakeholders and the public beginning in September 2006. Feedback was sought throughout the program, which assisted in improving the design and the effectiveness of the activities. At each large group consultation activity, feedback was sought on how effective that specific activity was and suggestions were sought on how to improve them in the future. Key findings were:

- Respondents felt the one on one discussions with staff, the information materials presented and panel displays were the most effective;
- Respondents indicated that the venues were suitable, easy to find, had the right amenities and sufficient parking;
- OPG provided advertising in the papers that respondents read the most; and
- About 1/3 of the respondents indicated that they had participated an earlier CIS and under 30% indicated that they had seen a display at a local community event.

Participants were asked to comment on how OPG could better accommodate the public at future information sessions. Overall, comments regarding the presentation were positive (73% of the comments received) and there were several suggestions to improve advertising, communication and information materials. Areas for improvement were reviewed by OPG staff as well as staff observations during the CIS events. In response to comments and observation, some key improvements to the program included:

- Broader distribution of the newsletter and invitation cards;
- Increased external signage at the CIS;
- Broader radio and newspaper advertising for each CIS;
- More details about the CIS in the newspaper advertising;
- Ensured presenters were knowledgeable about the technical aspects and EA of the Project;
- Handouts at the CIS were double sided where possible; and
- OPG created a continuous video of the site and the proposed environmental effects.

In particular, OPG discussed comments about attendance and the perception that more advertising would increase participation. It was determined that advertising was sufficient and that additional advertising would not increase participation.

Public attitude research was conducted in January 2008 and October 2008 as part of the Socio-Economic Impact Assessment. Survey participants were asked to rate OPG's job at informing them about the potential NND. Over the nine months, OPG's efforts were seen to have improved in both the LSA and RSA (Table 5.2-1 *Communications and Consultation TSD*).

10.5 Post Submission Communications & Consultation

10.5.1 Environmental Assessment

OPG will continue its communications and consultation program following submission of the EIS and the Application for a Licence to Prepare Site. Activities will include:

Notification Advertisements and Letters

Public notifications will be prepared and distributed at key stages or decision points via a press release, web communications, update letters to stakeholders and/or advertisements in local print media.

Website

The NND Project web site will continue to be updated. The web site serves as a vehicle to provide access to information, as well as a mechanism to receive input from interested persons as an enhancement of the public consultation program.

Information Line

The 1-800 information line will be maintained. When not answered in person, the dedicated line will inform callers how to obtain details/information about the site preparation licensing activity. Messages will be checked and responded to on weekdays and any required follow-up will be completed.

Media Relations

Ongoing liaison with respect to the environmental assessment and site preparation licensing activities will be initiated and maintained by OPG with reporters and news editors for both the electronic and print media.

OPG Employee Consultation Activities

The employee communication program will include articles written for all employee publications including OPG-wide and DNGS-specific vehicles - both electronic (such as OPG Today, Darlington's On-Site) and hard copy (Power News, which also reaches retirees). Staff presentations and Lunch and Learn sessions will be held. The Project-specific intranet site will be maintained to facilitate communication with employees.

Stakeholder Briefings and Interviews

Interviews and briefings will continue to be conducted to present information and provide an opportunity to have questions and comments addressed. Regular updates will be presented to elected officials, representatives of the DSPC and DNHC; and other key stakeholders on a frequency commensurate with key Project activities and milestones. Feedback from these meetings will be recorded for response and issue management tracking purposes.

Workshops

Key stakeholders with a high level of interest in the site preparation activity may be invited to participate in workshops that will involve meaningful discussions and provide substantive input to site preparation activities.

Open Houses/Community Information Sessions

Open Houses and/or CISs may occur throughout this period to share information, describe key activities and communicate progress. These types of sessions provide an opportunity for the public to ask questions, obtain clarification, and identify or raise any concerns or issues. A variety of mechanisms may be used to inform people about these sessions and encourage attendance, including paid advertisements in local newspapers, as well as, distribution of invitation cards and/or letters of invitation.

Comment forms and discussions may be used to identify public issues, concerns and questions that need to be addressed.

Comment and Issues Tracking

A comment database will be maintained to record and monitor all comments, correspondence and communications with the public and stakeholders involved in or affected by the site preparation activities. The objective of the issue management program is to address and resolve any issues and concerns held by the public or stakeholders to the extent possible.

10.5.2 Site Preparation & Construction Phase

During the Site Preparation and Construction phase, OPG will maintain a communications and consultation program. This will consist of:

Notification Advertisements and Letters

Public notifications will be prepared and distributed to announce the commencement of construction activity, via a press release, web communications, the Darlington Nuclear community newsletter (Darlington Neighbours) and advertisements in local print media.

Website

The OPG website for the NND Project will be updated. The web site serves as a vehicle to provide access to information, as well as a mechanism to receive input from interested persons as an enhancement of the public consultation program. Information such as: scope; schedule; descriptions; process steps; events; and contacts pertaining to site preparation will be maintained.

Information Line

A 1-800 information line will be maintained. When not answered in person, the line will inform callers how to obtain details/information about the site preparation and construction activity. Messages will be checked and responded to on weekdays and any required follow-up will be completed.

Media Relations

Ongoing liaison with respect to the site preparation and construction activities will be initiated and maintained by OPG with reporters and news editors for both the electronic and print media.

Open Houses/Community Information Sessions

Open Houses and/or CISs may occur throughout the site preparation and construction activities to share information, describe key activities and communicate progress. These types of sessions provide an opportunity for the public to ask questions, obtain clarification, and identify or raise any concerns or issues they may have. A variety of mechanisms will be used to inform people about these sessions and encourage attendance, including paid advertisements in local newspapers, information in the Darlington Neighbours community newsletters, distribution of invitation cards and/or letters of invitation. Comment forms and discussions may be used to identify public issues, concerns and questions that need to be addressed.

OPG Employee Consultation Activities

The employee communication program will include articles written for all employee publications including OPG-wide and DNGS-specific vehicles - both electronic (such as OPG Today, Darlington's On-Site) and hard copy (Power News). Staff presentations and Lunch and Learn sessions will be held. A specific intranet site will continue to be maintained to facilitate communication with employees.

Stakeholder Briefings and Interviews

Interviews and briefings will continue to be conducted to present information and provide an opportunity to have questions and comments addressed. Regular updates will be presented to representatives of the DSPC and DNHC and other key stakeholders on a frequency commensurate with key project activities and milestones. Feedback from these meetings will be recorded for response and issue management tracking system.

Workshops

Key stakeholders with a high level of interest in the site preparation and construction activities may be invited to participate in workshops that will involve meaningful discussions and provide substantive input to site preparation and construction activities.

10.5.3 Operation and Maintenance Phase

During the NND Operation and Maintenance phase, OPG will implement a site community relations program consistent with its practise at all of its generating station sites. Given the current program at the DN site, one can anticipate it may include:

- A local advisory committee, of local neighbours, business representatives, and officials from the community as well as DN site employees, input to land uses and environmental enhancements to station property not utilized in the production of electricity;
- Regular presentations to local and regional council as well as formal and informal meetings with the elected officials;
- Operation of a Public Information Centre where visitors would be able to receive information on current issues and be provided an opportunity to have questions and concerns addressed;
- Partnership with local schools (elementary, high school and post-secondary schools), to learn about environmental stewardship and biodiversity in partnership with local environmental organizations (e.g. the Darlington Provincial Park, Central Lake Ontario Conservation Authority, Ganaraska Region Conservation Authority, the Clarington Recreation Department);
- Financial support for community-supported Projects through a Corporate Citizenship Program, particularly in the education, environment, and minor sports areas;

- A regular community newsletter, distributed to residents and businesses in the Municipality of Clarington; and
- Providing municipal politicians and the local media an opportunity to visit the site for a tour of the station and an update on our performance (as required).

10.6 Aboriginal Engagement and Information Sharing

OPG has encouraged the ongoing engagement of Aboriginal Peoples during the conduct of its environmental assessments for generation development projects, and in a manner consistent with OPG's Aboriginal Relations Policy. OPG began its Aboriginal Engagement Program for the NND EA in the fall of 2006. The overall objective of this program was to encourage the participation of identified First Nations and Métis in the EA process in determining if there were potential effects that NND might pose to Aboriginal interests.

This section provides an overview of OPG's Aboriginal Engagement Program. Section 10.6.1 summarizes the requirements for assessing Aboriginal interests as described in the EIS Guidelines; Section 10.6.2 describes the engagement activities and information exchange shared with First Nations and Métis; and Section 10.6.3 provides an overview of the feedback resulting from dialogue throughout the EA study process.

10.6.1 EIS Guidelines – Aboriginal Engagement

The requirements for Aboriginal engagement are set out in the EIS Guidelines. The proponent must describe the involvement of any Aboriginal Peoples that may be affected by the Project, especially those claiming Aboriginal rights, title or established treaty rights at the location or in the vicinity of the Project. This description must include:

- A summary of the history of the proponent's relationship with Aboriginal Peoples with respect to the OPG DN site in general and the Project in specific;
- A description of the objectives of and the methods used for Aboriginal engagement;
- Issues or concerns raised through engagement and any details not otherwise subject to confidentiality agreements; and
- A description of how the proponent has addressed the issues or concerns raised by Aboriginal Peoples.

The Guidelines specify requirements regarding information pertaining to traditional knowledge, VECs and current use of lands (among others). Traditional knowledge are described as making an important contribution to EAs as they are undertaken. The term "traditional knowledge" refers to the broad base of knowledge held by individuals and collectively by communities.

Examples include knowledge based on spiritual teachings, personal observation and written tradition. In combination with other information sources, this is a valuable way to gain insight as to the potential impacts of a project and should be incorporated to the degree the proponent (OPG) has access or may reasonably be expected to acquire through appropriate due diligence.

The proponent must also describe how VECs were selected and what methods were used to predict and assess the adverse environmental effects of the Project on these components. The EIS must identify any change that the Project is likely to cause in the environment and any effect of such change on the use of lands and resources for traditional purposes by any Aboriginal community including, but not limited to, effects to hunting, trapping, fishing and gathering.

The EIS must also outline current use of lands, waters and resources, including those used for traditional purposes by Aboriginal persons that may be affected by the Project and those lands, waters and resources related to established or asserted Aboriginal rights. In addition, the proponent should identify lands, waters and resources of specific social, economic, archaeological, cultural or spiritual value to Aboriginal Peoples, including Métis, that assert Aboriginal rights, title or treaty rights, or in relation to which Aboriginal rights, title or treaty have been established and that may be affected by the Project.[20]

Please refer to the *Aboriginal Interests TSD* for a detailed description of EIS Guidelines as they pertain to Aboriginal engagement for the EA.

10.6.2 OPG Nuclear Aboriginal Engagement

OPG recognizes that it must conduct its business in a manner that is socially and environmentally responsible. OPG's demonstration of this commitment is founded within a corporate-wide policy (est. 2007) that provides a framework for engaging with Aboriginal Peoples. Importantly, there are supporting programs, committees and community initiatives that reflect its tenets and put the philosophy into practice.

OPG Nuclear has a record of contact and dialogue with Aboriginal communities, councils and organizations that begins in 1999 and continues through to 2009. OPG's engagement with First Nation communities on nuclear projects followed the creation of the *CEAA* in 1995 which established a legal basis for federal environmental assessments. Since that time, OPG has sought to ensure that Aboriginal views and perspectives are integrated into the environmental assessment studies it undertakes. OPG has maintained ongoing contact with Aboriginal Peoples

[20] Canadian Nuclear Safety Commission (CNSC) January 2009. *Guidelines for the Preparation of the Environmental Impact Statement for Ontario Power Generation's Darlington 'B' New Nuclear Power Plant Project.*

who may have a current and/or historic interest in the areas around the DN site and PN site. It is recognized that such interest may stem from past occupation and/or traditional land use prior to European settlement and the signing of treaties.

OPG's Aboriginal Engagement Program seeks to encourage information sharing with the following First Nations, signatories to the 1923 Williams Treaties:

- Alderville First Nation;
- Chippewas of Georgina Island First Nation;
- Curve Lake First Nation;
- Hiawatha First Nation; and
- Mississaugas of Scugog Island First Nation.

In addition, OPG has also encouraged involvement from other First Nations and Métis councils and organizations who may also have a current or historic interest in this area.

These groups include:

- Mississaugas of the New Credit First Nation (beginning in 2002);
- Métis Nation of Ontario (beginning in 2002);
- The Oshawa Métis Council (beginning in 2006);
- Kawartha Nishnawbe (beginning in 2006);
- Ontario Métis Aboriginal Association (beginning in 2006);
- Huron-Wendat First Nation (beginning in 2007);
- Mohawks of the Bay of Quinte First Nation (beginning in 2007); and
- The Northumberland Métis Council (beginning in 2009).

As detailed in the *Aboriginal Interests TSD*, OPG also initiated correspondence with the following Aboriginal communities at the request of the CNSC to determine what, if any, interest they have in the Project:

- Erie Indian Moundbuilders Tribal Nation (beginning in 2009);
- Chippewas of Rama First Nation (beginning in 2009); and
- The Six Nations of the Grand River.

10.6.2.1 NND Aboriginal Engagement Program - Objectives

The objectives of OPG's Aboriginal Engagement Program for the NND Project were to:

- Ensure that Aboriginal Peoples have adequate knowledge and opportunity to provide input during the EA study process concerning matters specific to Aboriginal history, culture, spirituality, and use of land and resources;[21]
- Create opportunities to facilitate discussion, consider input as provided and respond to concerns if and when expressed;
- Provide the necessary information and support (i.e. financial or otherwise) to ensure meaningful participation by Aboriginal Peoples; and
- Provide opportunity for identified First Nations and Métis to review the Aboriginal Interests TSD.

10.6.2.2 Aboriginal Engagement Methods

OPG encouraged the engagement Aboriginal Peoples that may have a historical relationship with, or interest in, the lands along the north shore of Lake Ontario from Toronto east to the Bay of Quinte to determine:

- How best to seek each community or organization's views in the EA study process;
- Whether local and traditional knowledge could assist in describing the existing environment;
- Whether the Project may have an environmental effect on any lands or resources currently used by Aboriginal Peoples for traditional purposes;
- Whether the Project has perceived impacts on Aboriginal and/or treaty rights; and
- Whether OPG correctly identified environmental attributes prior to their assessment and whether the proposed list adequately captured community views.

10.6.2.2.1 Notification Letters and Telephone Calls

Information sharing and engagement was undertaken at key points in the Project to ensure that identified First Nations and Métis councils and organizations had adequate time to receive

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21 The term "engagement" is used throughout this document in place of the term "consultation". Although the two terms are often used interchangeably, a distinction between the two will be made in this document. For the purposes of the NND EA, "engagement" conveys a form of communication that sought to encourage two-way dialogue and that allows for the inclusion of the distinct voice of Aboriginal communities and organizations. OPG's engagement with its Aboriginal contacts was based on a respect and sensitivity for the uniqueness of interests and concerns as held by each community and organization.

notification of developments and provide input should they wish to do so. Opportunities for input were welcomed throughout the EA but information sharing and engagement was solicited specifically at the following stages: prior to the submission of the Project Description, following the development of preliminary VECs for Aboriginal interests (among others), prior to confirming the final list of VECs for the Project, and prior to finalizing the *Aboriginal Interests TSD*. Please refer to the *Aboriginal Interests TSD* for a record of communication materials sent to members of First Nations, Métis Councils and organizations throughout the Project.

The primary objective of the notification letters was to determine how best to engage identified First Nations and Métis in the conduct of the EA. The letters were also used as a means to encourage participation at information sharing events. Follow up phone calls were made after each mailing for the purpose of:

- Ensuring that the information sent was received;
- Ensuring that all questions, requests for clarification and additional information were addressed; and
- Confirming how OPG could best accommodate an exchange of information and most appropriately facilitate future discussion.

10.6.2.2.2 Information Sharing Sessions

Pre-submission Engagement on the NND Project Description

In March 2007, OPG invited 10 Aboriginal communities and organizations to a pre-submission dialogue session on the NND Project Description prior to its submission to the CNSC. This session took place at the Darlington Information Centre in Bowmanville, Ontario. The objective of the session was to formally introduce these groups to the Project scope and establish a basis for ongoing discussion and information exchange.

Representatives of the Alderville and Curve Lake First Nations attended this dialogue session. Interest was expressed and clarification was sought on a number of topics including:

- Environmental considerations for existing and future operations (e.g. radioactivity, lake temperature, health of fish species, etc.);
- Plans for the long term management of used nuclear fuel;
- OPG's archaeological assessment and whether cultural artifacts had been discovered;
- Human health considerations; and
- Other regional projects.

Please refer to the *Aboriginal Interests TSD* for a copy of the meeting notes which detail the discussion shared at this session.

Roundtable Discussion: NND Environmental Assessment and Site Tour

In April 2008, OPG invited 11 First Nations and Métis councils and organizations to participate in a roundtable discussion and site tour at Darlington Nuclear in Bowmanville, ON. Representatives from Alderville and the Bay of Quinte First Nations participated in this session. The objective of the May 2008 session was to: share information on the NND EA and solicit feedback on preliminary VECs, OPG's Physical and Cultural Heritage Resources work program and the draft table of contents for the *Aboriginal Interests TSD*. OPG staff also encouraged dialogue among participants about:

- How best to seek the views of each community, council or organization in the EA study process;
- Whether local and traditional knowledge could assist in describing the existing environment;
- Whether the Project might cause an environmental effect on any lands or resources currently used by Aboriginal Peoples for traditional purposes;
- Whether the Project has perceived impacts on Aboriginal and/or treaty rights; and
- Whether OPG correctly identified environmental attributes prior to their assessment and whether the proposed list adequately captured community views.

Throughout the course of the day, discussion focused primarily on information sharing and Aboriginal interests. Specifically, participants noted the importance of OPG's continued efforts to engage Aboriginal communities on nuclear projects, investigate alternative approaches to encourage participation, and future opportunities for employment and training for members of Aboriginal communities.

Please refer to the *Aboriginal Interests TSD* for a copy of the meeting notes which detail the discussion shared at this session.

Roundtable Discussion: Considerations for Future Employment

In July 2008, OPG staff met with representatives of Alderville First Nation at their Council Offices in Roseneath, Ontario. The purpose of the meeting was to follow up on a request the community had made to obtain a contact in OPG's Nuclear Division and learn more about the considerations OPG was making with regard to employment and procurement opportunities for this Project and future initiatives in nuclear generation development. The meeting was also an opportunity for both staff and Aboriginal community representatives to follow up on the discussion shared at the May 2008 roundtable and site tour. Please refer to the *Aboriginal Interests TSD* which details the discussion shared at this roundtable meeting.

Roundtable Discussion: Preliminary Information Exchange with Métis Nation of Ontario

On January 29, 2009, OPG staff met with representatives of the Métis Nation of Ontario. The purpose of this meeting was to exchange information between the two organizations and help assist the MNO determine their level of interest and desired involvement for this Project.

This roundtable discussion revealed particular areas of interest by attendees including:

- Understanding whether the respective locations of traditional Métis harvesting territories and EA study areas overlap;
- Different methods of undertaking engagement for this EA and others in the future;
- Community councils having a potential interest in this Project (i.e. Oshawa and Northumberland); and
- The importance of continued information sharing and familiarizing Métis People with OPG's work should the Project proceed.

Please refer to the *Aboriginal Interests TSD* for a copy of the meeting note which details the nature of discussion between MNO and OPG staff.

Roundtable Discussion: Information Exchange with Métis Nation of Ontario, Oshawa and Northumberland Métis Councils

On June 8, 2009, OPG met with representatives of the Métis Nation of Ontario (MNO), and the Oshawa and Northumberland Métis Councils. The objective of this meeting was to build on an earlier meeting (January 2009) with the MNO regarding the EA, and whether the Project may affect Métis interests.

Discussion shared among participants throughout the afternoon was informative to all and helped develop a greater understanding of OPG's environmental assessment work and the nature of interests held by the MNO and Métis Councils. The following themes were noted during discussion:

- There is interest in gaining further knowledge about project work and activities as they relate interests of the Métis community;
- It is important to have adequate capacity to engage meaningfully with proponents.

- Developing a partnership between Métis and a proponent develops over time and requires continued effort;
- Métis interests are unique from those held by First Nation communities;
- Understanding the geographic boundaries of Métis harvesting territories is an ongoing process as more information is generated regarding Métis history, prior land use and occupation in Ontario;
- It is a challenge to understand the complexity of decision making bodies and identify appropriate contacts (at all levels) regarding engagement and consultation; and
- It can be disrespectful to refer to Métis as Aboriginal; the Northumberland Council would prefer that all references to Aboriginal be replaced with First Nation and Métis.

Please refer to the *Aboriginal Interests TSD* for a copy of the meeting note which details the nature of discussion between MNO and OPG staff.

Roundtable Discussion: Information Exchange with Métis Nation of Ontario, Oshawa and Northumberland Métis Councils

On July 6, 2009, OPG met with representatives of the MNO, and the Oshawa and Northumberland Métis Councils. The objective of this meeting was to build on dialogue generated in June 2009 regarding the EA, and to discuss whether the Project may affect Métis interests.

At the conclusion of this meeting, it was agreed that all participants had a better understanding of the Project and the scope of the EA being undertaken. The following themes were noted during discussion:

- Understanding a project of this scope takes time. It's important to be engaged early and often in the EA process;
- OPG has engaged the Métis community early on in the EA process which will allow for more meaningful participation. OPG's efforts to engage are appreciated;
- OPG has an effective framework for assessing potential environmental effects on Aboriginal interests and an approach that other proponents should follow;
- There are additional opportunities in this EA for Métis participation which will be explored (i.e. review and comment on VECs list, participation in Stage 4 surveying of pioneer homesteads and contribution of traditional ecological knowledge);
- The responsible management of potential effects to species is important; and
- The restoration of land associated with site preparation activities will ensure continued use by species.

Please refer to the *Aboriginal Interests TSD* for a copy of the meeting note which details the nature of discussion between MNO and OPG staff.

10.6.2.2.3 Third Annual Métis Heritage Celebration

On June 27, 2009, OPG staff participated in the 3rd Annual Métis Heritage Celebration. This weekend long event was hosted by the Oshawa Métis Council and held at Memorial Park in the City of Oshawa. The Oshawa Métis Council invited OPG staff to participate in this heritage celebration and share information with attendees on the NND Project and the EA. The heritage celebration showcased Métis history and culture through music, dance, story telling and interactive demonstrations.

A few themes emerged from discussion with public members including temporal considerations for the environmental assessment, benefits of employment to surrounding communities and decision making responsibilities concerning vendor selection. Please refer to the *Aboriginal Interests TSD* for more details regarding this event and the feedback received from participants.

10.6.2.2.4 Distribution of Draft Aboriginal Interests TSD for Review and Input

On March 30, 2009, OPG provided each Aboriginal community, council and organization that may have an interest in the lands and resources in the RSA, with a copy of the draft *Aboriginal Interest TSD*. The intent of this was to share OPG's work pertaining to the assessment of Aboriginal interests; to create an opportunity for additional dialogue; and to identify any required changes to the contents of the report.

10.6.2.2.5 Review and Explanation of EIS Results

OPG plans to review the findings of the EA with identified First Nations and Métis councils and organizations once released. This review will include an explanation of the impact statement and an opportunity to address any questions that Aboriginal groups may have.

10.6.2.2.6 Other Correspondence Regarding Aboriginal Engagement

Please refer to the Aboriginal Interests Technical Support Document for details regarding other correspondence with First Nations, other Aboriginal communities and federal authorities. This correspondence helped inform the Aboriginal Engagement Program and is therefore included in the *Aboriginal Interests TSD*.

10.6.2.2.7 Additional Initiatives

OPG continually sought to ensure that identified First Nations and Métis councils and organizations were informed of EA work as it was undertaken and notified of all opportunities to participate throughout the EA study process. Please refer to the *Aboriginal Interests TSD* for descriptions of additional components to OPG's engagement program that were developed over the course of the EA study to address capacity and information needs.

10.6.3 Feedback and Discussion

To date, feedback received and areas of discussion have included (in no particular order):

- Opportunities for future employment and training;
- The importance of continued efforts to engage Aboriginal groups on this EA;
- OPG's Physical and Cultural Heritage Resources assessment (methods and findings from archaeological surveying);
- Environmental considerations for existing landscape during Site Preparation and Construction Project phase;
- The importance of ensuring continued safety and consideration for human health; and
- Plans for the long term management of used fuel.

Discussions with First Nations and Métis have not revealed specific concerns or additional information regarding traditional or current Aboriginal land or resource uses, or pertaining to the VECs within the Study Areas.[22]

Discussions with First Nations and Métis have not resulted in confirmation (written or otherwise) that interests held by these communities, councils and organizations may be affected by the Project (although discussions to determine the interest of the MNO and Métis Councils are currently ongoing). Specifically, no concerns have been raised regarding:

- Aboriginal and treaty rights;
- Traditional or current Aboriginal land and resource uses;
- The use of local and traditional knowledge to assist in describing the existing environment; and/or
- Valued Ecosystem Components included for assessment.

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[22] This is consistent with previous contact made with representatives from the MNO and the Oshawa Métis Council who have not identified to OPG staff concerns pertaining to harvesting or other specific Métis community interests in the study areas for the NND Project.

OPG continued to encourage feedback from First Nation and Métis councils and organizations regarding how best to seek their views during the EA study process.

10.6.4 Post Submission Aboriginal Engagement

OPG will continue to share information with, and attempt to engage First Nations and Métis councils and organizations. The draft *Aboriginal Interests TSD* was sent to all Aboriginal contacts on March 30, 2009 for their review prior to its finalization and submission of the EIS. OPG will continue to communicate with those communities, councils and organizations expressing an interest in reviewing further information following the submission of the EIS and Licence to Prepare Site application.

11. PRELIMINARY PLAN FOR EA FOLLOW-UP PROGRAM

This Chapter provides a preliminary plan and scope for a follow-up and monitoring program for the Project, as required by the EIS Guidelines. OPG, as the Project proponent, will be responsible for the follow-up program.

A follow-up program under the *CEAA* has the following objectives:

- To verify the accuracy of the EA of a project; and
- To determine the effectiveness of any measures taken to mitigate the adverse environmental effects of a project.

In practice, these objectives are typically expanded to also:

- Confirm on an on-going basis, whether assumptions made during the EA remain accurate;
- Confirm that mitigation measures have been implemented and are effective; and
- In the event that applied mitigation measures are not completely effective in ameliorating adverse effects, assist in identifying new mitigation strategies that may be implemented.

The preliminary scope of the follow-up program as outlined in the following pages addresses the Site Preparation and Construction, and the Operation and Maintenance phases of the Project. The scope and nature of the follow-up program will be reviewed and adjusted on an ongoing basis to incorprate subsequent phases of the Project (e.g. decommissioning), evolving site conditions, and monitoring data as it is acquired (see Section 11.3, Adaptive Management).

11.1 Relationship of Follow-Up Program to Other Monitoring Programs

The follow-up program will have a specific focus on issues of relevance to the EA. As such, the program will be designed to incorporate pre-Project information such as EA baseline data as it may be applicable. Because of its very nature, the Project will involve a range and variety of other monitoring programs, each with its own scope and objective. These will include environmental monitoring carried out for related purposes including specific licence requirements and more general regulatory compliance; as well as overall operational monitoring that, although not required from a regulatory perspective, is necessary to confirm that facility performance goals are being achieved. In practice, the objectives of the various programs will not be mutually exclusive and, in fact, will be complementary in that collectively, they will produce data that will be useful in planning and implementing the long-term environmental management requirements of the Project.

To the extent practicable, all related activities and requirements will be merged into an over-arching and comprehensive environmental monitoring program that will consider the collective requirements of the individual elements, yet will provide for standardized procedures, protocols and efficiencies. Nonetheless, however, those elements relevant to EA follow-up will be consolidated with a specific report issued on an on-going basis for the express purpose of documenting EA follow-up activities and monitoring programs (see further discussion concerning reporting in Section 11.4).

11.2 Plan for Developing Final Follow-Up Program

This preliminary follow-up program is presented as a requirement of the Guidelines. It, and all other elements of this EIS, will be subject to review by the JRP and other stakeholders as appropriate. The preliminary program is intended to demonstrate the commitment of OPG, as the proponent, to an appropriate and thorough process of verifying that the changes to the environment as a result of the Project are as predicted and that any adverse effects are mitigated.

Upon acceptance of this EIS by the JRP and subsequently, by the Minister of the Environment, continued planning for Project implementation will include corresponding refinement of the follow-up program. Program refinement will be carried out within a consultative process that will have begun with review comments on this EIS and the associated licensing process. The stakeholders that may be involved in the follow-up program will be confirmed during the EIS review process, but the following may be included:

- The RAs (i.e., CNSC, DFO, TC and the Canadian Transportation Agency);
- The FAs (i.e., Health Canada, Environment Canada and INAC);
- Provincial ministries (e.g., MOE and MNR);
- Central Lake Ontario Conservation Authority;
- Aboriginal Peoples (i.e., having declared an interest in the Project);
- Regional and local municipal governments;
- Darlington Site Planning Committee; and
- Durham Nuclear Health Committee.

While the follow-up program will be developed considering the noted collective input, it will also remain dynamic throughout its full implementation period and continue to be responsive to the evolving nature of its purpose, objectives and on-going input from its stakeholders. The details of the program will be refined for implementation under the leadership and direction of the RAs generally through the following process:

- The preliminary follow-up plan will be reviewed and considered in the context of regulatory and stakeholder input received during review of the EIS;

- Details of the scope of each of the separate program elements developed for the individual environmental components will be expanded to consider the more specific aspects of monitoring/sampling location and frequency, parameters (including with regard for specific reactor selected and associated radionuclides), program duration, action triggers, etc.;

- Existing baseline data will be evaluated, including through the use of statistical analyses as appropriate, to confirm its adequacy as a benchmark against which to test for Project effects;

- The complementary objectives of existing monitoring programs (e.g., as they may currently be in place at the DN site) will be considered with a view to appropriate harmonization;

- The requirements of the other NND Project monitoring programs (e.g., REMP, facility performance monitoring) will be considered also with a view to appropriate harmonization with the EA follow-up program;

- Consultation with relevant stakeholders will be initiated as the follow-up program refinements are being planned and continue as its elements are further clarified to ensure all appropriate interests are considered; and

- The reporting chain and process for distributing monitoring data to stakeholders will be established through dialogue with stakeholders.

In addition, OPG will continue to consider the results of independent monitoring and studies such as Health Canada's Canadian Radiological Monitoring Network, the Ontario Ministry of Labour's Radiation Protection Monitoring Service and the Durham Region Health Department's periodic studies on radiation and health in the region.

11.3 Adaptive Management

The EA follow-up program will be developed and implemented specifically for purposes related to the EA. However, as noted above, construction and operation of the NND will also involve comprehensive environmental monitoring programs carried out for other purposes not directly related to the EA.

Although the EA follow-up program and other monitoring programs may be carried out for different purposes, they will be harmonized to the extent practicable to consider efficiency and their shared objectives. In principle, performance monitoring will be conducted to assess if the Project-related elements are functioning as designed; and follow-up monitoring will be focused on the interests of the EA. In practice, these objectives will not be mutually exclusive and the programs will be complementary in that both will produce monitoring data that will be useful in planning and implementing the long-term environmental management requirements of the Project.

The collective monitoring activities associated with the Project, both related and unrelated to the EA, will be conducive to the principle of adaptive management. The concept of adaptive management is included in the *CEAA* (s. 38) specifically in regards to follow-up programs, wherein it is indicated that the results of follow-up monitoring may be used for implementing adaptive management measures for improving the quality of future EAs.

Adaptive management is a planned and systematic process for continuously improving environmental management practices by learning from their outcomes. Adaptive management provides the flexibility to identify and implement new mitigation measures or to modify existing measures throughout the life of the project. In its simplest form, adaptive management as it relates to effects mitigation and environmental monitoring, integrates design, management and monitoring data to systematically test assumptions, learn from experience, and apply the knowledge gained (i.e., adapt) to subsequent actions.

Adaptive management will be inherent in the design and implementation of the EA follow-up and monitoring (and related) programs. Table 11.6-2 presents the preliminary framework for the NND Project follow-up and monitoring plan. Prior to its implementation, the plan will be refined and designed in detail, with this design incorporating principles of adaptive management. Adaptive management will subsequently become a fundamental aspect of its implementation to ensure that the monitoring elements remain valid, appropriately encompassing, and responsive to the objectives, including as their focus may evolve over time. The monitoring programs themselves will be routinely re-evaluated and their scopes adjusted to consider such aspects as changing site conditions, or the need to re-focus on specific operational or environmental issues of uncertainty or concern.

11.4 Information Management and Reporting

Because follow-up monitoring is an integral element of the EA, all monitoring data will be provided to the RAs and other FAs that they may choose to designate. The final distribution of monitoring data will be determined in conjunction with finalization of the program itself, however, it is also likely that some aspects of monitoring information will also be provided to other stakeholders as appropriate. Although the form and frequency of the reporting will be determined as the program is finalized, it is reasonable to anticipate that the data will be assembled into a formal monitoring report and submitted on a regular basis. As has been noted, many of the follow-up program elements are likely to be merged with related monitoring programs so it will be likely that data collected during the program will also be distributed to other parties and agencies, based on the requirements of those programs. However, those elements relevant to EA follow-up will be consolidated with a specific EA follow-up program report.

Depending on the results and considering the likely diminishing frequency of sampling events during the long-term, particularly with respect to mitigation measures that prove to be effective and stable, it may be that through agreement with stakeholders, the reporting frequency would be adjusted. Considering that the purpose of the follow-up program is to confirm EA predictions and the suitability of mitigation, it would be expected that the confidence gained by on-going monitoring would allow that the reporting frequency be adjusted.

11.5 Preliminary Follow-Up and Monitoring Program

Each of the likely effects of the Project identified in the EIS and associated TSDs was reviewed to determine how the predicted effect could be confirmed. The focus of the review was to identify which VECs, or other components of the environment, should be incorporated into the follow-up and monitoring program.

11.5.1 Program Overview

The proposed plan for the development of the follow-up and monitoring program consists of the following steps:

- Identification of the general timeframe for the follow-up program;

- Identification of the preliminary scope of follow-up studies related to the general timeframe; and
- Proposal of a process for developing the final scope and timing of the follow-up program (including details such as monitoring parameters, locations and frequencies).

11.5.2 General Timeframe for Follow-up and Monitoring Program

In carrying out the assessment, it was determined by the technical experts responsible for each of the environmental components that there was sufficient information to support the assessment of the likely effects of the Project. The extensive baseline information provided in the EIS and associated TSDs, which comprise an extensive sampling and assessment program, is judged to be adequate. Although the follow-up program will include a review of the adequacy of the available pre-Project information (including baseline data), it is not anticipated that there will be a need for substantial pre-construction monitoring in the follow-up and monitoring program. Thus, the focus of the proposed preliminary scope of the program is primarily, though not exclusively, on activities during and after the Site Preparation and Construction phase. The duration of the different components of the program would be reviewed through the consultative process outlined above.

11.6 Preliminary Scope of Follow-up and Monitoring Program

As noted above, the scope of any follow-up and monitoring program is focused on providing information needed to verify the predictions in the EIS and the effectiveness of the identified mitigation measures. Follow-up studies will be focused on specific potential effects and, as much as possible, will be limited to finite periods of time. This will allow results to be evaluated and any appropriate corrective action to be taken in a timely manner.

As noted above, a number of on-going monitoring programs not related to the EA follow-up program will also be carried out particularly during the implementation phases of the NND. These will include those that may be required as licence conditions as well as others that may be conducted as aspects of OPG's due diligence. Those programs will complement the follow-up campaign and data will be shared to meet the collective requirements. Table 11.6-1 summarizes likely fundamental monitoring requirements not associated with EA follow-up.

Table 11.6-2 provides a preliminary listing of the activities that will be specifically developed for the NND Project EA follow-up program. These were identified primarily as part of the mitigation measures in Chapter 5. It is anticipated that many of these activities will be incorporated into NND's overall Environmental Management System (EMS).

TABLE 11.6-1
Likely Monitoring Requirements Not Associated with EA Follow-Up

Environmental Media	Monitoring Location	Monitoring Program Description	Objective
Radiation and Radioactivity	Site and Local/Regional Study Area	• Monitoring associated with the Radiological Environmental Monitoring Program (REMP) or equivalent. • REMP program monitors radioactivity in air, water, foodstuffs, soil, groundwater, fish, lake water, lake sediment.	Determine radiological impact to the public resulting from operation of the NND.
Radioactivity in Effluents	Airborne and liquid effluent streams	• Airborne radionuclides (eg. tritium, particulates, iodine, noble gases). • Liquid radionuclides (eg. tritium, gross alpha, gross beta, gross gamma).	Demonstrate compliance with Derived Release Limits (DRLs) and Environmental Action Levels.
Radiation and Radioactivity Radiation Protection	NND	• Exposure control, contamination control and dosimetry including training programs, protection procedures, monitoring and ALARA.	Ensure the safeguarding of the health and safety of workers, public and the environment from radiological hazards.
Air, Noise	Site and Local Study Areas	• Development of relevant regulatory approvals for NND Operations. • Confirmation of compliance with regulatory approvals (confirmation only; no monitoring will be required).	Confirm compliance with regulatory approvals.
Surface Water	Site Study Area	• Development of relevant regulatory approvals for NND Operations. • Conduct monitoring as specified by approvals.	Confirm compliance with regulatory approvals.
Aquatic Environment	Site Study Area	• Conduct monitoring as specified by the Authorization for Works; or Undertakings Affecting Fish Habitat	Confirm compliance with regulatory approvals.

TABLE 11.6-2
Preliminary EA Follow-Up Program Elements

Environmental Sub-component	Program Description	Program Basis and Objective	Site Preparation	Construction	Operation & Maintenance
ATMOSPHERIC ENVIRONMENT					
Air Quality	Measure Total Suspended Particulate (TSP), PM_{10} and $PM_{2.5}$ during site preparation and construction activities to periodically confirm the effectiveness of the Dust Management Plan and verify EIS predictions.	**Basis:** No residual adverse effects on air quality or noise are predicted considering the implementation of mitigation measures. **Objective:** Confirm the effectiveness of the mitigation measures and the continuing absence of residual adverse effects.	✓	✓	
Noise	Measure noise levels during site preparation and construction activities to periodically confirm the effectiveness of the Noise Management Plan and verify EIS predictions.				
SURFACE WATER ENVIRONMENT					
Lake Circulation and Shoreline Processes	For the once through cooling option, monitor performance of new intake (e.g., velocities and associated effects on substrates, current deflection) and new discharge diffuser (discharge velocities and associated effects on substrates and current deflection; thermal plumes) during commissioning.	**Basis:** No adverse effects on lake circulation and shoreline processes are predicted. **Objective:** Confirm the continuing absence of adverse effects.			✓
Lake Water Temperature	For the once through cooling option, periodically monitor lake water temperatures near the surface and at the bottom to verify the performance of the intake and diffuser.	**Basis:** No residual adverse effects on lakewater temperatures are predicted considering the implementation of mitigation measures. **Objective:** Confirm the effectiveness of mitigation measures and continuing absence of adverse effects.			✓

TABLE 11.6-2 (Cont'd)
Preliminary EA Follow-Up Program Elements

Environmental Sub-component	Program Description	Program Basis and Objective	Site Preparation	Construction	Operation & Maintenance
SURFACE WATER ENVIRONMENT (Cont'd)					
Site Drainage and Water Quality	Undertake post-construction water quality sampling in Lake Ontario focused on verifying the effects of the Project as predicted in the EIS. To verify the effects of the EIS, sample stormwater discharges from the NND following a plan (with regard for parameters and frequency) appropriate for the facility.	**Basis:** No residual adverse effects on Lake Ontario water quality are predicted considering the implementation of mitigation measures. **Objective:** Confirm the effectiveness of mitigation measures and continuing absence of adverse effects.			✓
AQUATIC ENVIRONMENT					
Aquatic Habitat	Consistent with the Authorization for Works or Undertakings Affecting Fish Habitat conditions, monitor post-construction conditions to confirm success of habitat restoration and compensation plans.	**Basis:** No residual adverse effects are predicted on aquatic habitat considering the implementation of mitigation measures, which include a Fish Habitat Compensation Plan. **Objective:** Confirm the effectiveness of mitigation measures and continuing absence of residual adverse effects.			✓

TABLE 11.6-2 (Cont'd)
Preliminary EA Follow-Up Program Elements

Environmental Sub-component	Program Description	Program Basis and Objective	Site Preparation	Construction	Operation & Maintenance
AQUATIC ENVIRONMENT (Cont'd)					
Aquatic Habitat and Aquatic Biota	For the once-through lakewater cooling option, periodically monitor data on cooling water discharge temperature and plume characteristics interpreted in relation to fish habitat and susceptibility of VEC species, to verify EIS predictions.	**Basis:** No residual adverse effects are predicted on Aquatic Habitat and Aquatic Biota associated with cooling water discharges considering the implementation of mitigation measures. **Objective:** Confirm the effectiveness of mitigation measures and continuing absence of residual adverse effects.			✓
TERRESTRIAL ENVIRONMENT					
Vegetation Communities and Species Breeding Birds Insects Amphibians and Reptiles Landscape Connectivity	Monitor conditions to confirm the EIS predictions of habitat restoration post-construction.	**Basis:** Loss of terrestrial habitat (Cultural Meadow and Thicket, wetland ecosystems, and wildlife corridor), used by breeding birds, amphibians, and butterflies is predicted. Residual effects are not significant due to implementation of mitigation measures. **Objective:** Confirm the effectiveness of mitigation measures and continuing absence of significant residual adverse effects.	✓	✓	✓
Bird Communities and Species	Develop, prior to site preparation activities, a Bank Swallow mitigation plan for implementation during Site Preparation and Construction phase, and verify the implementation of the plan. Verify the results predicted in the EIS during initial operation of the NND.	**Basis:** Loss of nesting habitat on the DN site for Bank Swallows is identified as a residual adverse effect of the Project, although not significant due to the implementation of mitigation measures. **Objective:** Confirm the effectiveness of mitigation measures and continuing absence of significant residual adverse effects.	✓	✓	✓

TABLE 11.6-2 (Cont'd)
Preliminary EA Follow-Up Program Elements

Environmental Sub-component	Program Description	Program Basis and Objective	Site Preparation	Construction	Operations & Maintenance
TERRESTRIAL ENVIRONMENT (Cont'd)					
Mammal Communities and Species Bird Strikes	Periodically conduct wildlife mortality surveys during site preparation and construction.	**Basis:** The mammals present at the DN site are unlikely to be affected as a result of road mortality at a measurable level. Bird strike mortalities may result from the presence of large structures (such as natural draft cooling towers, should they be constructed) and buildings. **Objective:** Mammals: Confirm on-going validity of assumptions regarding road mortality used in the EA and continuing absence of adverse effects. Bird Strikes: Confirm the effectiveness of mitigation measures and continuing absence of significant residual adverse effects.	✓	✓	

TABLE 11.6-2 (Cont'd)
Preliminary EA Follow-Up Program Elements

Environmental Sub-component	Program Description	Program Basis and Objective	Site Preparation	Construction	Operations & Maintenance
GEOLOGICAL AND HYDROGEOLOGICAL ENVIRONMENT					
Groundwater Flow and Quality	Monitor groundwater flow to confirm EIS predictions.	**Basis:** No residual adverse effects are predicted on groundwater flow and quality considering the implementation of mitigation measures. **Objective:** Confirm the effectiveness of the mitigation measures and the continuing absence of residual adverse effects.	✓	✓	✓
	Confirm EIS predictions post-construction of on-site groundwater flow regime.	**Basis:** Groundwater flow modelling carried out to support the assessment of effects incorporated assumptions concerning post-development physical flow characteristics. **Objective:** Confirm ongoing validity of assumptions used in the EA and continuing absence of residual adverse effects.			✓
	Confirm baseflow estimates in Darlington Creek at the beginning of the Operation and Maintenance phase.	**Basis:** The assessment of effects incorporated assumptions concerning post-development contributors to, and flow characteristics in, Darlington Creek. **Objective:** Confirm ongoing validity of assumptions used in the EA and continuing absence of residual adverse effects.	✓	✓	

TABLE 11.6-2 (Cont'd)
Preliminary EA Follow-Up Program Elements

Environmental Sub-component	Program Description	Program Basis and Objective	Site Preparation	Construction	Operations & Maintenance
LAND USE					
Land Use	Monitoring Regional Policy (e.g., Growing Durham Study; DROP Amendment process). Monitor additional relevant policy. Monitor committee and Council minutes and the Study approval process.	**Basis:** No residual adverse effects are predicted on sensitive land uses in proximity to the DN site, considering the implementation of mitigation measures. **Objective:** Confirm the effectiveness of the mitigation measures and the continuing absence of residual adverse effects.	✓	✓	
	Confirm projected population, at the end of the site preparation and construction activities, to ensure that emergency response plan is consistent with the projections.	**Basis:** Effective emergency response planning relative to the NND is dependent upon accurate and up-to-date population data in the affected communities. **Objective:** Confirm ongoing validity of assumptions used in the EA.	✓	✓	✓

TABLE 11.6-2 (Cont'd)
Preliminary EA Follow-Up Program Elements

Environmental Sub-component	Program Description	Program Basis and Objective	Site Preparation	Construction	Operations & Maintenance
TRAFFIC AND TRANSPORTATION					
Transportation System Safety (Road)	As part of the Traffic Management Plan, undertake pre-Project road condition assessment as a baseline for considering incremental Project-related degradation. Follow with periodic inspections of road conditions to document changes relative to baseline during construction. As part of the Traffic Management Plan, at the beginning of the Operation and Maintenance phase, verify road safety as predicted in the EIS.	**Basis:** The Project will add traffic to the existing roadways and contribute to ongoing degradation of the roads system. It is intended that undertakings between the appropriate parties will facilitate improvements with respect to traffic safety and roadway degradation related to the NND Project. **Objectives:** To establish a baseline status for road conditions; and periodically assess conditions to evaluate degradation attributable to the Project.	✓	✓	✓
SOCIO-ECONOMIC ENVIRONMENT[1]					
Physical Assets (Community Character and Image)	Undertake Public Attitude Research (PAR) at the end of each phase of the Project.	**Basis:** Negative change in the character of communities (due to presence of cooling towers) is identified as a residual adverse effect (not significant) of the Project. **Objective:** Verify the continuing absence of a significant residual adverse effect.	✓	✓	✓
Social Assets (Community and Recreational Facilities and Services)	Undertake a recreational user survey of the DN site recreational facilities at the start of the Construction phase and the Operation and Maintenance phase.	**Basis:** Reduced use and enjoyment of the DN site recreational facilities is identified as a residual adverse effect (not significant) of the Project. **Objective:** Verify the continuing absence of a significant residual adverse effect.		✓	✓

TABLE 11.6-2 (Cont'd)
Preliminary EA Follow-Up Program Elements

Environmental Sub-component	Program Description	Program Basis and Objective	Site Preparation	Construction	Operations & Maintenance
SOCIO-ECONOMIC ENVIRONMENT[1] (Cont'd)					
Social Assets (Ability to use and enjoy property)	Undertake a door to door survey of DN site neighbours at the start of the Construction phase and the Operation and Maintenance phase.	**Basis:** Disruption to use and enjoyment of property (due to presence of cooling towers and nuisance-related effects of truck haulage) is identified as a residual adverse effect (not significant) of the Project. **Objective:** Verify the continuing absence of a significant residual adverse effect.		✓	✓
HEALTH – NON-HUMAN BIOTA					
Non-Human Biota	No residual adverse effects on non-human biota are predicted. However, if follow-up and monitoring programs conducted for other environmental components (as described in the foregoing) suggest changes or conditions that may lead to effects on non-human biota, the Ecological Risk Assessment will be updated, including the identification of mitigation measures or other actions that may be appropriate to address such effects.	**Objective:** Verify the continuing absence of radiological and non-radiological effects on non-human biota.		✓	✓
PUBLIC CONSULTATION					
Public Consultation	Develop a follow-up Communication Plan.	**Objective:** Ensure the public is informed about the progress of the Project.	✓	✓	✓

Note:
[1] As described in Section 9.3, residual adverse effects on Human Health relate to mental well-being as a result of disruption to, and reduced use of, private property and recreational features on the DN site. These residual adverse effects are common with the same effects in the Socio-Economic Environment. Follow-up monitoring elements described above for these effects in the Socio-Economic Environment will also serve as follow-up for the effects in terms of Human Health.

12. PRELIMINARY DECOMMISSIONING PLAN

The EIS Guidelines Section 8.6 requires that "*a preliminary decommissioning plan for the facility must be included in the EIS". More specifically,* the EIS should identify *"the preferred decommissioning strategy, including a justification of why this is the preferred strategy. It must also include end-state objectives, the major decontamination, disassembly and remediation steps; the approximate quantities and types of waste generated; and an overview of the principal hazards and protection strategies envisioned for decommissioning*".

Beyond the preliminary decommissioning plan requirement, Section 4.1 of the Guidelines requires that the scope of the Project for EA purposes include *"decommissioning and abandonment"* of the NND facility. This section of the Guidelines acknowledges that decommissioning activities can only be *"conceptually"* described at this time. Furthermore, Section 9.2 requires that the temporal boundaries of the assessment of environmental effects of the NND Project include *"eventual decommissioning and abandonment"*. Because of the preliminary nature of the decommissioning plan available at the pre-implementation phase of any nuclear power generation project, the level of information available for assessing the environmental effects of the decommissioning and abandonment phase is less detailed than that which is available for the implementation phases of the project. Therefore, the assessment of potential environmental effects of eventual NND decommissioning, presented in Section 12.10 of this chapter, is presented at a conceptual level.

12.1 Regulatory Requirements for Decommissioning

The CNSC regulates nuclear activities through a multi-stage licensing process which requires separate applications for site preparation, construction, operating, decommissioning and abandonment licences. As early as possible, a Preliminary Decommissioning Plan must be submitted in accordance with the CNSC's Regulatory Guide G-219 for Decommissioning Planning for Licensed Activities. Preliminary Decommissioning Plans (PDPs) have been developed for all of OPG's existing nuclear facilities and are being developed for New Nuclear – Darlington (NND) and its associated waste management facilities. The PDPs will describe the activities that will be required to decommission these facilities and to restore the sites for other OPG uses. The PDPs are not detailed plans for the future decommissioning of either of these facilities. However, they demonstrate that the planned decommissioning is feasible with existing technology.

The decommissioning program described in this section addresses only NND, including its associated waste management facilities (i.e., does not include DNGS).

12.1.1 Forecast of Decommissioning Dates

Decommissioning of NND will begin after a decision is made to cease operating the station. For EA planning purposes, decommissioning is assumed to begin in 2100. It may be possible that shutdown of one or more of the reactors may occur prior to this date if a future decision is made not to refurbish the reactor(s) or as part of a staggered shutdown sequence, and should that be the case, those reactors would be placed in safe storage under the existing Operating License.

Similarly, decommissioning of waste management facilities will occur after all the stored used fuel and low and intermediate-level wastes have been removed to appropriate off-site long-term waste management facilities and a decision is made to shut down the facility. Although the waste management facilities are located on the same site as NND, the life-cycle management plans of these facilities are separate from each other and as such, decommissioning of each facility will occur as required.

12.2 Decommissioning Strategy

12.2.1 Reactors

Similar to other OPG-owned reactors, the preferred decommissioning strategy for NND is one of deferred dismantling. Deferred dismantling occurs when the reactors and stations are safely stored for several decades after shut down to allow radiation levels to decay prior to dismantling and site restoration. The preferred decommissioning strategy of deferred dismantling minimises both the occupational radiation dose to workers and the potential exposure of the public and the environment. While the specific details for each of the three reactor technologies differ depending on the design and layout of the buildings and systems, the overall decommissioning strategy and principles are identical.

The decommissioning strategy of deferred dismantling involves three main phases as follows:

- Phase I – Preparation for Safe Storage;
- Phase II – Safe Storage and Monitoring; and
- Phase III – Dismantling, Disposal and Site Restoration.

12.2.2 Nuclear Waste Management Facilities

Decommissioning a nuclear waste management facility is an operation different from decommissioning a nuclear generating station and as such, employs a different strategy. The purpose of the waste management facility is to provide interim storage for waste materials (including used fuel) in a safe and secure manner. The waste management facility is expected to be free from radiological contamination and will not result in large quantities of radioactive materials requiring disposal. Activities for the removal of the stored waste and demolition of the waste management facilities will be considerably less complex than the activities involved in decommissioning a nuclear power plant.

Waste management facilities will generally be dismantled after the stored nuclear waste is removed from the facility. Although a Safe Storage and Monitoring period is not required, the dismantling may be delayed by a few years after the facility is taken out of service in order to optimise the scheduling of resources (e.g., wait until all storage buildings in a facility have been taken out of service, rather than dismantle each building as it comes out of service).

12.2.3 Abandonment

As indicated earlier, the EIS Guidelines require that the scope of the NND Project and the temporal boundaries of the assessment of environmental effects of the Project include "abandonment" following decommissioning of the site of the NND and related facilities. It is important to note that it would not be OPG's intention to actually abandon the site at that point. As explained in the EIS Guidelines (Section 4.1), the transition from the end of the decommissioning phase to the abandonment phase is effectively a conversion of the site from a licensed state to *"an unlicensed state"*, no longer under CNSC regulatory oversight. A Licence to Abandon the site is not a requirement of the regulatory process for decommissioning as such. For example, the CNSC Regulatory Guide G-219 does not include "abandonment" in its definition of "decommissioning", nor does it require abandonment to be explicitly included in the content of preliminary or detailed decommissioning plans. However, G-219 does require that such plans include end-state objectives for the site and any predicted requirements for long-term institutional control following decommissioning if release of the site from regulatory control is proposed. Accordingly, if and when OPG decides that it wishes the site to be released from CNSC licensing control after decommissioning (which may depend on its plans for future use of the site), OPG will apply to the CNSC for a Licence to Abandon the site.

12.3 Preparing for Decommissioning

As indicated in Section 2.6.14, for EA purposes, the operating phase in the life of each NND reactor unit is considered to end when the unit has been permanently shut down and the reactor has been defueled in preparation for decommissioning. Prior to final shutdown of the entire NND station, it is possible that one or more units may cease to operate while other units continue to operate. This may necessitate some physical modifications and activities to the non-operating units to ensure that they are isolated from systems that are required for the continued safe operation of the remaining units. These activities may include defuelling and dewatering the non-operating reactor unit(s), if not completed earlier, subject to the provisions of the operating licence.

Prior to beginning decommissioning, OPG will complete those regulatory activities necessary to comply with the requirements of the *NSCA* and Regulations of the CNSC, the *CEAA* and Regulations (if determined to be applicable) and the other applicable Federal and Provincial statutes and regulations. Some of the actions that will be required include:

- Submit a notification of the intent to decommission the station to the CNSC and determine if *CEAA* is applicable;
- Inform the public, key stakeholders and the host community of the decommissioning and obtain their input for the development of the Detailed Decommissioning Plan (DDP);
- Complete an Environmental Assessment for the decommissioning project (as required);
- Prepare and submit the DDP and other documents for the station to the CNSC; and
- Obtain the licences and permits required for the decommissioning work.

The major decontamination, disassembly and remediation steps envisioned for decommissioning the NND station and related waste management facilities are described in Sections 12.4 and 12.5, respectively. Although end-state objectives are not explicitly stated for each phase or planning envelope (only for the final phase), due to the preliminary nature of this decommissioning plan, the conditions expected to exist at the end of each phase or planning envelope are indicated.

12.4 Steps in Decommissioning a Station

12.4.1 Phase I - Preparation for Safe Storage

During Phase I, the reactors will be defuelled and dewatered, unless this has been completed as part of the wind-down of the Operation Phase (see Section 12.3). Most of the external non-fixed surface contamination will be removed from accessible areas of the station. Internal chemical decontamination will remove the majority of radioactive material contained within contaminated systems. The largest source of remaining radioactivity will be used fuel remaining in the Irradiated Fuel Bay (IFB) and the neutron activated reactor vessel and internals. Most of the other hazardous, non-nuclear materials will also be removed. During this period, the normal station environmental surveillance and monitoring program will be maintained.

Radiation and contamination surveys of the station and its systems will be performed. Physical barriers will be installed to allow other units to function as the preparation continues and to control access to all radiation areas. Plant systems will be drained, de-energised and secured except for those required during the next phase. Non-essential equipment from offices, workshops and storerooms will also be removed.

12.4.2 Phase II –Safe Storage and Monitoring

The Safe Storage and Monitoring phase will allow time for the decay of the short-lived fission and activation products that remain in plant components. The duration of this phase is determined by balancing the reduced decommissioning cost and occupational dose achieved by allowing the residual activity to decay against the increased social and economic costs of a longer storage period. OPG has determined that a Safe Storage and Monitoring phase of approximately 30 years offers a reasonable balance of safety and cost. This decision will be reassessed periodically in light of experience, cost, changing technology and the possible requirement of the site for other purposes.

Throughout the Safe Storage and Monitoring phase, resident maintenance personnel will perform routine inspections, preventive maintenance and corrective maintenance. This work force will maintain the structures in a safe condition, provide adequate lighting and perform periodic preventive maintenance on essential services. The existing site security arrangements for the facility will continue unless they are modified by agreement with the CNSC.

Environmental surveillance and monitoring will be carried out during the safe storage period to ensure that potential releases of radioactive material to the environment are detected and controlled if they occur. It is anticipated that the environmental surveillance program will be an abbreviated version of the program that has been used during normal station operations. Routine radiological monitoring of contaminated structures and systems will also be performed. Procedures for responding to unanticipated changes in the radiological environment of the site and potential releases to the environment will be prepared and implemented if required.

12.4.3 Phase III – Dismantling, Disposal, and Site Restoration

The third and final phase of decommissioning, Dismantling, Disposal and Site Restoration will typically extend over approximately 10 years. It begins with the removal of any remaining radioactive material. The resulting radioactive waste will be transported to an approved offsite disposal facility following which, systems and equipment will be physically dismantled and removed. Surveys will be conducted to verify the site meets the necessary clearance levels before the remaining buildings and structures are demolished. The site will be restored to a condition suitable for other uses. As part of this work, OPG may apply to the CNSC for a Licence to Abandon the site if required (see Section 12.2.3).

Dismantling work would begin after the detailed planning has been completed and the necessary licences, permits and approvals have been obtained. The work in this phase can be divided into a series of conceptual steps:

- Prepare the buildings and site;
- Dismantle systems;
- Dismantle structures;
- Manage the waste; and
- Restore the site.

Work in the different steps may occur in parallel. Surveys for radioactive and other hazardous materials will be performed throughout the dismantling work, culminating in a final survey. All material removed during the decontamination and dismantling of the nuclear units will be routed to the central waste processing area, which will characterise, process, and prepare the material for release or shipment to an appropriate disposal or recycling facility.

A series of surveys for radioactive and other hazardous materials will be performed throughout the course of the dismantling work. The surveys will be based on guidelines available at the time the work is to be done. Several different types of surveys are likely to be performed at different stages of the decommissioning:

- **Scoping Survey** to locate the contamination remaining in the facility at the end of the Safe Storage period;

- **Characterization Surveys** to identify the nature and form of the remaining contamination in order to assist in the planning of the decontamination work;

- **Remediation Control Surveys** to guide and monitor the decontamination work. They are also used to help to control the exposure of decontamination workers to radiation and hazardous materials; and

- **Final Surveys** to verify that the facility has been decontaminated to the extent that all remaining buildings, components and the site itself have residual activity levels below the established clearance levels. The final surveys will be performed when the remediation control surveys indicate that all the residual levels of radioactive and hazardous material in a work area are below the established clearance levels.

Dismantling of the remaining buildings and structures may proceed once the final surveys have confirmed that the residual contamination levels in a work area or unit are below the established clearance levels, and the results of these surveys have been accepted by the CNSC and other regulatory agencies to support any application for a Licence to Abandon.

By the end of the Dismantling, Disposal and Site Restoration phase, the site will be free of industrial hazards. The end-state objectives for the site are to ensure that all radioactive contamination in excess of the established clearance levels and all other hazardous materials will have been removed from the site, all of the station systems will have been dismantled and all of the buildings demolished; and, that subsurface structures will have been drained, de-energised, decontaminated, removed to a nominal removal depth (generally about 1 m) and capped. The site will be remediated and restored to a state suitable for other OPG uses, and it will meet the criteria established by the CNSC for a Licence to Abandon. Restoration work may include cleaning the site to remove any remaining inactive waste and debris, covering the site with gravel and topsoil and establishing a covering of vegetation to prevent soil erosion.

12.5 Steps in Decommissioning a Waste Management Facility

Waste management facility decommissioning plans are logically divided into the following three decommissioning planning envelopes:

- The processing building(s) for dry storage containers and low-level wastes;
- The storage buildings; and
- The remaining site (outdoor surfaces).

Decommissioning approaches are discussed below.

12.5.1 Processing Buildings

All equipment, furniture and supplies in radiologically zoned areas of the processing buildings will be surveyed and decontaminated as necessary prior to clearance for non-radiological use, recycling or disposal. The active ventilation system will be dismantled and, depending on the feasibility of decontamination, disposed of as low-level radioactive waste.

No significant radiological or chemical hazards are expected to be present in the waste processing building(s) at the time of decommissioning. The processing building(s), due to the nature of its operations, stores a variety of consumables, some of which are classified as hazardous materials. It is expected that remaining inventories of non-radioactive hazardous materials, such as small quantities of unused paint supplies and remaining chemical waste, will be dispositioned in accordance with the applicable regulatory requirements in force at the time of decommissioning.

Interior structural surfaces will be surveyed to identify areas requiring decontamination. The characterization survey will determine the nature and extent of contamination, for the purposes of hazard assessment as well as to facilitate and control decontamination work. On completion of decontamination work, a final clearance survey will be carried out. Non-radiologically zoned office space will be appropriately surveyed prior to clearance. If contamination is found in office areas, decontamination, followed by an additional clearance survey, will be carried out. While there is no reason to expect particulate contamination to be released from the HEPA-filtered active ventilation system, a confirmatory survey of roof surfaces as appropriate will be carried out prior to radiological clearance of the processing buildings. Drains will be surveyed and removed separately if found to be contaminated prior to demolishing the building.

General hazards that could be encountered during decommissioning of processing buildings include conventional hazards that would be associated with any structural demolition project.

12.5.2 Storage Buildings

The waste storage buildings are expected to be free from radiological contamination. Nevertheless, before decontamination or dismantling of structural components takes place, a survey will be carried out to identify the presence of detectable contamination in each building. Since the buildings are unlikely to be contaminated, this initial characterization survey should be designed to meet the full requirements of a final clearance survey. Spot decontamination, followed by a final survey of potentially affected areas, will be carried out if necessary. When the structure has been verified to meet clearance levels, and after CNSC approval, it will be dismantled and demolished for recycling and disposal of structural materials.

No hazardous materials will be used in the construction of the storage buildings and no hazardous materials will be stored in these structures. General hazards that could be encountered during decommissioning include conventional hazards similar to those associated with any structural demolition project.

12.5.3 Outdoor Surfaces

No radiological or chemical hazards are expected to be present outdoors within the site at the time of decommissioning (i.e., on asphalt or concrete yard surfaces); nevertheless, a final clearance survey will be carried out across the site for confirmation of non-radiological status.

General hazards that could be encountered during decommissioning include conventional hazards that would be associated with removal of fencing and the excavation and removal of yard surfaces.

12.6 Waste Management During Decommissioning

12.6.1 Radioactive Waste Management

12.6.1.1 Management of Used Nuclear Fuel

The *Nuclear Fuel Waste Act (NFWA)* enacted in 2002 requires nuclear energy corporations to establish the Nuclear Waste Management Organization (NWMO) to study the options available to recommend a long-term management approach for used fuel. The NWMO issued its study report *"Choosing a Way Forward - The Future of Canada's Used Nuclear Fuel"* in November 2005. It was intended to assist the federal government in choosing the approach for the long-term management of Canada's nuclear fuel waste. The recommended Adaptive Phased Management approach was accepted by the federal government, and their process has now entered the siting phase. It is assumed that a long-term used fuel management facility will be in-service by 2035 and that it would accept used fuel from the new reactors.

When the station is shut down, all of the used fuel resident in the reactor units will be transferred to the IFBs for an initial cooling period of at least ten years, after which it will be transferred to interim onsite dry storage or to a suitably licensed off-site facility.

12.6.1.2 Management of Low-and Intermediate-Level Waste

Radioactive wastes will be processed and packaged on site in order to reduce worker exposure, to meet the regulatory requirements for waste transport and disposal and to reduce the volume of low-density materials such as paper and plastic.

The decommissioning of NND will produce a relatively large number of components (e.g., pumps, vessels, motors) that will need to be packaged for disposal as LLW or L&ILW. Other smaller components and equipment will be cut to fit and placed in standard waste containers. Contaminated concrete (e.g., surface contaminated concrete from the IFBs) will be broken up and loaded into disposal containers.

Wastes will be packaged for transport and disposed of according to the requirements of the applicable federal and provincial regulations. The necessary packages will be identified, designed, tested and procured prior to the decommissioning project. The required licences, approvals and certifications will also be obtained before the packages are put into service. L&ILW will be shipped offsite to a long-term waste management facility that will have sufficient capacity to accept all of the wastes generated during the decommissioning of NND.

The projected quantity of low and intermediate level waste (L&ILW) that will be generated during the decommissioning of DNGS is shown in Table 12.6-1, and that generated from decommissioning of the associated waste management facilities in Table 12.6-2. The decommissioning waste volumes for NND have not yet been estimated, however, due to the optimized designs of the new reactor types being considered, the total decommissioning waste volumes are expected to be less than those estimated for DNGS. Note that the split between low-level waste and intermediate-level waste may also be different for the different reactor types.

Decommissioning of the waste management facilities is not expected to produce any intermediate-level radioactive waste. The waste volumes for decommissioning of the waste management facilities are based on those estimated for current waste management facilities at OPG's Western Waste Management Facility (WWMF) and Darlington Waste Management Facility (DWMF). It is anticipated that decommissioning waste volumes for new waste management facilities would be similar to these due to the similarity in construction and operation of the facilities.

TABLE 12.6-1
Projected Quantities of L&ILW Generated During Decommissioning of DNGS

Low-level Radioactive Waste Volume (m^3 for four unit station)	Intermediate-level Radioactive Waste Volume (m^3 for four unit station)
35,998	2,613

TABLE 12.6-2
Projected Quantities of L&ILW Generated During Decommissioning of DWMF

Waste Management Facilities	Total L&ILW Volume (m^3 per structure)
Used fuel processing building	95
Use fuel dry storage building (each)	20
Low-level waste processing building	500
Low- & intermediate-level waste storage building (each)	10
Refurbishment waste storage building (each)	10

Note: estimated volumes are based on WWMF and DWMF preliminary decommissioning plans.

12.6.2 Hazardous Waste Management

Hazardous wastes will be packaged for transport and disposal according to the requirements of the applicable federal and provincial regulations. All hazardous wastes will be transferred to an appropriate, licensed waste management facility for storage or disposal.

Designated Substances are defined in the Regulations made pursuant to the Ontario *Occupational Health and Safety Act*. An assessment of the Designated Substances used at NND will be completed as required. The results of the assessments made on other OPG stations indicate that three Designated Substances are likely to be found in those stations at the time of shutdown:

- **Asbestos** – Asbestos – containing materials are not expected to be used at NND. However, should some of these materials be used in the future, a database of known asbestos – containing materials would be maintained and inspections carried out to ensure the asbestos is appropriately sealed and identified;

- **Lead** – Lead blocks, plate and blankets are typically used for radiation shielding around nuclear generating stations. Lead paints are not expected to be used at NND; and

- **Mercury** – Mercury is not used as a construction material. However, it is used in thermometers, manometers, hygrometers, mercury-wetted relays, magnetol and mercoid switches, vacuum pump temperature switches, sealed batteries and various types of lamps (fluorescent, mercury vapour, metal halide, etc.). Free mercury would not be stored or used at NND.

Small quantities of some other Designated Substances, such as benzene and isocyanates, are occasionally used during projects but they are not routinely stored at either station. Silica containing materials are not used as decontamination (sandblasting) agents within the Protected Area of the stations. However, they may be used in workshops outside of the Protected Area.

Most of the hazardous materials stored on the site (flammable, cryogenic gases, oxidisers, corrosives, etc.) will be consumed during routine plant operations. It is anticipated that the inventories will be reduced as the units are successively shut down so that only small quantities will remain after the last unit is shut down. Some of the remaining materials (e.g., welding gases) will be consumed during the Preparation for Safe Storage phase. Others, such as the fuel oil for the standby generators, can be removed for use at other sites.

12.6.3 Other Wastes

The bulk of the non-hazardous waste materials generated during the decommissioning will be produced during the Dismantling, Disposal and Site Restoration phase. Non-hazardous wastes that meet the established clearance levels will be re-used or recycled wherever possible.

If the volume or value of the contaminated scrap metal generated during the decommissioning is sufficient to justify further processing, chemical cleaning, electro polishing, mechanical abrasion or melting might be used to decontaminate scrap metal. Any metals that are decontaminated to levels below the clearance levels established in the DDPs will be released for recycling or disposal.

Concrete rubble may be used on site for fill. Other non-contaminated materials will be released for disposal according to regulations applicable at that time.

12.7 Potential Hazards and Protection Strategies

12.7.1 Hazards

The principal radiological, chemical and construction hazards that might be encountered during the decommissioning are a combination of hazards likely to be encountered during a routine shutdown or outage of an operating station and which may arise during dismantling or demolition work.

The main feature that distinguishes the decommissioning of a nuclear station from that of any other large industrial plant is the radiological hazard. Thirty years after shutdown, the radiological dose rates would have greatly been reduced.

A thorough assessment of hazards that may be encountered during the decommissioning project will be performed during the preparation for decommissioning.

12.7.1.1 Radiological Hazards

During Phase I Preparation for Safe Storage, the potential radiation hazards are likely to be associated with handling used fuel, tritiated heavy water (if applicable), filters and resins, performing decontamination work and working in gamma radiation fields near station systems and components. Used fuel will continue to be stored in the facility for at least ten years after shutdown and the work required to transfer this fuel to a long-term facility or dry storage will continue.

At the beginning of Phase II Safe Storage and Monitoring, the radiation hazards will primarily be due to tritium and cobalt-60 and these hazards will decay significantly over the course of this phase. It is expected that all of the radiological hazards will be removed by the end of the decontamination and disposal work during Dismantling, Disposal and Site Restoration.

12.7.1.2 Non-Radioactive Hazards

Decommissioning will also involve non-radioactive hazards such as chemical, industrial and construction, biological and transportation hazards. These are described below.

12.7.1.3 Chemical Hazards

During Phase I Preparation for Safe Storage, chemical hazards may be encountered during chemical decontamination of the primary heat transport system and processing the waste, draining and cleaning the water treatment facility tanks, or while handling cleaning agents during decontamination work. No unusual chemical hazards are expected during Phase II Safe Storage and Monitoring. During Phase III Dismantling, Disposal and Site Restoration, chemical hazards are expected during handling of the cleaning agents used during decontamination work, during transportation of the bulk or waste chemicals, and the concrete dust generated during dismantling.

12.7.1.4 Industrial and Construction Hazards

No unusual industrial and construction hazards are likely to be encountered during the Preparation for the Safe Storage and Safe Storage and Monitoring phases. Construction hazards during the Dismantling, Disposal and Site Restoration phase will likely be similar to those encountered during other industrial decommissioning projects. Some of these construction hazards include:

- The operation of heavy construction equipment in close proximity to workers;
- Fire caused by cutting torches and grinders;
- The collapse of equipment or structures during dismantling;
- The use of blasting and other techniques to demolish concrete structures;
- Falls, lifting heavy objects, falling objects, use of hand tools and other hazards routinely encountered during construction work; and
- Working at heights inside the station.

12.7.1.5 Biological Hazards

Biological hazards from organisms and materials that might be found on the site during the decommissioning could include:

- Stings and bites from insects, rodents, birds or other animals that might live or nest inside accessible buildings;
- Toxins and antigens produced by moulds and other fungi that might grow on surfaces (particularly those made of wood or other biological materials); and
- Infections or adverse reactions resulting from exposure to organisms living in decaying biological material or their by-products.

12.7.1.6 Transportation Hazards

Throughout the decommissioning program, the most likely activity that could present radiological hazards to the public would be accidents during the offsite transport of radioactive wastes. Given OPG's experience in transporting radioactive waste safely, there should not be any increased radiological risk to the public due to waste shipments during decommissioning.

Transportation hazards mainly include motor vehicle accidents such as during highway travel, vehicle-pedestrian collisions and vehicle-wildlife collisions. However, there are mitigation measures to ensure that transportation hazards are reduced and those measures are expected to remain in place until decommissioning activities are complete. In addition, the transportation of all radioactive and other hazardous materials will comply with the requirements of the *Transportation of Dangerous Goods Act* and Regulations and all other applicable regulations.

12.7.1.7 Other Potential Hazards

Other potential hazards may include:

- Working under inclement weather during temperature extremes, lightning and high winds;
- Working around open water such as the forebay;
- Working at heights such as the working on the meteorological tower and stacks;
- Risk of fire (e.g., from use of cutting torches);
- Flying/falling objects falling to the ground;
- Sharp objects e.g. torn or cut metals;
- Hoisting and lifting (e.g., some objects may be too heavy to lift by hand);
- Working in open, or below-grade concrete structures; and
- Working near live services (e.g., electrical or compressed air).

12.7.2 Protection Strategies

A DDP will be prepared to support the application for a Decommissioning Licence. The DDP will identify all the decommissioning activities and associated protection strategies which will be carried out.

12.7.2.1 Radiological Protection Strategies

All decommissioning activities will be carried out in accordance with the decommissioning license Radiation Protection Program. The procedures set out in the Radiation Protection Program with respect to dose control and contamination control will continue to be followed until they are suspended or modified in consultation with the CNSC. Where required, Radiation Work Plans and detailed procedures will be prepared before work begins.

12.7.2.2 Chemical and Construction Protection Strategy

OPG will ensure that all decommissioning work is conducted in accordance with the requirements of the applicable Occupational Health and Safety (OH&S) regulations.

A Decommissioning Operations Contractor (DOC) will likely be retained to perform the decommissioning work during the Dismantling, Disposal and Site Restoration Phase of the decommissioning project. The DOC will be given charge and control of the work area (or designated parts of the work area) as the “Constructor”. The DOC will be responsible for:

- Registering the Construction Project with the Ontario Ministry of Labour as required by the Construction Safety Regulations made pursuant to the *Occupational Health & Safety Act*; and
- Providing the personnel, equipment, procedures and training required for the protection of workers, the public and environment.

12.7.2.3 Occupational, Public and Environmental Safety

The design of NND and its associated waste management facilities, as well as the policies and principles for its operation serve to protect workers, the public and the natural environment. Administrative and engineering controls will also be established as necessary for the decommissioning of the station and associated facilities, such that dose consequences are within established radiological criteria.

Operational history will provide a good preliminary indication of whether the potential for contamination exists within buildings or on yard surfaces. The results of initial facility surveys will identify radiological and conventional safety hazards that may be present when decontamination, dismantling and demolition work packages are carried out. Detailed safety assessments for individual work packages will be carried out prior to commencement of decommissioning work, based on operating history and these surveys.

The principles of radiation protection and occupational health and safety will be applied to site decommissioning work. Building services such as ventilation, electrical power, fire prevention and control, and drainage will be maintained as required before demolition commences.

Occupational dose limits will not be exceeded throughout decommissioning activities. Environmental monitoring of the site and surrounding area will be maintained throughout used fuel removal, decommissioning, and waste management. The potential public and environmental impacts from transportation of used fuel and decommissioning waste from the Darlington site to the final disposal facility will be minimised by the use of approved packaging and containers, trained staff, and approved procedures. Non-radiological aspects of decommissioning nuclear facilities could include dust, noise and increased traffic resulting from decommissioning and demolition activities. Applicable regulations relating to radioactive waste transportation and disposal will be observed.

In accordance with decommissioning work requirements, final clearance surveys will be carried out to confirm that clearance objectives have been attained for areas and materials released for unrestricted public use.

12.7.2.4 Security

The DOC and sub-contractors will be required to comply with procedures regarding physical security as required under appropriate Nuclear Security Regulations and Standards. Section 2.8.1 provides a general description of security measures in place at the DN site. The description is general and limited due to the prescribed (restricted) nature of such information according to *NSCA* legislation.

12.7.2.5 Safeguards

In accordance with an agreement between the Government of Canada and the IAEA, nuclear Safeguards are implemented at OPG’s nuclear generating stations. These international Safeguards apply to fuel and other designated nuclear materials used at the station. The existing Safeguards provisions will continue until modified or terminated by agreement with the CNSC.

12.8 Quality Assurance Program

Quality management programs will be implemented to assure that all appropriate requirements, including occupational, public, and environmental protection are met during the decommissioning of NND and its associated waste management facilities.

12.9 Decommissioning Experience

There is considerable experience available with the decommissioning and dismantling of nuclear facilities. Worldwide, a number of nuclear power reactors have been completely decommissioned and the sites released for other uses, including in the United States, where about 10 reactors have been dismantled and a further 13 are undergoing decommissioning, and Germany, where two power reactors and 21 research reactors have been decommissioned. Additional reactors are currently undergoing decommissioning in Spain, France, Sweden and various countries of the former Soviet Union.

This growing experience demonstrates the feasibility of OPG’s end-state objective for decommissioning of the NND station as stated at the end of Section 12.4.3.

The new generation of reactors considered for this Project all include modular designs and other features that aim to simplify the construction and eventual decommissioning process. As such, they should not present any significant new challenges for decommissioning using existing practices.

12.10 Potential Environmental Effects of Eventual NND Decommissioning

Because of the preliminary nature of the decommissioning plan available at the pre-implementation phase of a nuclear power generation project (refer to Section 12.1), the level of information available for assessing the environmental effects of the decommissioning phase is less detailed than that which is available for the implementation phases of the project. Although the framework applied in the following subsections to consider the potential effects during the decommissioning phase is similar to that used for assessing effects of the implementation phases of the NND Project, the assessment is based on less design detail and is, therefore, presented at a conceptual level. Nevertheless, this assessment is supported by experience and studies from actual decommissioning projects elsewhere.

This conceptual assessment is based on the decommissioning strategy and process steps (Sections 12.2-12.5), waste management processes (Section 12.6), potential hazards and protection strategies (Section 12.7), quality assurance program (Section 12.8) and decommissioning experience (Section 12.9) described in the foregoing sections of this chapter. An important part of the assessment basis is the end objective of the NND decommissioning program: all radioactive and other hazardous materials will be removed from the site, all station systems dismantled, all buildings demolished, and all subsurface structures removed to a nominal depth and capped, such that the site would be available for alternative use (see Section 12.4.3).

12.10.1 Study Area and Timeframe for Conceptual Assessment

The Site, Local, and Regional Study Areas applied for this conceptual decommissioning assessment are the same as those used for assessing effects of the implementation phases of the Project. This is considered a reasonable geographic framework for a conceptual assessment at this time, although it is recognized that the environment in these study areas will continue to evolve until the future point in time when decommissioning will be undertaken.

Based on the "deferred dismantling" strategy described in Section 12.2, the durations of the decommissioning phases are assumed to be as follows:

- Phase I – Preparation for Safe Storage – duration depending primarily on the rate of fuel removal, likely several years, unless this was begun or completed toward the end of the Operation Phase;
- Phase II – Safe Storage and Monitoring – duration approximately 30 years; and,
- Phase III – Dismantling, Disposal and Site Restoration – duration approximately 10 years.

As indicated in Section 12.1.1, it is assumed that decommissioning will begin in 2100 and decommissioning of the NND station will be completed as a whole after all units have been shut down.

Decommissioning of waste management facilities associated with the NND station will occur after all the used fuel and low and intermediate-level wastes have been removed to appropriate off-site long-term waste management facilities.

It is assumed that a long-term used fuel repository will be in service by 2035 and that shipment of used fuel to the repository could begin any time after that. However, final decommissioning of the on-site facilities required for dry storage of used fuel and any refurbishment wastes from NND is not assumed to occur until at least 10 years beyond the end of the proposed NND Operation and Maintenance phase (i.e. beyond 2110). This timeline provides a conservative margin for long-term waste management facilities to become available before they would be needed for used fuel and other radioactive wastes arising from NND operation and decommissioning. Nevertheless, if a significant delay in availability of long-term waste management facilities were to occur for some reason, OPG has previously concluded that technology is available for retrieving and repackaging used fuel and other wastes for continued storage in on-site interim facilities as long as may be necessary (OPG 2003c).

12.10.2 Interactions Between Decommissioning and the Environment

The primary concern during decommissioning of any nuclear facility is the potential release of radioactivity into the environment, including exposure to humans and non-human biota. Potential hazards are likely to be a combination of those which normally arise during shutdown of an operating nuclear station and those which may arise during dismantling of any large industrial facility.

During preparation for the 30-year Safe Storage and Monitoring phase, potential hazards are expected to be associated with:

- residual radioactivity in systems and components;
- handling used fuel, tritiated heavy water (if applicable), filters and resins; and,
- decontamination activities.

During the Safe Storage and Monitoring phase, residual radiation fields will be decaying. After approximately one year from shutdown, gamma radiation is expected to become the only residual external radiation hazard in the station vicinity other than the used fuel storage facility.

As indicated in Section 12.6.1.1, used fuel will remain in licensed on-site interim storage facilities until transferred off site to a licensed long-term used fuel management facility. It is currently expected that the long-term facility will be in service, and off-site shipment of used fuel commenced, by 2035. It is also anticipated that off-site shipment of used fuel will be included in the scope of operations for the long-term facility (i.e., and not the nuclear generating stations). At the time of decommissioning, used fuel shipment programs and procedures will be well-established.

Radiation and industrial hazards are likely to be associated with dismantling, waste handling, transportation and disposal. For example, deposited activation and fission products may be released to the workplace or the environment on opening and dismantling systems and components. External and internal hazards may take the form of airborne activity or surface contamination of equipment, tools and work areas. Industrial hazards will be similar to those present with any large-scale dismantling or demolition project.

12.10.3 Assessment of Environmental Effects of Future Decommissioning

The assessment of potential environmental effects of NND decommissioning, presented in the following subsections, includes consideration of the effects of normal and abnormal decommissioning activities and effects of the environment on decommissioning. Because of the very preliminary nature of this assessment, cumulative effects and significance of residual effects are only considered in general terms, taking into account the application of effective and practical mitigation measures where appropriate.

This conceptual assessment approach is adapted from a similar decommissioning assessment carried out for the environmental assessment of the PNGS A Return to Service Project (OPG 2000a). That assessment was based on OPG's nuclear decommissioning plans at the time, as well as nuclear EA experience and professional judgement.

12.10.3.1 Effects of Normal Decommissioning Activities

<u>Potential Radiological Effects on Humans and Environment</u>

In planning for decommissioning, OPG objectives regarding potential radiological hazards are to:

- prevent detrimental health effects to employees and the public;

- limit detrimental health effects to employees and the public to levels as low as reasonably achievable (ALARA), social and economic factors being taken into account; and
- provide a level of health and safety which is as good as, or better than, that of comparable safe industries.

The potential hazards associated with decommissioning and the protection strategies, which will be implemented to minimize release of radioactivity to the environment and radiation doses to humans and non-human biota, are described in Section 12.7.

The eventual NND decommissioning process will result in a staged reduction of material and radioactivity at the site. Accordingly, there will be a staged reduction in emissions and exposures to workers, the public and the environment. The radiological effects are expected to be well below applicable regulatory limits. Furthermore, they are expected to be substantially less than the effects associated with operation and maintenance of the NND station, which are already expected to be very low. This is supported by the results of U.S. generic environmental assessments of nuclear reactor decommissioning (OPG 2000a).

Potential Effects on Atmospheric Environment

Some dust and particulate matter may be released to the atmosphere during dismantling and demolition operations. Heavy equipment and vehicles used for transport of waste and other materials may release exhaust gases into the atmosphere. The nature and extent of these releases will depend on the type of equipment used and the intensity and duration of their operations. Construction equipment and blasting may result in increased noise levels during dismantling and demolition work. As for the implementation phases of the Project, Good Industry Management Practices will be applied and can reasonably be expected to mitigate any adverse atmospheric effects of decommissioning beyond the DN site.

Potential Effects on Surface Water Environment

As for the implementation phases of the Project, Good Industry Management Practices will be applied during decommissioning to ensure compliance with applicable water quality criteria, including treatment of surface water discharges, as required, before they are released to the environment.

A temporary increase in turbidity may result from filling and sealing the cooling water intake and discharge structures (particularly if the station is implemented with the once-through cooling option) as well as from runoff during dismantling and site restoration work. In addition, other dismantling activities may change the site topography and possibly increase site runoff. However, erosion control techniques and other practical measures are available which can effectively mitigate any adverse environmental effects.

Potential Effects on Aquatic Environment

Some increase in turbidity of the water along the shoreline may result from filling and sealing of the station's cooling water intake and discharge structures (particularly if the station is implemented with the once-through cooling option) as well as from runoff during the dismantling and site restoration work. Changes in runoff from the site may potentially affect local aquatic life and thus may need to be mitigated. As indicated above regarding surface water, erosion control and other practical measures will be applied to mitigate any adverse effects.

Potential Effects on Terrestrial Environment

The dust produced during demolition and site restoration work may temporarily affect some of the vegetation within the DN site. These areas will be restored when the dismantling and clean-up is complete.

Areas of the DN site that are not routinely used during station operation may become wildlife habitat. Many of the birds and larger mammals are highly mobile and would probably move between the site and the surrounding area (particularly within the existing east-west wildlife corridor) in search of food. Wildlife populations may increase during the 30-year Safe Storage and Monitoring period since there will be relatively little activity on the site. The increased level of activity during the subsequent dismantling and site restoration work, along with the noise and dust that may be generated, could adversely affect this local wildlife. Increased vehicular traffic during active phases of the decommissioning program, and associated traffic noise, activity and vehicle/animal collisions, may also affect local wildlife. However, this disturbance would be temporary and wildlife populations would be expected to recover and return to the site at the end of decommissioning.

Potential Effects on Geological and Hydrogeological Environment

It is not expected that decommissioning activities will involve substantial alteration of the topography of the DN site. Therefore, any potential effects of decommissioning on soil quality, groundwater quality and groundwater flow conditions will be bounded by the already-assessed effects of site preparation and construction (no residual adverse effects predicted).

Monitoring of existing and proposed additional on-site landfill and surplus soil fill areas may be required for a number of years after they are closed to ensure that they do not adversely affect local groundwater.

Potential Effects on Land Use

In general, it is reasonable to expect that any potential effects of NND decommissioning on adjacent off-site land uses will be bounded by the already-assessed effects of site preparation and construction (no residual adverse effects predicted).

Radioactive and hazardous wastes generated during decommissioning will be transported to appropriate off-site facilities for long-term storage or disposal. It is expected that most of the non-radioactive waste from demolition of buildings and other structures will be recycled or reused, both on and off the site (e.g., concrete crushed and used for roadways, metal and wood components salvaged and/or remanufactured, etc.) or disposed of at appropriate off-site disposal facilities.

It is premature at this stage to speculate about potential changes in land uses within and around the DN site after decommissioning of the NND station and associated waste management facilities. If the site continues to be used for electricity generation purposes, a realistic option, the land use within the DN site would not likely change significantly.

Potential Effects on Socio-Economic Environment

The three decommissioning phases will have different levels and durations of activity that are likely to result in different associated effects on local and regional communities. Actual activities associated with these decommissioning phases will be intermittent, but it is important to understand the overall flow of activities as they will be the major source of potential socio-economic effects.

During Preparation for Safe Storage Phase

The most noteworthy change in socio-economic conditions, during the transition from the NND operation and maintenance phase to the decommissioning phase, is expected to be the downsizing of the workforce as the NND units are shut down. However, it is important to note that this change is attributable to the staged ending of NND operation, not to the subsequent decommissioning of the NND facilities. Most of the operational workforce will not be required after the units have been shut down. Some specialized external workers could be hired, but most of the workers required for this initial decommissioning phase will likely be drawn from the existing operations staff.

Any nuisance effects associated with worker traffic and other NND related traffic during the initial decommissioning phase are likely to be small compared to the effects of the implementation phases already assessed. Transportation of low-level and intermediate-level radioactive waste to off-site long-term waste management facilities during this period is not expected to become a concern within the community, as this will become routine and familiar practice throughout the operation and maintenance phase.

Although there may be some local OPG expenditures associated with the initial phase of decommissioning, the host municipality and region may be concerned that the amount of OPG spending and tax revenue will be significantly reduced after the station is no longer producing electricity. However, it is assumed that some form of taxes would continue until active dismantling of the station begins.

During Safe Storage and Monitoring Phase

Over the 30-year Safe Storage and Monitoring period, only a relatively small workforce will be required. This requirement may nevertheless present opportunities for some local employment and consumer spending. It is assumed that the tax payments to the host municipality would remain constant over this period.

During Dismantling, Disposal and Site Restoration Phase

When the decommissioning process is ready for dismantling to begin, the workforce would be expected to increase to several hundred at peak. Since dismantling activities would be expected to extend over approximately 10 years, many of these workers may move into the community. There may be local spending associated with the dismantling activities. It is possible that local contractors and suppliers would benefit. These changes would likely affect both local and regional communities.

During this period, L&ILW will be shipped off site to a licensed long-term waste management facility. The volume of wastes arising during dismantling would not be expected to result in a significant increase in frequency of off-site shipments compared to that during NND operation.

Because the dismantling program would be gradual (spread over approximately 10 years), any further reduction in municipal tax payments (beyond the earlier reduction associated with the end of NND operation) would likely also be gradual rather than sudden.

At the conclusion of dismantling and site restoration, future use of the site is expected to be of interest to the local/regional community. The visual effects of the DN site, although familiar by this time, would be reduced. The workforce would no longer be required and the local spending associated with dismantling and site restoration would come to an end. After the completion of decommissioning, the amount of municipal taxes to be paid would depend on the new land use.

12.10.3.2 Potential Effects of Decommissioning Malfunctions and Accidents

Hazards that might potentially give rise to adverse environmental effects during decommissioning, in the event of malfunctions or accidents, are described in Section 12.7. The main hazard that distinguishes decommissioning of a nuclear station from that of any other large industrial plant is the radiological hazard. However, with the deferred dismantling strategy, the radiological hazard would be greatly reduced after 30 years or more of Safe Storage and Monitoring.

The nature of possible malfunctions and accidents and their potential environmental effects will differ from phase to phase in the NND decommissioning program. The potential effects of any spills resulting from chemical decontamination of station systems, or from draining and flushing of conventional fuel storage tanks and the water treatment plant, are likely to be bounded by the conventional spill scenarios addressed in Chapter 7.

Of all the activities involved in the decommissioning program, demolition of buildings and structures will likely present the greatest risk of accidents. However, the risks and environmental consequences of such accidents are well known, as are the mitigation strategies to prevent or control any adverse effects. For example, accidents that might occur during blasting (to demolish some of the concrete structures) may present a hazard to the decommissioning workforce, but their environmental effects are likely to be limited. The consequences would be limited by the fact that most of the radioactive and other hazardous materials will have been removed from the site before the demolition begins.

During all phases of decommissioning, low-level and intermediate-level radioactive waste will be transported off site to a licensed long-term waste management facility. Used fuel will also be transported off site to licensed long-term waste management facilities before decommissioning of the NND station and associated on-site waste management facilities is completed. Based on OPG's extensive experience in transportation of radioactive materials (more than 30,000 shipments covering millions of kilometres without a single accidental radioactive release), and the stringent transportation packaging and system design and licensing requirements, future off-site shipments of radioactive wastes and used fuel are considered very unlikely to result in any malfunctions or accidents that could lead to significant environmental effects.

12.10.3.3 Potential Effects of the Environment on Decommissioning

The potential effects of the environment (including severe natural events) on NND systems and structures, during NND station operation, has been addressed in Chapter 6. It is reasonable to expect that the potential effects of any such natural events during decommissioning will be bounded by those during operation. While buildings and structures may become more vulnerable to potential seismic events, severe storms and flooding after demolition has begun, the off-site environmental effects of any incremental damage to buildings and structures is not expected to be significant since most of the radioactive and other hazardous materials will have been removed from the site before the demolition begins.

12.10.3.4 Potential Cumulative Effects

The assessment of cumulative effects presented in Chapter 8 included the potential combined effects of NND operation and NND decommissioning to a limited extent. It considered the spatial and temporal overlap between the early stages of decommissioning of one or more of the NND units and the latter stages of operation of the remaining NND unit(s). Any further effort at this time to predict what other on-site or off-site projects and activities may coincide with NND decommissioning would be difficult and subject to great uncertainty.

Nevertheless, it is reasonable to anticipate that the cumulative radiological doses to the public and environment will decrease as decommissioning of the NND units progresses. Furthermore, cumulative doses will be reduced substantially below the levels associated with operation and maintenance of the station which are predicted to be very low to begin with.

12.10.4 Availability of Effective and Practical Mitigation Measures

A number of successful decommissioning projects in the U.S. and other countries have demonstrated that technology and procedures are available to safely and effectively decommission nuclear facilities. Companies have demonstrated successful approaches to safe storage and eventual dismantling of generating stations as well as the packaging, transportation, and storage/disposal of radioactive waste.

Based on the protection strategies outlined in Section 12.7.2 and the international decommissioning experience outlined in Section 12.9, it is reasonable to anticipate that effective and practical mitigation options will be available, when required in future, so that NND decommissioning is not likely to cause significant adverse effects on humans or their environment.

12.10.5 Significance of Residual Adverse Decommissioning Effects

Experience indicates that decommissioning, when properly planned and carried out with effective control and mitigation, is likely to result in only minor adverse environmental effects. However, the determination of significance of environmental effects of any major project, particularly socio-economic effects, is generally best made in consultation with stakeholders who may be affected. Specific effects which may eventually be caused by NND decommissioning will be assessed more fully in future (see Section 12.3), as the beginning of decommissioning approaches, and their significance will be determined based on local environmental, social and economic conditions which prevail at that time.

13. CONCLUSIONS OF THE EIS

This EIS for the NND Project was prepared by OPG, as the proponent. It is based on Guidelines issued by the CNSC in January 2009 and OPG is confident that it meets the full requirements of those Guidelines. The EIS reflects both the underlying principles of environmental assessment and the overarching prescriptive of the Guidelines, which is to produce a document that *"… allows a joint review panel, regulators, members of the public and Aboriginal groups to understand the project, the existing environment, and the potential environmental effects of the project".* In preparing the EIS, OPG, has:

- Continued a 40-year tradition of meaningful consultation with the municipality within which the DN site resides and the communities in its vicinity and otherwise relevant to it, including Aboriginal Peoples;
- Considered issues of sustainable development;
- Evaluated the environmental and social implications of the range of reasonable variations by which the Project may evolve, including as they relate to reactor type and number of units; technology for condenser cooling; management of L&ILW, and storage of used fuel;
- Applied the precautionary principle in evaluating the Project such that the outer bounds of development scenarios considered reasonable are analysed;
- Considered issues of malfunctions, accidents and malevolent acts;
- Identified mitigation measures for addressing potential environmental effects, some of which will be incorporated into the Project design to pre-empt environmental consequence; and others that were identified through the EA process to further ameliorate effects of the Project; and
- Proposed an Environmental Management Plan to ensure that the environmental safeguards outlined in the EIS are implemented as well as a preliminary plan for the EA follow-up program that will be used to verify the accuracy of the predictions made in the EIS, confirm that the mitigation measures are integrated as intended, and that these measures are, in fact effective.

13.1 Conclusion Regarding the Project

The Sections that follow summarize OPG's conclusions regarding environmental effects likely to be associated with the NND Project.

13.1.1 Effects of the Project on the Environment

The EIS includes an assessment of potential effects of the Project on the environment in a context of 13 individual environmental components (Sections 5.2 through 5.14). Residual adverse effects (i.e., after mitigation) were determined in the Aquatic and Terrestrial Environments, in Land Use, and in the Socio-Economic Environment. All residual adverse effects and one cumulative effect were evaluated for significance, and the EIS concludes that the NND Project will not result in any significant adverse environmental effects on the environment.

It is notable that no significant residual adverse effects on the health and safety of workers and on the general well-being of the public are anticipated as a result of the Project. Radiation doses from the NND Project are expected to be well below the regulatory limits for human exposure and dose to the public will represent only a small fraction of the annual dose received from natural background radiation in the vicinity of the DN site. These doses are not expected to result in health effects on the public or on workers, or to result in adverse effects in non-human biota.

A number of beneficial effects of the Project are described in the EIS. These include that the Project will, or is likely to:

- Contribute to the maintenance of the social structure and stability of LSA communities and selected municipalities across the RSA; and serve as a positive contributor to the anticipated population growth in these areas because of the increased proportion of the population associated with the Project;
- Create new apprenticeship opportunities that will generate a substantial number of new certified tradespeople available for the Project itself and/or Ontario's construction labour market subsequently;
- Serve to maintain the skilled employment base of the energy sector throughout the RSA and LSA in the short term, and contribute to the expansion of the skills base over the long term;

- Be a driver for increased enrolment in post secondary educational programs that provide energy or nuclear related degrees or certificates and other training programs that support certification in a skilled trade;

- Be a driver for increased local and regional economic development during each of its phases, and for further development of the Durham Energy Industry Cluster and the Clarington Energy Business Park through the likely establishment of new business operations in the RSA that are involved in the nuclear service industry;

- Create new direct, indirect and induced employment opportunities for existing and potential in-movers to the RSA and LSA and positively influence employment growth in these municipalities;

- Create new business activity and opportunities due to increased spending associated with Project employment, and expenditures on goods and services;

- Improve economic viability and increase investment in tourist accommodation businesses (i.e., hotels and motels) resulting in improved stock of tourist accommodations in the LSA;

- Contribute to increased total household income throughout the RSA and LSA;

- Contribute to increased rate of growth in property values and increased sales volumes in the LSA municipalities;

- Increase municipal tax and other revenues;

- Serve as a driver for the initiation of new housing developments in the Municipality of Clarington, the provincially-identified growth centres of the Cities of Pickering and Oshawa, and other communities within Durham Region; and

- Promote diversification of the housing stock in the Municipality of Clarington.

13.1.2 Effects of the Environment on the Project

The EIS also describes the potential for the environment to adversely affect the NND Project. The iterative process of evaluating effects of the environment on the Project involved the identification of those environmental conditions with a reasonable probability of occurrence and the potential to alter the Project or pose hazard to workers or the public; followed by consideration of the features inherent in the Project design and operational protocols to resist such effects. Potential environmental conditions considered in this aspect of the EA included flooding, severe weather, the biophysical environment itself (e.g. fish, algae and mussels that may affect condenser cooling operations), seismicity, and climate change.

It was concluded that no significant effects on the Project are anticipated as a result of conditions in the environment. Notable among the findings was the determination that no seismic-related issues were identified that would make the DN site unsuitable for construction of new nuclear facilities.

13.1.3 Cumulative Environmental Effects

Potential effects of the NND Project in combination with the overlapping effects of other projects and activities (i.e., cumulative effects) are considered in the EIS. Some 34 other projects were evaluated to determine if and how effects associated with them might combine with the residual adverse effects of the NND Project (as noted above, residual adverse effects of the Project were identified in the Aquatic and Terrestrial Environments, in Land Use, and in the Socio-Economic Environment). In all cases, the cumulative effects were found to be such that no additional mitigation measures would be necessary to protect the environment. One cumulative effect (i.e., the combined visual and related community effects resulting from the possible NND Project cooling towers and other tall structures existing and foreseeable in the vicinity of the DN site) was evaluated for significance and determined to be not significant.

Although no residual radiological health effects were determined likely to result from the NND Project, potential health effects associated with radioactivity were examined further in terms of cumulative effects because of a general concern among the public that their health, safety and well-being may be affected by radiation and radioactivity from nuclear power projects. The cumulative doses to members of the public and to workers were found to be well below regulatory limits, and no additional mitigation measures were considered necessary.

Further, although no residual effects on local traffic, air quality, labour market or community infrastructure were determined likely to result from the NND Project, these aspects of the environment were also evaluated further for cumulative effects. This further assessment was triggered by public response to OPG's communication and consultation program which indicated some concern that the concentration of projects and activities planned and foreseeable within the Municipality of Clarington over the coming decade may result in adverse effects on these areas of the environment.

13.2 Conclusion Regarding Alternative Means of Implementing the Project

The assessment of likely environmental effects of the NND Project was carried out on the basis of a bounding description of the Project (the Scope of the Project for EA Purposes is described in Chapter 2). This approach provided for the inclusion of alternative means of implementing certain key elements of the Project within the bounding envelope and as such, they were assessed as inherent elements of the Project. The EIS has concluded that the NND Project, when evaluated in the context of its bounding envelope, and considering the identified mitigation measures, will not result in significant adverse effects on the environment. Therefore, any and all of the alternative means included in the bounding envelope will be acceptable elements of the Project from an environmental perspective. (As an example; the bounding envelope included the range of reasonable alternatives for managing Project-related L&ILW. Because the bounding envelope assessed was determined to not result in residual adverse environmental effects of significance, all considered alternatives for management of L&ILW are deemed acceptable for the NND Project.)

Because all alternative means have proven to be acceptable from an EA perspective, as Project planning continues, OPG will make decisions concerning aspects of its implementation including the alternative means addressed in this EIS that are within its control. In addition to environmental considerations, those decisions will ultimately include factors such as cost, proven performance, availability and constructability.

The following pages present a discussion of the alternative means that have been incorporated into the Project bounding envelope. The discussion is framed as a qualitative overview of their advantages and disadvantages as environmental context for future decisions concerning those aspects of the Project. Where appropriate, conclusions regarding OPG's preference of the alternatives considered are provided below, based on the findings of the EIS.

13.2.1 Alternative Reactor Designs and Numbers of Units

As discussed in Section 2.1, the Project Description submitted to the CNSC in April 2007 describes four alternative reactor technologies. Three reactor types are currently under consideration by the Province of Ontario in a procurement process (currently suspended) that will conclude with selection of a preferred vendor and reactor technology. While those three reactor types were used in establishing the bounding framework for this EA, any reactor type with effects that are bounded will be acceptable from an environmental perspective. The EIS has concluded that any reactor type that fits within the bounding framework will not cause a significant adverse environmental effect. Should the design that is ultimately selected by the Province be other than those considered in this EIS, any necessary adjustments would be made to the EIS to take into account any substantial changes in the environment, the circumstances of the Project, and new information of relevance to the assessment of effects of the Project.

For the purposes of the analysis of effects, the only substantive differences among reactor types are in the areas of radiological emissions, accident and malfunction scenarios, size and vulnerability to seismic events. The issue of size is related to footprint, which is considered in the bounding framework. The remaining areas of difference are within the mandate of the CNSC under the *NSCA*.

Because the reactor procurement process is the responsibility of the Province of Ontario, OPG does not express a preference concerning reactor types or the number of units to be constructed.

13.2.2 Alternatives for Condenser Cooling

The options considered in this EIS for condenser cooling include once-through lakewater cooling; natural draft cooling towers and mechanical draft cooling towers. A fourth option, fan-assisted natural draft cooling towers, is considered to be bounded by the mechanical and natural draft cooling towers and is not addressed separately.

As is the case for all other alternative means, the EIS has concluded that none of the condenser cooling alternatives will result in a significant adverse effect. However, assessment in a context of the bounding envelope has not provided for a consideration of the relative preference of the alternatives for condenser cooling. The discussion that follows presents a qualitative evaluation of the advantages and disadvantages of the condenser cooling options in a context of the environmental components within which there is a distinction between the options. A preferred option is indicated within each considered environmental component based on the relative environmental effects, notwithstanding that none of the effects was deemed a residual adverse effect of significance.

Atmospheric Environment

The once-through lakewater cooling option is preferred within the Atmospheric Environment. From the atmospheric perspective, there is little differentiation between the cooling tower options; therefore, all are equally less-preferred. The once-through lakewater cooling option has no meaningful interactions with this environmental component whereas all forms of cooling towers will result in a degree of interaction with the atmosphere. Changes in conditions in the Atmospheric Environment associated with operation of cooling towers include meteorological (e.g., fogging, icing, water deposition), aesthetic (visual effects of vapour plumes) and physical (salt deposition). These changes are not considered adverse environmental effects in the Atmospheric Environment, however, they are considered as pathways for possible effects in other environmental components (e.g. Terrestrial Environment, Land Use). All cooling towers will also produce sound. The mechanical and fan-assisted towers will generate more sound than natural draft towers; however, in all cases, increased sounds levels will largely be limited to the DN site and not evident at the nearest off-site sensitive receptors.

Surface Water Environment

All forms of cooling towers are generally equally preferred over once-through lakewater cooling in terms of the assessed parameters within the Surface Water Environment. The large volume of cycled lakewater associated with once-through cooling will result in substantially greater changes in lake current and water temperature conditions than will the cooling tower options. Offsetting the preference for cooling towers to some degree, however, will be the treatment requirement for cooling tower effluent before it can be discharged to Lake Ontario. The once-through lakewater cooling option will not involve treatment of the flows returned to the lake.

A parameter not assessed specifically in the Surface Water Environment, however, and which is relevant in the comparison of condenser cooling options, is water consumption; and the once-through cooling option is preferred in this context. The difference between water consumption and water withdrawal is that consumed water does not return to the environment as liquid, while withdrawn water does. A key difference between once-through systems and cooling towers is the amount of water they consume versus the amount they withdraw. A once through system consumes very little water in comparison to a cooling tower, but withdraws approximately 70 times more water than a cooling tower (MPR 2009). As noted in Section 5.3.2.2, the cooling towers options are assumed to operate on a "four cycle" system meaning that 75% (4.5 m^3/s) of the water withdrawn from Lake Ontario will be lost to evaporation in the cooling towers. The remaining 25% will bleed-off from the cooling towers and be returned to Lake Ontario after appropriate treatment.

Aquatic Environment

All forms of cooling towers are generally equally preferred over once-through lakewater cooling within the Aquatic Environment. The loss of aquatic habitat and biota (e.g., invertebrates) will be proportionately less for the smaller intake and discharge structures associated with cooling towers than for the larger structures required for once-through lakewater cooling. Although all forms of water withdrawal from Lake Ontario will result in a degree of aquatic biota loss through impingement and entrainment, it is accepted that any such losses for once-through cooling, even though not significant in terms of lake-wide populations, will be greater than losses associated with cooling tower intakes because of the difference in the water volumes withdrawn. It is also accepted that lakewater temperature changes associated with once-through cooling will be greater than changes as a result of cooling towers.

Terrestrial Environment

Once-through lakewater cooling is the preferred option within the Terrestrial Environment. Of the cooling tower options, the mechanical and fan-assisted towers are preferred over natural draft towers because of their lower height (and associated bird strike potential). While it is likely that Project activities will extend over a generally similarly-size physical area regardless of cooling options, it can be expected that the greater area requirements associated with cooling towers (and most notably mechanical draft towers) would limit opportunities for selective preservation of terrestrial features. Dust disturbance to habitat and biota, although not identified as a residual effect, will be directly related to the quantity of soil handled; and the cooling tower options will all require a greater extent of soil handling than will once-through cooling. Bird strike mortality is identified as a residual adverse effect. Although deemed not significant, the incidence of bird strikes will be greatest with natural draft towers and least (i.e., none) with once-through cooling.

Land Use

Once-through lakewater cooling is the preferred option within the Land Use environmental component because it will not result in any interactions with either land use or visual setting. The natural draft cooling towers are least preferred because of the imposing physical presence of the towers in the LSA and to a lesser degree in the RSA, combined with the visible vapour plume released from them. The mechanical and fan-assisted towers are preferred over natural draft towers because the tower structures are not likely to be generally visible from outside of the SSA, however, the visibility of the vapour plumes released from them will be similar to that from the natural draft towers. As described in Section 5.8, tower and plume visibility would be factors in the quality of views, and in the land use and development patterns within their viewshed.

Socio-Economic Environment

The once-through lakewater cooling option is preferred within the Socio-Economic Environment. Effects in this environmental component associated with cooling towers are primarily related to the response of people and their community to: i) their presence; and ii) their visibility. Where towers may be present yet are not highly visible, the response of people is likely to be less negative than in the case of towers being present with their high visibility being a constant reminder of such presence. Accordingly, natural draft towers are least preferred because their imposing physical presence in combination with the vapour plume released will be highly visible within the LSA and portions of the RSA. Because of their lower profile, mechanical draft and fan-assisted towers will be much less visible with their presence indicated primarily by the released vapour plumes.

Summary Statement of Preferences

The assessment of effects has established that the interactions between the environment and each of the condenser cooling alternatives will not result in significant adverse effects. The following is notable, however, in terms of relative preference of the condenser cooling alternatives that can be inferred from the assessment:

- On balance, it can reasonably be concluded that in qualitative and relative terms, the environmental effects associated with cooling towers are greater than those that would result from once-through lakewater cooling. The most evident effect of once-through lakewater cooling is the loss of aquatic biota through impingement and entrainment. However, the assessment has concluded that entrainment and impingement losses associated with the Project will not be significant in terms of lake-wide populations of either the most-affected species (primarily nearshore invasive species) or native species;
- A comparison of condenser cooling options commissioned by OPG (MPR 2009) concluded that the three cooling tower options considered in the EIS (i.e., natural draft, mechanical draft and fan-assisted) and the once-through lakewater cooling option were all appropriate for the NND Project. However, the study also recommended the once-through lakewater cooling option for the NND Project on the basis of its overall greater cost effectiveness and other advantages including: i) a greater relative benefit in maximizing the electrical output from the site; ii) the absence of the visual effects associated with cooling towers and their vapour plumes; iii) a non-significant increase in fish impingement mortality; and iv) the more efficient use of the existing site area;
- Although it remains objective on the subject, especially in light of the vendor selection process and the conclusions of the EIS, OPG has stated its preference for once-through lakewater cooling because of its extensive experience with this technology at its existing facilities and the high performance level of such a system at DNGS, including management of fish entrainment and impingement; and
- OPG is also aware of perceptions and opinions within the LSA communities. Durham Region, the Municipality of Clarington and the City of Oshawa have all expressed their objections to the use of cooling towers for this Project. Results of consultations with the public and focused public attitude research have been clear in that the heightened visibility of the DN site as a consequence of cooling towers will be accompanied by increased awareness in the community of the site as dominant industrial feature on the Clarington waterfront landscape. This will translate into a negative change in the character of the community and the perceptions of those that live within it.

Based on the above, OPG's preferred option for condenser cooling is once-through lakewater cooling.

13.2.3 Alternatives for Management of L&ILW

Two alternative means of managing L&ILW were considered: i) management of the waste on the DN site in a new L&ILW management facility; and, ii) transport of the L&ILW off the DN site to an appropriately licensed facility elsewhere. Both options were incorporated into the Project for EA Purposes (Chapter 2) and were assessed individually including aspects associated with transportation to an off-site facility. A consideration of alternative onsite locations for a L&ILW management facility was included in the framework of the bounding site development layout. The assessment of effects established that neither form of management of L&ILW will result in a significant residual adverse effect.

Differences among on-site locations for a L&ILW management facility are not a factor in terms of environmental effects or OPG's preference since, regardless of location on the site, OPG will continue to manage L&ILW in a manner similar to the current proven practices at its nuclear facilities, including implementation of procedures to minimize doses to workers and the general public. Similarly, OPG's proven record of safely transporting such wastes for over 35 years demonstrates that transportation of L&ILW can be carried out routinely and safely, and as such, the requirement to transport (or not) the waste to an off-site location is also not a factor in terms of environmental effects or OPG's preference for the managing L&ILW.

Notwithstanding the above, OPG's preference is to transport L&ILW resulting from NND operation to OPG's operating Western Waste Management Facility (WWMF), recognizing that some larger components (e.g., steam generators resulting from mid-life refurbishment) will likely require onsite storage and management at the DN site. This preference is based on the fact that OPG has a well-established program, including physical plant and other related infrastructure, at the WWMF for management of these materials and use of the WWMF for L&ILW generated at NND will eliminate the need to replicate the program elsewhere.

13.2.4 Alternatives for Storage of Used Fuel

Regardless of which reactor type is selected for the NND Project, the management process for used fuel will consist of the transfer of the used fuel from the reactor to water-filled pools (i.e., Used Fuel Bay) for a period of initial decay and cooling (typically for a period of approximately 10 years) following which it will be placed into dry-storage containers and stored onsite in a purpose-built used fuel storage facility.

Each reactor will require design-specific used fuel management components, most notably, the dry storage containers, and alternatives for those containers were considered in the EA. Two technologies were included for used fuel stemming from ACR-1000 operations; the AECL MACSTOR system and OPG's dry storage containers (DSCs). The used fuel from operations of the EPR and AP1000, both PWRs, will be similar and the dry storage technologies considered in the EA include metal casks, concrete canisters, and concrete modules.

The assessment of effects established that all considered forms of dry storage of used fuel will be acceptable from an environmental perspective (i.e., will not result in a significant residual adverse effect). Evaluation of alternative onsite locations for the used fuel dry storage facility is considered in the framework of the bounding site development layout. However, as noted in Section 2.5.8, the preliminary safety assessment for the NND Project assumes that the waste processing and/or storage buildings for used fuel will be located within the DN site at a distance of not less than 150 m from the DN site perimeter fence and south of the CN rail line. Should the vendor choose to locate these structures closer to the perimeter fence or north of the CN rail line, the safety assessment will be updated accordingly during the NND licensing process.

Based on the above and recognizing that key elements of used fuel dry storage (i.e., containers) will be reactor-specific, OPG's only expression of preference for used fuel storage is that the onsite dry storage facility, which will be required for all reactor types, be located at least 150 m from the perimeter fence, and in the area south of the CN railroad tracks (as noted above, however, should this preference not be possible (e.g., because of space considerations) the safety assessment will be updated as necessary to confirm acceptability of alternative locations within the DN site).

13.2.5 Alternatives for Excavated Material Management

As described in Section 2.4.2, aggregation of possible site layout scenarios into a single bounding site development layout supported the assessment of effects of the Project within an encompassing envelope that considered the reasonable ranges in the physical parameters (e.g., areal extent of disturbance) associated with site preparation and construction activities. The bounding site development layout was adopted as the configuration being assessed, thereby resulting in a conservative evaluation of likely environmental effects.

The bounding site development layout incorporated the upper values for soil and rock excavation to ensure the conservative nature of the analyses. However, the individual scenarios included in the bounding site development layout were substantially different in terms of material quantities. The following discussion focuses on issues related to soil and rock management since the potential variation in the quantities is considerable and potentially affected planning and design decisions, including OPG's preference.

Total Material Excavated

The layout scenarios adopted for EA purposes are conceptualizations of how the site might be developed. They are realistic yet conservative, and considerably influenced by factors that remain uncertain, such as selection of the condenser cooling option, and opportunities for soil use and disposal. Excavation quantities for the scenarios are indicated in Table 13.2-1 with EA assumptions concerning use and disposal of the material. They, and the development concepts from which they were derived, are considered to be reasonable and conservative based on conditions at the DN site and overall development requirements; and therefore, appropriate for EA purposes.

TABLE 13.2-1
Excavated Material Quantities for Model Plant Layout Scenarios

Layout Scenario	Total Excavated (Mm^3)	Placed in Northwest Landfill Area (Mm^3)	Placed in Northeast Landfill Area (Mm^3)	Placed as Lake Infill (Mm^3)	Placed in Offsite Disposal Area (Mm^3)
1	9.4	1.2	4.5	3	0.7
2	9.8	1.2	4.5	3	1.1
3	12.4	1.2	4.5	3	3.7

The total excavation quantity ranges from 9.4 to 12.4 Mm^3. All layout scenarios assume similar quantities of lake infilling and material placed as landfill in two onsite fill areas. The remainder quantity of excavated material will be directed to offsite disposal. Scenario 3 which includes the largest quantity of excavation was adopted as the bounding site development layout.

Material Placement in Onsite Landfills

All layout scenarios assume placement of 1.2 Mm^3 and 4.5 Mm^3 of excavated material in the existing Northwest Landfill Area and in a new Northeast Landfill Area, respectively. The Northwest Landfill Area is a mound of surplus soil placed during construction of DNGS and it is contemplated that up to 1.2 Mm^3 of additional soil may be placed in this location. Preliminary calculations suggest that a greater quantity of soil may be accommodated in the Northwest landfill Area; however, any decision to place added soil at this location must consider other factors. For example, an existing C of A for a construction waste landfill in this area prescribes the maximum elevation to which that facility may extend. As well, other future development on the DN site unrelated to the NND Project may require use of this area; and it is anticipated that highway and road reconstruction north of the area associated with the Highway 407 East Link may further limit the future capacity of this area for soil disposal.

The Northeast Landfill Area will be developed for disposal of excavated material associated with the NND Project. The quantity of 4.5 Mm^3 proposed for the Northeast Landfill Area is the estimated maximum that can be placed in this location.

Off-site Disposal of Excavated Material

All scenarios include a requirement for disposal of excavated material at one or more off-site locations. The material may be used to rehabilitate extraction pits and quarries or other development sites, or similar beneficial uses. OPG will also explore opportunities for use of this material on other construction projects. For example, it is anticipated that construction of Highway 407 and its East Link to Highway 401 may require substantial quantities of borrow material, some or all of which may be provided from the NND Project.

Lake Infill

All layout scenarios include placement of approximately 40 ha of lake infill in a configuration that extends from the eastern boundary of the DN site to the DNGS wharf area, a distance of approximately 2.5 km. The infill will extend into the lake about 100 m at its western limit and 450 m at its eastern limit. This infill configuration has been established for EA purposes and it represents a realistic case.

Lake infill achieves several functional objectives. It provides the means for the necessary stabilization of the shoreline in the development area; creates a security management zone along the lakefront in front of both the existing and proposed stations; and it creates surface area for equipment laydown and ancillary facility development area, both of which are in high demand during construction projects of this type. Lake infill also provides one of the means to dispose of excavated soil resulting from site development and, hence, reduces the amount of soil that would have to be transported offsite.

Summary Statement of Preferences

All Project development scenarios will generate a substantial quantity of excavated material. All scenarios also provide that some amount of this material be utilized onsite as lake infill; some be disposed of onsite in constructed landfills; and the remainder be disposed of at offsite locations.

The assessment of effects has determined that the activities directly associated with excavated material handling do not generally result in residual adverse effects; and in cases where there may be residual adverse effects (e.g., nuisance effects associated with truck haulage routes) they are not significantly adverse. However, it is acknowledged that there will be a degree of environmental consequence associated with soil handling, and that it will be directly proportional to the quantity of soil handled. Accordingly, the following is noted in terms of OPG's relative preference of the site development variables as they relate to excavated material management:

- Some amount of soil and rock excavation is necessary to facilitate the Project, and the environmental consequences of the excavation and material management will increase in proportion to the quantity involved. Where all other factors are equal, it is OPG's preference to minimize the quantity of excavated material to be managed and the distance it will have to be transported;
- An amount of lake infill offers important operational benefits, including security management and lakefront stabilization. Although the infill will result in loss of some nearshore fish habitat, OPG is fully committed to the development of a Fish Habitat Compensation Plan that will offset any habitat losses associated with the NND Project; and
- Offsite disposal of excavated soils will involve shipment of the material by truck to destinations currently undetermined. Although no significant adverse effects would result from offsite transport, it is OPG's preference that, to the extent practicable, excavated soils be accommodated within the DN site where management strategies and mitigation measures will be most effectively implemented to ameliorate environmental effects.

In summary, the NND Project will generate surplus excavated material that must be accommodated in some manner. The assessment of effects has established that the activities associated with material excavation and management will not result in significant residual adverse effects. However, there will be environmental consequence relative to the quantity of material involved. As such, it is OPG's preference that the quantity of excavation be minimized and that this material be managed, to the extent possible, on the DN site including an amount placed as lake infill to benefit both the NND Project and the ongoing physical security of DNGS.

13.3 Recommendation of Ontario Power Generation

The EIS concludes that the NND Project, taking into account the mitigation measures identified, will not result in any significant adverse environmental effects, including effects from accidents, malfunctions and malevolent acts, effects of the environment on the Project, and cumulative effects. Accordingly, OPG recommends that the JRP accept these conclusions as the basis for recommending to the Minister of the Environment that this EIS be accepted as is within his or her authority under the *Canadian Environmental Assessment Act*.

Further, the EIS and its conclusions are based on a bounding definition of the NND Project that considers an eventual build-out of up to four reactors (producing up to 4,800 MW of electricity) and a site development layout that incorporates the range of scenarios considered reasonable based on the requirements of the Project and the characteristics of the DN site. As noted in Section 1.1, an application to prepare the site was made to the CNSC in September 2006. A revised submission providing additional information in support of the application is being submitted to the CNSC generally concurrently with this EIS. The Project works as they are described in that supporting information are within the bounding definition of the NND Project included in this EIS.

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15. SPECIAL TERMS

15.1 Units

a	annum
Bq	becquerel
Bq/kg-C	becquerel per kilogram of Carbon
C	Celsius
cm	centimetre
dm	decimetre
dB	decibel
dBA	A-weighted decibel
ft^2	square feet
g	gram
Gy	gray (unit of dose)
GW	gigawatt
h	hour
ha	hectare
Hz	hertz
km	kilometre
kV	kilovolt
L	litre
L_{eq}	Energy equivalent continuous sound level (dBA)
µg	microgram
µGy	microgray
µm	micrometre
µSv	microsievert
M	million
m	metre
m^2	square metre
m^3	cubic metre
masl	metres above sea level
mbsl	metres below sea level

mg/L	milligrams per litre
mm	millimetre
mSv	millisievert
Mm^3	million cubic metres
MIGD	Million Imperial Gallons per Day
MLD	million litres per day
MW	megawatt
MW(e)	megawatt (electrical)
nGy/h	nanogray per hour
NTU	nephelometric turbidity units
p-Sv	person-Sieverts
ppm	parts per million
s	second
Sv	sievert
wt%	weight percent
y	year
γBq-MeV	gamma Becquerel megaelectron volt (measure of gamma energy of noble gas emissions)

15.2 Abbreviations and Acronyms

AAQC	Ambient Air Quality Criterion
ACNS	Advisory Committee on Nuclear Safety
ACR-1000	Reactor manufactured by AECL
ACRP	Advisory Committee on Radiological Protection
AECB	Atomic Energy Control Board
AECL	Atomic Energy of Canada Limited
AERMOD	Atmospheric dispersion modelling system developed by the American Meteorological Society and the United States Environmental Protection Agency. AERMOD includes PRIME (Plume Rise Model Enhancements) algorithms
ALARA	As Low As Reasonably Achievable
ALWMS	Active Liquid Waste Management System
ANFO	Ammonium Nitrate/Fuel Oil (blasting agent)
ANSI/ANS	American National Standards Institute/American Nuclear Society

ANSI	Area of Natural and Scientific Interest
AP1000	Reactor manufactured by Westinghouse
AQO	Air Quality Objective
ASA	Adjacent Study Area
ATK	Aboriginal Traditional Knowledge
B	Boron
B&B	Bed and Breakfast
BDBA	Beyond Design Basis Accident
Be-7	Beryllium 7
BHF	Built Heritage Features
BOD_5	Biochemical Oxygen Demand
BP	Before Present
BSI	British Standards Institution
BSMP	Bank Swallow Monitoring Program
BTEX	Benzene, Toluene, Ethylbenzene and Xylenes
C-14	Carbon 14
C of A	Certificate of Approval
$CaCO_3$	Calcium Carbonate
CAC	Community Advisory Council
CANDU	CANada Deuterium Uranium (trademark of AECL)
CAV	Cumulative Absolute Velocity
CBRN	Chemical, Biological, Radiological and Nuclear
CCW	Condenser Cooling Water (also Condenser Circulating Water)
CCME	Canadian Council of Ministers of the Environment
CDF	Core Damage Frequency
CEA	Canadian Electricity Association
CEAA	Canadian Environmental Assessment Act
CEA Agency	Canadian Environmental Assessment Agency
CEAR	Canadian Environmental Assessment Registry
CEBP	Clarington Energy Business Park
CEOF	Corporate Emergency Operations Facility

CEQG	Canadian Environmental Quality Guidelines
10 CFR 5.68	US NRC Regulation
CGSB	Canadian General Standards Board
CH_4	Methane
CHP	Combined Heat and Power Plants
CIS	Community Information Session
CLOCA	Central Lake Ontario Conservation Authority
CLU	Cultural Landscape Unit
CN	Canadian National
CNA	Canadian Nuclear Association
CNEP	Consolidated Nuclear Emergency Plan
CNR	Canadian National Railway
CNSC	Canadian Nuclear Safety Commission
Co-60	Cobalt 60
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CO_2(eq)	Carbon Dioxide Equivalent
COPC	Constituent of Potential Concern
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CP	Canadian Pacific
CPC	Canadian Privy Council
CPR	Canadian Pacific Railway
CRMN	Canadian Radiological Monitoring Network
Cs-134	Cesium 134
Cs-137	Cesium 137
CSA	Canadian Standards Association
CSAO	Construction Safety Association of Ontario
CWPCP	Courtice Water Pollution Control Plant
CWS	Canada Wide Standard
D_2O	Deuterium Oxide (heavy water)
DBA	Design Basis Accident
DDP	Detailed Decommissioning Plan

DEEMP	Darlington Environmental Effects Monitoring Program
DEER	Darlington Ecological Effects Review
DEMO	Durham Emergency Management Office
DFO	Department of Fisheries and Oceans
DGR	Deep Geologic Repository
DIAND	Department of Indian Affairs and Northern Development
DN	Darlington Nuclear
DNNP	Darlington New Nuclear Project
DN Site	Darlington Nuclear Site
DNGS	Darlington Nuclear Generating Station
DNHC	Durham Nuclear Health Committee
DOC	Decommissioning Operations Contractor
DOE	United States Department of Energy
DPIISC	Darlington Planning and Infrastructure Information Sharing Committee
DPP	Darlington Provincial Park
DQO	Data Quality Objectives
DRL	Derived Release Limit
DROP	Durham Region Official Plan
DRPS	Durham Regional Police Service
DSC	Dry Storage Container
DSEA	Durham Strategic Energy Alliance
DSM	Demand Side Management
DUFDS	Darlington Used Fuel Dry Storage
DWMF	Darlington Waste Management Facility
EA	Environmental Assessment
EAA	Environmental Assessment Act
EB	Eastbound (traffic related)
EC	Environment Canada
EFW	Energy From Waste
EIS	Environmental Impact Statement
ELC	Ecological Land Classification
EMF	Electric and Magnetic Fields

EMO	Emergency Management Ontario
EMP	Environmental Management Plan
EMS	Environmental Management System
ENEV	Estimated No Effect Value
EP	Emergency Preparedness
EPA	Environmental Protection Act
EPP	Environmental Protection Plan
EPR	Reactor manufactured by AREVA
EPRI/SQUG	Electric Power Research Institute/Seismic Qualification Utility Group
ERA	Ecological Risk Assessment
ERO	Emergency Response Organization
ERPG	Emergency Response Planning Guidelines
ERT	Emergency Response Team
ESA	Environmentally Significant Area
ESA	Endangered Species Act
ESDM	Emission Summary and Dispersion Modelling
ESE	East South East
ESG	ESG Incorporated
ETE	Evacuation Time Estimate
EVP	Executive Vice President
FA	Federal Authority
FAQ	Frequently Asked Questions
FASSET	Framework for Assessment of Environmental Impact
FEMA	Federal Emergency Management Agency
FNEP	Federal Nuclear Emergency Plan
FPCAP	Federal-Provincial Committee on Air Pollution
FPTCCCEA	Federal-Provincial-Territorial Committee on Climate Change and Environmental Assessment
GCM	Global Climate Model
GDP	Gross Domestic Product
GDS	Guaranteed Defueled State

GHG	Greenhouse Gas
GLFC	Great Lakes Fishery Commission
GLWQA	Great Lakes Water Quality Agreement
GM	General Motors
GS	Generating Station
GSC	Geological Survey of Canada
GSS	Guaranteed Shutdown State
GTA	Greater Toronto Area
GTAA	Greater Toronto Airports Authority
H_2O	Light Water
HADD	Harmful Alteration, Disruption or Destruction (of Fish Habitat)
HAZMAT	Hazardous Materials
HC	Health Canada
HEPA	High Efficiency Particulate Air (Filter)
HQEOC	CNSC Headquarters Emergency Operations Centre
HTO	Tritiated Water
Hydro One	Hydro One Networks Inc.
HVAC	Heating, Ventilating and Air Conditioning
Hz	Hertz
I-131	Iodine 131
I-132	Iodine 132
IAEA	International Atomic Energy Agency
IARC	International Agency for Research on Cancer
ICI	Industrial, Commercial and Institutional
ICRP	International Commission on Radiological Protection
IES	Institute for Environmental Studies
IFB	Irradiated Fuel Bay
IGLD	International Great Lakes Datum
IJC	International Joint Commission
ILW	Intermediate Level Waste
INAC	Indian and Northern Affairs Canada

IO	Infrastructure Ontario
IPCC	Internnational Panel on Climate Change
IPSP	Integrated Power System Plan
ISO	International Organization for Standardization
ISR	Integrated Safety Review
IX	Ion Exchange
JRP	Joint Review Panel
JSL	Jurisdictional Screening Level
K-40	Potassium 40
k_{eff}	Effective Neutron Multiplication Factor
L&ILW	Low and Intermediate Level Waste
LGL	LGL Limited
LHIN	Local Health Integration Network
LLRWMO	Low-Level Radioactive Waste Management Office
LLRW	Low-Level Radioactive Waste
LLSB	Low Level Storage Buildings
LLW	Low Level Waste (radioactive)
LNDA	Low Natural Dispersion Area
LOC	Lake Ontario Committee
LOMU	Lake Ontario Management Unit
LOS	Level of Service (related to traffic)
LOSMP	Lake Ontario Shoreline Management Plan
LRF	Large Release Frequency
LSA	Local Study Area
LTPS	Licence to Prepare Site
LTWMF	Long Term Waste Management Facility
MAL	Maximum Acceptable Level
MCC	Ontario Ministry of Culture and Communications
MCL	Ontario Ministry of Culture

MDL	Method Detection Limit
MEI	Ministry of Energy and Infrastructure
MIKE 3	3-D Hydrodynamic Model
MISA	Municipal/Industrial Strategy for Abatement
MMAH	Ontario Ministry of Municipal Affairs and Housing
MNO	Métis Nation of Ontario
MNR	Ministry of Natural Resources
MOE	Ontario Ministry of the Environment
MOL	Ministry of Labour
MOU	Memorandum of Understanding
MP	Member of Parliament
MPAC	Municipal Property Assessment Corporation
MPMO	Major Projects Management Office
MPP	Member of Provincial Parliament
MPR	Municipal Peer Review
MPRMT	Municipal Peer Review Management Team
MTO	Ontario Ministry of Transportation
NB	Northbound (traffic related)
N/A	Not Applicable
NBC	National Building Code of Canada
NCIC	National Cancer Institute of Canada
NDR	National Dose Registry
NEA	Nuclear Energy Agency
NEW	Nuclear Energy Worker
NFC	National Fire Code of Canada
NFPA	National Fire Protection Association
NFWA	Nuclear Fuel Waste Act
NGDC	National Geophysical Data Center
NGS	Nuclear Generating Station
NHIC	Natural Heritage Information Centre
NM	Not measured
NND	New Nuclear – Darlington

NOAEL	No Observed Adverse Effects Level
NO_x	Nitrogen oxides
NO_2	Nitrous Oxide
NPCC	Northeast Power Coordinating Council
NPT	Treaty on the Non-proliferation of Nuclear Weapons
NRC	United States Nuclear Regulatory Commission
NRCan	Natural Resources Canada
NRF	Nuclear Response Force
NSCA	Nuclear Safety and Control Act
NSS	Nuclear Safety Solutions
NUREG	NRC Regulatory Guide
NUREG/ CR-6504	NRC Regulatory Guide – An Updated Nuclear Criticality Slide Rule: Technical Basis
NWMD	Nuclear Waste Management Division
NWMO	Nuclear Waste Management Organization
NY	New York
OASD	Ontario Archaeological Sites Database
OBCA	Ontario Business Corporations Act
OBT	Organically Bound Tritium
OCAA	Ontario Clean Air Alliance
ODWS	Ontario Drinking Water Standards
OEB	Ontario Energy Board
OECD	Organization for Economic Cooperation and Development
OH	Ontario Hydro
OH&S	Occupational Health and Safety
OHSA	Occupational Health and Safety Act
OHSAS	Occupational Health and Safety Assessment Series
OHSMS	Occupational Health and Safety Management System
OMAA	Ontario Metis Aboriginal Association
OMNR	Ontario Ministry of Natural Resources
OPA	Ontario Power Authority
OPG	Ontario Power Generation Inc.

PAH	Polyaromatic Hydrocarbon
PAL	Protective Action Level
PAR	Public Attitude Research
PARTS	Pickering A Return to Service
PCB	Polychlorinated Biphenyl
PCI	Pavement Conditions Index
PDP	Preliminary Decommissioning Plan
PEOC	Provincial Emergency Operations Centre
pH	Index of the concentration of hydrogen ions in solution
PHAI	Port Hope Area Initiative
PHR	Pressurized Hybrid Reactor
PM_{10}	Inhalable Particulate Matter < 10 µm in diameter
$PM_{2.5}$	Inhalable Particulate Matter < 2.5 µm in diameter
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
PN	Pickering Nuclear
PNEP	Provincial Nuclear Emergency Plan
PNERP	Provincial Nuclear Emergency Response Plan
PNGS	Pickering Nuclear Generating Station
PNGS A	Pickering Nuclear Generating Station A
PNGS B	Pickering Nuclear Generating Station B
POI	Point of Impingement
PPE	Plant Parameter Envelope
PPS	Provincial Policy Statement
PRA	Probabilistic Risk Assessment
PSA	Peak Spectral Acceleration
PSHA	Probabilistic Seismic Hazard Assessment
PSW	Provincially Significant Wetland
PTG	Places to Grow: Growth Plan for the Greater Golden Horseshoe
PTTW	Permit To Take Water
PUC	Public Utilities Commission (Oshawa)
PWMF	Pickering Waste Management Facility
PWQO	Provincial Water Quality Objective

PWR	Pressurized Water Reactor
Q&A	Questions and Answers
RA	Responsible Authority
RD-337	CNSC Regulatory Document 337 – Design of New Nuclear Power Plants
RD-346	CNSC Regulatory Document 346 – Site Evaluation for New Nuclear Power Plants
R&R	Radiation and Radioactivity
RCCAs	Rod Cluster Control Assemblies
RCMP	Royal Canadian Mounted Police
RCSF	Retube Components Storage Facility
REMP	Radiological Environmental Monitoring Program
RFP	Request for Proposals
RLWMS	Radioactive Liquid Waste Management System
RMD	Regional Municipality of Durham
RMT	Radioactive Material Transportation
RSA	Regional Study Area
RWSB	Retube Waste Storage Building
SAGE	Safe and Green Energy
SARA	Species At Risk Act
SB	Southbound (traffic related)
SCD	Stakeholder Comment Database
SCR	Stakeholder Comment Record
SEA	Significant Environmental Aspect
SF_6	Sulphur Hexafloride
SGB	Safety Goal Based
SGSB	Steam Generator Storage Building
SI	Screening Index
SLA	Screening Level Assessment
SMC	Site Management Centre
SO_2	Sulphur dioxide

SPM	Suspended Particulate Matter
Sr-90	Strontium 90
SRF	Small Release Frequency
SSA	Site Study Area
SWM	Stormwater Management
TBM	Tunnel Boring Machine
TC	Transport Canada
TDG	Transportation of Dangerous Goods Act
TDS	Total Dissolved Solids
TERP	Transportation Emergency Response Plan
TFWT	Tissue Free Water Tritium
TGICA	Task Group on data and scenario support for Impact and Climate Assessment
TLD	Thermoluminescent Dosimeter
TMI	Three Mile Island
TMP	Transportation Master Plan
TRF	Tritium Removal Facility
TRV	Toxicity Reference Value
TS	Transformer Station
TSD	Technical Support Document
TSP	Total Suspended Particulates
TSS	Total Suspended Solids
U-234	Uranium 234
U-235	Uranium 235
U-238	Uranium 238
UFDS	Used Fuel Dry Storage
UFDSF	Used Fuel Dry Storage Facility
UHRS	Uniform Hazard Response Spectrum
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
UN WCED	United Nations World Commission on Environment and Development
UOIT	University of Ontario Institute of Technology
US	United States

US EPA	United States Environmental Protection Agency
US DOE	United States Department of Energy
US DOT	United States Department of Transportation
US NRC	United States Nuclear Regulatory Commission
V/C	Volume-to-Capacity Ratio
VCHC	Valued Cultural Heritage Component
VEC	Valued Ecosystem Component
VOC	Volatile Organic Compound
VP	Vice President
VSC	Valued Socio-Economic Component
WB	Westbound (traffic related)
WCED	World Commission on Environment and Development
WHO	World Health Organization
WMF	Waste Management Facility
WNW	West North West
WPCP	Water Pollution Control Plant
WSP	Water Supply Plant
WWMF	Western Waste Management Facility

15.3 Glossary of Terms

Aboriginal Peoples Inclusive of interests beyond Aboriginal and Treaty rights, and include any other interests that might be identified by Aboriginal Peoples.

Aboriginal Rights Those rights of Aboriginal Peoples which are not found in treaties or land claim agreements.

Aboriginal Traditional Knowledge Knowledge that is held by, and unique to Aboriginal Peoples. It is a living body of knowledge that is cumulative and dynamic and adapted over time to reflect changes in the social, economic, environmental, spiritual and political spheres of the Aboriginal knowledge holders. It often includes knowledge about the land and its resources, spiritual beliefs, language, mythology, culture, laws, customs and medicines. It may be considered in the environmental assessment of a proposed project. The term traditional ecological knowledge (TEK) is often used interchangeably with the term Aboriginal traditional knowledge (ATK). However, TEK is generally considered to be a subset of ATK that is primarily concerned with knowledge about the environment.

Absorbed dose In exposure assessment, the amount of a substance that penetrates an exposed organism's absorption barriers (e.g. skin, lung tissue, gastrointestinal tract) through physical or biological processes. The term is synonymous with internal dose.

Acid Rain Acidified particulate matter in the atmosphere that is deposited by precipitation onto a surface, often eroding the surface away.

Activity A measurement of the number of becquerels of a radioactive species in a sample.

Adaptive Management The integration of design, management, and monitoring to systematically test assumptions in order to adapt and learn, and apply and implement.

Additional mitigation measures	Measures, further to in-design mitigation measures, deemed technically and economically feasible, to eliminate, reduce or control adverse environmental effects of the Project, and which may include restitution for any damage to the environment caused by such effects through replacement, restoration, compensation or any other means.
Airshed	The term denotes a geographical area that shares the same air because of topography, meteorology, and climate.
ALARA	As Low As Reasonably Achievable - A principle in radiation protection according to which radiation exposures are kept as far below the regulatory limits as reasonable, taking into account social and economic factors. These factors could include, for example, the financial impact of protection measures as balanced against the benefit obtained.
Alpha radiation	Particles emitted by some radioactive nuclei, each particle consisting of two protons and two neutrons bound together.
Ambient Air	The air occurring at a particular time and place outside of structures. Often used interchangeably with "outdoor air."
Anthropogenic	Of, relating to, or resulting from the influence of human beings on nature.
Aquatic Habitat	For the Project, aquatic habitat includes the physical areas of Lake Ontario, tributary watercourses and ponds within the study area. In these different areas, it is characterized by conditions of flow, current, bathymetry, temperature, substrates, and water quality that influence its status with respect to the federal Fisheries Act (FA) (i.e., whether it is fish habitat, and of what type).
Aquifer	A saturated geologic formation (rock or sediment) capable of storing, transmitting and yielding reasonable amounts of groundwater to wells and springs.
Areas of Natural and Scientific Interest (ANSI)	An area of land and water containing natural landscapes or features which have been identified as having values related to natural heritage protection, scientific study, or education.

Atmosphere The gaseous mass or envelope of air surrounding the Earth. From ground-level up, the atmosphere is further subdivided into the troposphere, stratosphere, mesosphere, and the thermosphere.

Baseflow The sustained flow (amount of water) in a stream that comes from groundwater discharge or seepage.

Baseload The minimum amount of electric power delivered or required at a steady rate over a given period of time.

Background radiation The radiation in the natural environment, including cosmic rays and radiation from naturally radioactive elements. It is also called natural radiation.

Becquerel (Bq) The unit of radioactive decay equal to 1 disintegration per second.

Benthos The whole assemblage of plants or animals living on the lake or river bottom; distinguished from plankton.

Beta radiation High-energy electrons that are emitted by some radioactive nuclei.

Biota The animal and plant life of a region.

Bounding scenario A credible accident or malfunction scenario that is developed for assessment purposes and is determined to have potential effects that are greater than other credible scenarios with similar releases and characteristics. This facilitates the assessment of a single scenario to determine the possible environmental effects from a group of scenarios.

Carbon Dioxide (CO_2) A colourless, odourless, non-poisonous gas that is a normal part of the earth's atmosphere. Carbon dioxide is a product of fossil-fuel combustion as well as other processes. It is considered a greenhouse gas as it traps heat (infrared energy) radiated by the earth into the atmosphere and thereby contributes to the potential for global warming.

Constituent of Potential Concern A constituent of potential concern (COPC) is a chemical constituent in the environment that may be of potential concern for ecological receptors. A chemical is identified as a COPC when it has a concentration in the environment higher than a given criterion, which typically includes background concentrations and regulatory criteria such as the CCME and MOE. The process for selecting these constituents is discussed further in Section 4.1.1. All radionuclides are considered COPC.

Carbon Monoxide (CO) A colorless, odorless gas resulting from the incomplete combustion of hydrocarbon fuels. CO interferes with the blood's ability to carry oxygen to the body's tissues and results in numerous adverse health effects.

Combustion The combining of oxygen with other elements through a chemical reaction that generates heat. Colloquially known as burning.

Condenser circulating water Cooling water pumped through a heat exchanger to condense the steam from the turbine exhaust back into water.

Cooling water For the Project, water taken from Lake Ontario to be used as a heat sink to remove heat from various reactor systems and components.

Climate Determined by the daily weather interactions over many years. Characteristics used in determining climate are temperature, precipitation, humidity, sunshine, and cloudiness, wind, and air pressure.

Critical group Potential critical groups include individuals whose location, habits or diet may cause them to receive a higher radiation dose (on average) than individuals in other exposed population groups. Therefore, doses to potential critical groups are used to estimate the maximum realistic impact of emissions.

Darlington Waste Management Facility (DWMF) The DWMF provides dry fuel storage for the Darlington reactors.

Decibel (dB)	Unit of level when the base of the logarithm is the 10th root of 10 and the quantities concerned are proportional to power.
Decibel, A-Weighted (dBA)	Unit representing the sound level measured with the A-weighting network on a sound level meter.
Decommissioning	The act of removing a regulated facility from operation and operational regulation. This usually entails a certain amount of cleanup (decontamination).
Derived Release Limit	The release rate for a radionuclide or a group of radionuclides that would result in the average member of the critical group (most exposed group of members of the public) receiving an annual dose of 1 mSv.
Diffuser	A submerged structure consisting of a manifold with many ports through which the effluent is discharged as turbulent jets into the receiving water at high velocity to promote initial mixing.
Dispersion	Spreading of mass during transport resulting from both physical mixing and molecular diffusion from areas of high concentration to low concentration.
Dispersion model	Mathematical relationship between emissions and air quality which simulates on a computer the transport, dispersion, and transformation of compounds emitted into the air.
Ecological Land Classification (ELC)	A Canadian system that classifies land from an ecological perspective; a southern Ontario version of the ELC has recently been devised to provide a consistent and comprehensive approach to identifying ecologically similar areas.
Effective dose	This term is intended to express radiation doses in a manner such that the long-term biological harm to humans will be approximately the same per unit of effective dose, regardless of the type of radiation involved or the parts of the body exposed to radiation.
Efficiency	The efficiency of a generating unit in converting the thermal energy contained in a fuel source to electrical energy.

Effluent	Discharge from an industrial process.
Electrical power	The rate of delivery of electrical energy and the most frequently used measure of capacity. The typical basic units of electrical power are the kilowatt (kW) and megawatt (MW).
Emission factor	For stationary sources, the relationship between the amount of pollution produced and the amount of raw material processed or burned. For mobile sources, the relationship between the amount of pollution produced and the number of vehicle miles traveled. By using the emission factor of a pollutant and specific data regarding quantities of materials used by a given source, it is possible to compute emissions for the source. This approach is used in preparing an emissions inventory.
Emission rate	The weight of a pollutant emitted per unit of time (e.g., grams / second).
Emissions	Releases to the environment, such as air, noise, radioactivity and water.
Endangered species	Any indigenous species of flora or fauna that, on the basis of the best available scientific evidence, is threatened with immediate extinction throughout all or a significant portion of its range within a given jurisdiction; identified in Regulations under the Endangered Species Act; endangered species as identified by COSEWIC. A species facing imminent extinction or extirpation in Ontario which is a candidate for regulation as identified by COSSARO.
Energy	The capability for doing work (potential energy) or the conversion of this capability to motion (kinetic energy). Energy has several forms, some of which are easily convertible and can be changed to another form useful for work. Most of the world's convertible energy comes from fossil fuels that are burned to produce heat that is then used as a transfer medium to mechanical or other means in order to accomplish tasks.
Entrainment	Occurs when aquatic invertebrates, fish eggs and fish larvae are drawn into a water intake and cannot escape.

Environmental Assessment	A process for identifying project and environment interactions, predicting environmental effects, identifying mitigation measures, evaluating significance, reporting and following-up to verify accuracy and effectiveness. Environmental Assessment is used as a planning tool to help guide decision-making, as well as project design and implementation.
Environmental effect	As defined in the *Canadian Environmental Assessment Act.*
Exclusion Zone	A parcel of land within or surrounding a nuclear facility on which there is no permanent dwelling and over which a licensee has the legal authority to exercise control (from *Class I Nuclear Facilities Regulations*).
Exposure pathway	The path from sources of pollutants via, soil, water, or food to human and other species or settings.
First Nation	Although the term First Nation is widely used, no legal definition of it exists. Among its uses, the term “First Nations peoples” refers to the Indian peoples in Canada, both Status and non-Status. Some Indian peoples have also adopted the term “First Nation” to replace the word “band” in the name of their community.
Fuel	Any substance that can be burned to produce heat. It is also a material that can be fissioned in a nuclear reaction to produce heat.
Gamma radiation	High-energy, short-wavelength electromagnetic radiation (similar to X-rays) emitted during radioactive decay. Gamma rays are very penetrating and require dense materials (such as lead or steel) for shielding.
Generating unit	Any combination of physically connected reactor(s), boiler(s), combustion turbine(s), or other prime mover(s), generator(s), and auxiliary equipment operated together to produce electricity.
Generator	A machine that converts mechanical energy into electrical energy.

Good Industry Management Practice	A technique, method or process that has been adopted by a significant proportion of the subject industry, and shown to be effective at delivering the desired outcome with few problems, unforeseen complications and negative results. Good Industry Management Practices are based on repeatable procedures that have been shown to be effective over time and during for large numbers of applications. For purposes of this EIS, Good Utility Practices as they are recognized in the North American electrical utility industry and Good Industry Management Practices are considered to be the same.
Gray	Standard international unit for absorbed radiation dose, equal to the absorption of one joule of radiation energy per kilogram of material. Absorbed doses are frequently expressed in milligray (mGy), equal to one-thousandth of a gray, and must specify the medium in which the energy is absorbed.
Greenhouse Gases (GHGs)	A collection of gaseous substances, primarily consisting of carbon dioxide, methane, and nitrogen oxides that have been shown to warm the earth's atmosphere by trapping solar radiation.
Grid	The layout of an electrical transmission and/or distribution system.
Gross Beta	The total amount of beta radioactivity present in a media, regardless of specific radionuclide source.
Groundwater	Subsurface water, or water stored in the pores, cracks, and crevices in the ground below the water table; water passing through, or standing in, soil and underlying strata.
Heavy water	Water that has had its hydrogen atoms replaced with the hydrogen isotope deuterium. Symbol: D_2O.
Hydraulic conductivity	The term used to describe the permeability of water through a medium; a controlling factor on the rate at which water can move through a permeable medium.
Hydrazine	A strong reducing agent widely used to remove oxygen dissolved in coolant water in nuclear power production. It is a colourless liquid with an ammonia-like odor.

Impingement	Occurs when an entrapped fish is held in contact with the intake screen and is unable to free itself.
In-design mitigation measures	Features included in the Project design for the purpose of pre-empting possible environmental effects of the Project, based on good practice and OPG experience.
Intake structure	The hydraulic structure on the bottom of Lake Ontario near the DN site that is used to withdraw water from the lake to provide process water (e.g. cooling water, service water) to the plant.
Intermediate Level Waste	Consists mostly of used reactor components, as well as the resins and filters used to keep reactor water systems clean. These items, which cannot be handled without shielding, are stored in steel-lined storage structures.
Irradiated Fuel Bay	Water-filled pool-type storage (also called “wet bay”, or “wet storage”), located at reactor sites, in which used nuclear fuel is stored, cooled and shielded.
Isotopes	Atoms of an element that differ only by the number of neutrons in the nucleus.
Joint Review Panel	A Review Panel appointed pursuant to the *Canadian Environmental Assessment Act* and the *Nuclear Safety and Control Act*. The CEA Agency and the CNSC are both involved in the EA and regulatory review of the project.
Lake infill	For the Project, the portion of Lake Ontario along its shoreline in front of the DN site to be filled to create the necessary ground surface area to accommodate the Project; also, the material used to fill this area.

Landfill	The DN site has an existing Landfill Site (the Northwest Landfill Area) that was developed during the construction of the DNGS. This area is a mound of surplus soils that also includes an area within it that is operated under a provincial Certificate of Approval as a closed construction waste landfill. Any new Landfill, including the proposed Northeast Landfill Area and the possible re-opening of portions of the Northwest Landfill Area, will be used for disposal of excavated inert soils and rock. Any construction and hazardous wastes associated with NND will be removed from site for disposal at appropriate waste management facilities.
Light water	Ordinary water (H_2O), e.g., the water found in lakes and drinking water, as distinguished from heavy water (D_2O).
Low Level Waste	Consists of minimally radioactive materials such as mop-heads, rags, paper towels, floor sweepings and protective clothing used in the nuclear stations during routine operation and maintenance. This waste does not require shielding and, after any processing, is stored in Low Level Storage Buildings.
Malfunction or Accident	Upset conditions outside of those arising from normal operations.
Meteorology	The science of the atmosphere and its direct effects upon the earth's surface. Meteorology is especially concerned with how atmospheric conditions affect the weather.
Métis	Persons of mixed European and North American Indian Heritage.
Method detection limit	The minimum concentration of a substance that can be distinguished from background levels.
Mitigation	An action or design intended to reduce the severity or extent of an environmental impact.
Monitoring	The periodic or continuous sampling and analysis of air pollutants in ambient air or from individual pollution sources.
Moraine	A prominent physiographic feature comprised of a mix of silts, sands and gravels deposited during the last glacial episode.

Neutron	Electrically neutral elementary particle that is part of the nucleus of the atom.
Nitrate (NO_3)	A chemical formed when nitrogen from ammonia (NH_3), ammonium (NH_4), and other nitrogen sources combines with oxygenated water.
Nitric Oxide (NO)	Precursor of ozone, NO_2, and nitrate; nitric oxide is usually emitted from combustion processes. Nitric oxide is converted to nitrogen dioxide (NO_2) in the atmosphere, and then becomes involved in the photochemical processes and / or particulate formation. (See Nitrogen Oxides.).
Nitrogen Oxides (Oxides of Nitrogen, NO_x)	A general term pertaining to compounds of nitric oxide (NO), nitrogen dioxide (NO_2) and other oxides of nitrogen. Nitrogen oxides are typically created during combustion processes, and are major contributors to smog formation and acid deposition.
Nuclear electric power (Nuclear Power)	Electricity generated by the use of the thermal energy released from the fission of nuclear fuel in a reactor.
Nuclear Energy Worker	A worker who might receive as a result of their work or occupation a radiation dose greater than the dose limit for the general public.
Nuclear Fission	The process of splitting atoms or fissioning them.
Nuclear Fuel	Fissionable materials that when placed in a nuclear reactor, will support a self-sustaining fission chain reaction, producing heat in a controlled manner for process use.
Nuclear power plant	A generating plant in which heat produced in a nuclear reactor by the fissioning of nuclear fuel is used to drive a steam turbine.
Nuclear reactor	A device in which a fission chain reaction can be initiated, maintained, and controlled. Nuclear reactors are used in the power industry to produce steam used for the generation of electricity.
Nuclear Waste Management Organization (NWMO)	The NWMO was established in 2002 by Ontario Power Generation Inc., Hydro-Québec and New Brunswick Power Corporation. This organization was formed to assume responsibility for the long-term management of Canada's used nuclear fuel. The NWMO operates in accordance with the Nuclear Fuel Waste Act.

Nuclide Any atom with a unique number of protons and neutrons: nuclides sharing the same number of protons but having different numbers of neutrons are called Isotopes (see "Isotopes").

Outfall Discharge point of a waste stream into a body of water.

Particulate Matter (PM) Any material, except pure water, that exists in the solid or liquid state in the atmosphere. The size of particulate matter can vary from coarse, wind-blown dust particles to fine particle combustion products.

Parts Per Million (ppm) and Parts Per Billion (ppb) These terms give scientists a way to describe how much of a substance is contained in a sample: parts of analyte per million parts of sample, for instance. In atmospheric chemistry these become volume parts of analyte per volume parts of atmosphere: ppmv, ppbv, etc.

Plant Parameter Envelope (PPE) A PPE is a set of vendor based postulated design parameters that establish the bounding framework for key features of the Project. A fully developed PPE represents the limiting values for the common elements of the different design options being considered and serves as a conservative surrogate for actual reactor design information that varies among the options.

Plume A plume is a visible smoke-like structure, which may contain pollutants emitted from an exhaust or smoke stack and released into the atmosphere. This elongated band of smoke has changing characteristics that vary with its local environmental conditions. These conditions may include the physical and chemical nature of the pollutant, weather conditions and downwind topography.

$PM_{2.5}$ Includes tiny particles with an aerodynamic diameter less than or equal to a nominal 2.5 microns. This fraction of particulate matter penetrates most deeply into the lungs.

PM_{10} A criteria air pollutant consisting of small particles with an aerodynamic diameter less than or equal to a nominal 10 microns (about 1/7 the diameter of a single human hair).

Polycyclic Aromatic Hydrocarbon (PAH)	Chemicals that are formed during the incomplete burning of coal, oil and gas, garbage, or other organic substances.
Porous veneer intake	A specially designed water intake, which incorporates fish protection features, for delivery of cooling water to the power plant.
Potable	Water safe for drinking.
Precipitation	Deposition of rain, snow, sleet, dew, frost, fog, or hail.
Project	The New Nuclear – Darlington (NND) Project scope includes site preparation, construction, operation, decommissioning and abandonment of up to four new nuclear power reactors for the production of up to 4,800 megawatts of electrical generating capacity for supply to the Ontario grid (as per Guidelines for the Preparation of the EIS, Section 4).
Proponent	Ontario Power Generation Inc. (OPG).
Protective Action Level	A dose (to whole body or thyroid) at which the Province of Ontario recommends that a protective action be considered or taken in order to mitigate against the effects of exposure to radiation.
Radioactive waste	A material (liquid, gaseous, or solid) that contains a radioactive "nuclear substance," (as defined in Section 2 of the Nuclear Safety and Control Act), and which the owner has declared to be waste. In addition to containing nuclear substances, radioactive waste may also contain non-radioactive hazardous substances.
Refurbishment waste	Radioactive waste produced from the refurbishment and life extension of reactors including retubing (fuel channel replacement); steam generator replacement (large heavy object wastes, i.e. steam generators); and/or feeder pipe replacement.
Risk Assessment	Qualitative and quantitative evaluation of the risk posed to the environment by the actual or potential presence and/or use of specific pollutants.
Runoff	The part of rainfall that is not absorbed directly by the soil but is drained off in rills or streams.

Runoff-Surface (overland flow) Precipitation that cannot be absorbed by the soil because the soil is already saturated with water (saturation excess overland flow); precipitation that exceeds infiltration; the portion of rain, snow melt, irrigation water, or other water that moves across the land surface and enters a wetland, stream, or other body of water (overland flow). Overland flow usually occurs in urban settings (pavement, roofs, etc.) or where the soils are very fine textured or heavily compacted.

Screening Index The ratio of estimated site-specific exposure to a single chemical over a specified period to the estimated exposure level, at which no adverse health effects are likely to occur.

Sievert A measurement unit of radiation dose. Frequently expressed as millisievert (mSv), equal to one-thousandth of a sievert, or as a microsievert (mSv), equal to one-millionth of a sievert.

Species at Risk As defined in the federal *Species at Risk Act.*

Spent fuel Nuclear fuel removed from a reactor following irradiation, no longer usable in its current form because of depletion of fissile material, poison build-up or radiation damage (alternatively termed "used fuel").

Stakeholder An individual or group with an interest in the success of an organization in delivering intended results because those individual or group can affect or be affected by the organization's actions, objectives, and policies.

Stormwater Water that originates during precipitation events (rainfall or snowmelt) and either infiltrates into the ground or becomes surface runoff that flows directly into surface water bodies (lakes, rivers, etc.) or is channelled into storm sewer systems.

Sulphur Dioxide (SO_2) A strong smelling, colorless gas that is formed by the combustion of fossil fuels. Power plants, which may use coal or oil high in sulphur content, can be major sources of SO_2. SO_2 and other sulphur oxides contribute to the problem of acid deposition.

Surface water Water found in ponds, lakes, streams, rivers, and inland seas.

Sustainability	Indicator selected with the aim to provide information on the essence of sustainable development; it may refer to systemic characteristics such as carrying capacities of the environment, or it may refer to interrelations between economy, society, and the environment.
Terrestrial Environment	The components related to, living on, or located on the Earth's land areas, including but not limited to all organic and inorganic matter, living organisms and their habitat, and their interacting natural systems.
Thermal plume	Plume resulting from a heated discharge, such as cooling water; its behaviour is governed by density differences and buoyancy effects as well as momentum effects. Typically reported as a temperature difference from the ambient conditions.
Threatened species	Any indigenous species of flora or fauna that, on the basis of the best available scientific evidence, is experiencing non-cyclical decline throughout all or a portion of its Ontario range, and is likely to become endangered if factors responsible for the decline continue unabated; threatened species as defined by COSEWIC. COSSARO - A species that is at risk of becoming endangered in Ontario if limiting factors are not reversed.
Topography	The contour of the land surface; the arrangement of the land surface including its relief and the position of its natural and man-made features.
Total Suspended Particulate (TSP)	Particles of solid or liquid matter -- such as soot, dust, aerosols, fumes, and mist up to approximately 30 microns in size.
Treaty	Formal agreement(s) between certain Aboriginal peoples and the Government of Canada.
Tributary	A stream or river which flows into a mainstem (or parent) river, both of which serve to drain the surrounding drainage basin of its surface water and groundwater by leading the water out into an ocean or some other large body of water.

Turbidity	A water quality parameter that is indicative of the cloudiness or haziness of a fluid caused by individual particles (suspended solids) that are generally invisible to the naked eye.
Turbine	A machine for generating rotary mechanical power from the energy of steam. Turbines convert the kinetic energy of fluids to mechanical energy.
Uptake	The process/act by which a contaminant (e.g. a radionuclide) enters a biological organism (e.g. inhalation, ingestion by humans).
Uranium (U)	A heavy, naturally radioactive, metallic element (atomic number 92). Its two principally occurring isotopes are uranium-235 and uranium-238. Uranium-235 is indispensable to the nuclear industry because it is the only isotope existing in nature, to any appreciable extent, that is fissionable by thermal neutrons. Uranium-238 is also important because it absorbs neutrons to produce a radioactive isotope that subsequently decays to the isotope plutonium-239, which also is fissionable by thermal neutrons.
Used fuel	Nuclear fuel removed from a reactor following irradiation, no longer usable in its current form because of depletion of fissile material, poison build-up or radiation damage (alternatively termed “spent fuel”).
Volatile Organic Compounds (VOCs)	Carbon-containing compounds that evaporate into the air (with a few exceptions). VOCs contribute to the formation of smog and / or may themselves be toxic. VOCs often have an odor, and some examples include gasoline, alcohol, and the solvents used in paints.
Vulnerable species	Any indigenous species of flora or fauna that is represented in Ontario by small but relatively stable populations, and/or that occurs sporadically, or in a very restricted area of Ontario, or at the fringe of its range; vulnerable species as defined by COSEWIC.
Watershed	An extent of land where water from rain or snow melt drains downhill into a body of water, such as a river, lake, reservoir, estuary, wetland, sea or ocean, and includes both the streams and rivers that convey the water as well as the land surfaces from which water drains into those channels.

Water Table	The water surface in an unconfined aquifer; the level below which the pore spaces in the soil or rock are saturated with water; the upper surface of the zone of saturation.
Western Waste Management Facility (WWMF)	The WWMF is a centralized processing and storage facility for OPG's low and intermediate-level radioactive wastes, and dry storage for used fuel from the Bruce nuclear generating stations.

APPENDIX A

FINAL EIS GUIDELINES

Guidelines for the Preparation of the Environmental Impact Statement for Ontario Power Generation's Darlington New Nuclear Power Plant Project

January 2009

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PART 1 – INTRODUCTION

1. CONTEXT

1.1 Purpose of the Guidelines

The purpose of this document is to identify for the proponent, Ontario Power Generation (OPG), the nature, scope and extent of the information that must be addressed in the preparation of the Environmental Impact Statement (EIS) for its proposed New Nuclear Power Plant project (the OPG Darlington NNPP project) for the creation of approximately 4,800 MW of electrical generation capacity. The proponent will prepare and submit an EIS that examines the potential environmental effects, including cumulative effects, of the site preparation, construction, operation, refurbishment if required, decommissioning and abandonment of the project, and that evaluates their significance. In addition, the proponent will address all requirements for a Licence to Prepare Site detailed in Appendix 2 of this document. This information will be used by the joint review panel established pursuant to the *Canadian Environmental Assessment Act* and the *Nuclear Safety and Control Act* as the basis for a public review.

While the EIS guidelines provide a framework for preparing a complete and accessible EIS, it is the responsibility of the proponent to provide sufficient data and analysis on any potential environmental effects to permit proper evaluation by a joint review panel, the public, and technical and regulatory agencies. The EIS guidelines outline the minimum information requirements while providing the proponent with flexibility in selecting methods to compile and analyze data for the EIS.

Exchanges between the proponent and other government organizations, Aboriginal people and stakeholders, where appropriate, are encouraged to ensure that the EIS responds adequately to these guidelines.

1.2 Environmental Assessment and Regulatory Process

On September 20, 2006, OPG wrote to the Canadian Nuclear Safety Commission (CNSC) indicating its intent to initiate the regulatory process to prepare a site, construct and operate up to four new nuclear reactors on the existing OPG Darlington Nuclear Site within the Regional Municipality of Durham in Ontario. The proposed OPG Darlington NNPP would generate up to 4,800 MW of electrical generating capacity for supply to the Ontario grid.

The OPG Darlington NNPP project includes site preparation, construction, operation, decommissioning and abandonment of up to four new nuclear reactors. Operations would involve activities required to operate and maintain the NNPP, including management of all conventional and radioactive wastes. The EIS will consider the potential environmental effects, including cumulative effects, of all phases of the project. The proponent is considering a range of reactor designs, but has not yet decided on a specific technology. It is anticipated that the OPG Darlington NNPP would have an approximate 60-year operating life and could include a mid-life refurbishment.

The principal buildings and structures are grouped into three primary areas: the power block, the cooling system and the switchyard. The power block consists of the buildings housing the nuclear reactors and all associated facilities and equipment. Two methods of cooling water systems are being considered for the removal of heat from the reactor: 1) cooling towers; or 2) once-through cooling system which would draw from, and discharge, to Lake Ontario. A new switchyard may be required to transmit electricity from the power station to the provincial grid.

The project triggers the *Canadian Environmental Assessment Act g*iven that the proponent requires authorizations under section 24(2) of the *Nuclear Safety and Control Act* in order for the project to proceed. In addition, authorizations by: Transport Canada under paragraph 5(1)(a) of the *Navigable Water Protection Act*; Fisheries and Oceans Canada under subsection 35(2) of the *Fisheries Act*; and the Canadian Transportation Agency under subsection 98(2) and subsection 101(3) of the *Canadian Transportation Act* may also be required for this project. All of these authorizations require that an environmental assessment is completed before any authorizations are granted that would enable the project to proceed in whole or in part.

On March 20, 2008, the Minister of the Environment announced his referral of the OPG NNPP to a review panel pursuant to the *Canadian Environmental Assessment Act*, and indicated that the CNSC and the Canadian Environmental Assessment Agency (CEAA) should pursue a joint environmental assessment process. A joint review panel under the *Canadian Environmental Assessment Act* and the *Nuclear Safety and Control Act* is being established to undertake an environmental assessment and regulatory review of this project. The joint review panel for this project will evaluate information that relates to the environmental assessment. The joint review panel will also consider information submitted by OPG in support of their application for a Licence to Prepare Site for a Class 1 Nuclear Facility, in accordance with the requirements of the *Nuclear Safety and Control Act* and its regulations.

The Province of Ontario's Ministry of the Environment indicated on April 5, 2007 that its legal position was that the province has no mandate to make nuclear facilities subject to the Ontario *Environmental Assessment Act*. As such, it did not foresee having any environmental assessment responsibility. However, the Province did indicate its desire to remain informed about the progress of the federal environmental assessment so that it could understand the potential implications for projects in the provincial domain.

1.3 Preparation and Review of the EIS

The EIS guidelines were prepared by the CEAA and the CNSC, in consultation with Fisheries and Oceans Canada (DFO), Transport Canada and the Canadian Transportation Agency.

An EIS is a document prepared by a proponent that allows a joint review panel, regulators, members of the public and Aboriginal groups to understand the project, the existing environment, and the potential environmental effects of the project. The proponent must also provide, as outlined in Appendix 2, all information required to support the licence to prepare site application for the joint review panel, as a panel of the

Commission, to consider and render a licensing decision under the *Nuclear Safety and Control Act*.

The proponent will prepare an EIS that addresses the requirements of these guidelines for submission to the joint review panel that will be established for this project. The EIS will then be made available to the public and stakeholders for a comment period on whether the EIS is in conformity with these guidelines. The joint review panel will determine whether additional information is required before convening public hearings.

The EIS that is made available for public and stakeholder comment should not contain:

- information that could cause specific, direct and substantial harm to the proponent, to a witness or specific harm to the environment by the disclosure of;
- information that involves national or nuclear security;
- information that is confidential (i.e., financial, commercial, scientific, technical, personal or other nature), that is treated consistently as confidential, and the person affected has not consented to the disclosure; or
- information that is likely to endanger the life, liberty or security of a person through its disclosure.

The proponent must inform the joint review panel in writing for a determination as to whether specific information requested by these guidelines should be submitted to, and retained by the joint review panel, as confidential. Such requests must contain as much detail as possible about the information to be kept confidential and provide a rationale for the request. All requests, as well as the joint review panel's determinations respecting the requests, will be made available on the project's online public registry.

Following public hearings, the joint review panel, as a panel of the CNSC, will prepare and submit a report that includes, but is not limited to, the rationale, conclusions and recommendations of the joint review panel relating to the environmental assessment of the project, including any mitigation measures and follow-up program.

This joint review panel report will be submitted to the Minister of the Environment to the Ministers of the Responsible Authorities. The report will be made available to the public at that time. The government will then respond to the joint review panel's report. The Government of Canada's response to the joint review panel report will be made available by the CEAA.

Subsequent to the Government of Canada response, the joint review panel will render a licensing decision for a Licence to Prepare Site under the *Nuclear Safety and Control Act.*

2. GUIDING PRINCIPLES

2.1 Environmental Assessment as a Planning Tool

Environmental assessment is a planning tool used to ensure that projects are considered in a careful and precautionary manner in order to avoid or mitigate the possible adverse effects of development on the environment and to encourage decision-makers to take actions that promote sustainable development and thereby achieve or maintain a healthy environment and a healthy economy.

The environmental assessment of this project must, in a manner consistent with those purposes, identify its possible environmental effects; propose measures to mitigate adverse effects; and, predict whether there will be likely significant adverse environmental effects after mitigation measures are implemented.

2.2 Public Participation and Aboriginal Engagement

Public participation[1] is a central objective of the overall review process. Public participation provides the public and organizations with a fair opportunity to contribute to the planning of projects that may affect them; allows proponents and federal authorities to better understand and address public concerns and priorities; reduces the potential for adverse environmental effects by identifying community knowledge and Aboriginal traditional knowledge that may be applied in the environmental assessment; and builds greater public trust in the environmental assessment process.

Meaningful public participation requires the proponent to address concerns of the general public regarding the anticipated or potential environmental effects of the project. In preparing the EIS, the proponent is required to engage residents and organizations in all affected communities, other interested organizations, and relevant government agencies. The proponent must provide in the EIS the highlights of this engagement, including the methods used, the results, and the ways in which the proponent intends to address the concerns identified, including a summary of issues raised during such engagement.

Another objective of the overall review process is to involve potentially affected Aboriginal people in order that the environmental assessment can identify any changes that the project may cause in the environment and the resulting effects of any such changes on the current use of lands and resources for traditional purposes by Aboriginal persons. The proponent must ensure that it engages with Aboriginal people that may be affected by the project and that have asserted or have established Aboriginal rights,

[1] As described in CEAA's Public Participation Guide (May 2008), terms such as "participation," "consultation," "involvement" and "engagement" are often used interchangeably, although they may mean different things to different people. These guidelines endeavour to use these terms in a manner that is consistent with the 'Public Participation Terminology' described in this CEAA Guidance.

Aboriginal title or treaty rights. In preparing the EIS, the proponent must ensure that Aboriginal people have the information that they require in respect of the project and of how the project may impact them. The proponent is required to describe in the EIS how the concerns respecting Aboriginal people will be addressed. That description must include a summary of discussions, the issues or concerns raised, and should consider and describe any asserted or established Aboriginal rights, Aboriginal title and treaty rights. The EIS must document the potential impact of the project on asserted or established Aboriginal rights, Aboriginal title and treaty rights, and the measures to prevent or mitigate those potential impacts.

Meaningful involvement in the environmental assessment takes place when all parties involved have a clear understanding of the proposed project as early as possible in the review process. Therefore, the proponent is required to:

- continue to provide up-to-date information describing the project to the public and especially to the communities likely to be most affected by the project;
- involve Aboriginal people in determining how best to deliver that information (e.g., the types of information required, translation needs, different formats, the possible need for community meetings); and
- explain the results of the EIS in a clear and direct manner to make the issues comprehensible to as wide an audience as possible.

2.3 Traditional Knowledge

Traditional knowledge, which is rooted in the traditional life of Aboriginal people, has an important contribution to make to an environmental assessment. Traditional knowledge refers to the broad base of knowledge held by individuals and collectively by communities that may be based on spiritual teachings, personal observation and experience on land and sea or passed on from one generation to another through oral and/or written traditions. This tradition is dynamic, substantive, and distinct living knowledge.

Traditional knowledge, in combination with other information sources is valuable in achieving a better understanding of potential impacts of projects. Traditional knowledge may, for example, contribute to the description of the existing physical, biological and human environments, natural cycles, resource distribution and abundance, long and short-term trends, and the use of lands and land and water resources. It may also contribute to project siting and design, identification of issues, the evaluation of potential effects, and their significance, the effectiveness of proposed mitigation, cumulative effects and the consideration of follow-up and monitoring programs.

Certain issues relevant to the review process are firmly grounded in traditional knowledge, such as harvesting, cultural well-being, land use, heritage resources, and others. Although the basis for traditional knowledge and science-based knowledge can differ, they may on their own or together, contribute to the understanding of these issues.

The joint review panel will promote and facilitate the contribution of traditional knowledge to the review process. It is recognized that approaches to traditional knowledge, customs and protocols may differ among Aboriginal communities and persons with respect to the use, management and protection of this knowledge. The joint review panel will consider the views of communities and traditional knowledge holders during the joint review process and determine which information should be kept confidential. The proponent must incorporate into the EIS the traditional knowledge to which it has access or that it may reasonably be expected to acquire through appropriate due diligence, in keeping with appropriate ethical standards and without breaching obligations of confidentiality.

Alternatively, the proponent may facilitate the presentation of such knowledge by persons and parties having access to this information to the joint review panel during the course of the review. If requested by an Aboriginal people, the proponent should cooperate with that people to develop a mutually agreed-upon arrangement for the Aboriginal people themselves to provide traditional knowledge throughout the joint review process, either by themselves or in collaboration with the proponent.

2.4 Sustainable Development

Sustainable development seeks to meet the needs of present generations without compromising the ability of future generations to meet their own needs.

Environmental assessment provides a systematic approach for identifying, predicting and evaluating the potential environmental effects of projects before decisions are made. In addition, environmental assessment provides the means to identify mitigation measures for adverse effects. Environmental assessment promotes sustainable development and contributes to decision-making that can ultimately provide net ecological, economic and social benefits to society.

A project that is supportive of sustainable development must strive to integrate the objective of net ecological, economic and social benefits to society in the planning and decision-making process and must incorporate citizen participation. T he project, including its alternative means, must take into account the relations and interactions among the various components of the ecosystems and meeting the needs of the population. The proponent must include in the EIS consideration of the extent to which the Project contributes to sustainable development. In doing so, the proponent must consider, in particular:

- the extent to which biological diversity may be affected by the project; and
- the capacity of renewable resources that are likely to be significantly affected by the Project to meet the needs of present and future generations.

2.5 Precautionary Approach

One of the purposes of environmental assessment is to ensure that projects are considered in a careful and precautionary manner before authorities take action in connection with them, in order to ensure that such projects do not cause significant adverse environmental effects. The precautionary approach recognizes that a lack of full scientific certainty should not be used as a reason to postpone decisions where there is a potential for high level of risk or irreversible harm.

The document “A Framework for the Application of Precaution in Science-based Decision Making About Risk” [Reference 1] sets out guiding principles for the application of precaution to science-based decision making. The framework aids the decision-maker to assess whether precautionary decision-making is in keeping with Canadians’ social, environmental and economic values and priorities.

The proponent must indicate how the precautionary principle was considered in the design of the Project in at least the following ways:

- demonstrate that all aspects of the project have been examined and planned in a careful and precautionary manner in order to ensure that they do not cause serious or irreversible damage to the environment and/or the health of current or future human generations;
- outline and justify the assumptions made about the effects of all aspects of the project and the approaches to minimize these effects;
- evaluate and compare alternative means of carrying out the Project in light of risk avoidance, adaptive management capacity and preparation for surprise;
- demonstrate that in designing and operating the project, priority has been and will be given to strategies that avoid the creation of adverse effects;
- provide that contingency plans explicitly address worst-case scenarios and include risk assessments and evaluations of the degree of uncertainty;
- identify any proposed follow-up and monitoring activities, particularly in areas where scientific uncertainty exists in the prediction of effects; and
- present public views on the acceptability of all of the above.

In doing so, the proponent shall consider the guiding principles set out in the “Framework for the Application of Precaution in Science-based Decision Making About Risk”.

2.6 Study Strategy and Methodology

The proponent is expected to observe the intent of the EIS guidelines and to identify all environmental effects that are likely to arise from the project (including situations not explicitly identified in these guidelines), the mitigation measures that will be applied, and the significance of any residual adverse effects. It is possible that the EIS guidelines include matters that, in the judgement of the proponent, are not relevant or significant to the project. If such matters are omitted from the EIS, they must be clearly identified in the EIS with appropriate justification so that the public and other interested parties have an opportunity to comment on this judgement. Where the joint review panel disagrees with the proponent's decision, it may require the proponent to provide additional information.

The proponent must explain and justify methods used to predict impacts of the project on each valued ecosystem component (VEC), which includes biophysical and socio-economic components, the interactions among these components and on the relations of these components within the environment. The information presented must be substantiated. In particular, the proponent must describe how the VECs were selected and what methods were used to predict and assess the adverse environmental effects of the project on these components. The value of a component not only relates to its role in the ecosystem, but also to the value placed on it by humans. The culture and way of life of the people using the area affected by the project may themselves be considered VECs.

In describing methods, the proponent must document how it used scientific, engineering, traditional and other knowledge to reach its conclusions. Assumptions must be clearly identified and justified. All data, models and studies must be documented such that the analyses are transparent and reproducible. All data collection methods must be specified. The uncertainty, reliability and sensitivity of models used to reach conclusions must be indicated. The sections in the EIS regarding existing environment and potential adverse environmental effects predictions and assessment must be prepared using best available information and methods, to the highest standards in the relevant subject area. All conclusions must be substantiated.

The EIS must identify all significant gaps in knowledge and understanding where they are relevant to key conclusions presented in the EIS. The steps to be taken by the proponent to address these gaps must also be identified. Where the conclusions drawn from scientific and technical knowledge are inconsistent with the conclusions drawn from traditional knowledge, the EIS must contain a balanced presentation of the issues and a statement of the proponent's conclusions.

2.7 Use of Existing Information

In preparing the EIS, the proponent is encouraged to make use of existing information relevant to the project. When relying on existing information to meet the requirements of various sections of the EIS guidelines, the proponent must either include the information directly in the EIS or clearly direct (e.g., through cross-referencing) the joint review panel to where it may obtain the information. When relying on existing information, the proponent must also comment on how representative the data are, clearly separate factual lines of evidence from inference, and state any limitations on the inferences or conclusions that can be drawn from them according to the criteria for information quality set out in section 2.6 of the EIS Guidelines. For instance:

- assumptions must be clearly identified and justified;
- all data, models and studies must be documented such that the analyses are transparent and reproducible;
- the uncertainty, reliability and sensitivity of models used to reach conclusions must be indicated;
- conclusions must be substantiated; and
- the studies must be prepared using best available information and methods, to recognized standards of good practice in the relevant subject area.

3. PRESENTATION OF THE EIS

For clarity and ease of reference, the EIS should be presented in the same order as the EIS guidelines. However, in certain sections of the EIS, the proponent may decide that the information is better presented following a different sequence. The EIS must include a guide that cross-references the EIS guidelines with the EIS so that points raised in the EIS guidelines are easily located in the EIS.

In the interest of brevity, the EIS should make reference to, rather than repeat, information that has already been presented in other sections of the document. A key subject index would also be useful and should reference locations in the text by volume, section and sub-section. The names of the proponent's key personnel and/or contractors and sub-contractors responsible for preparing the EIS must be listed. Supporting documentation can be provided in separate volumes, and referenced by volume, section and page in the text of the EIS. The proponent must submit the EIS and all supporting documents in hard copy and in an electronic format to facilitate internet access and for record keeping and review.

The proponent must present the EIS in the clearest language possible. However, where the complexity of the issues addressed requires the use of technical language, a glossary defining technical words and acronyms must be included. The proponent should provide charts, diagrams and maps wherever useful to clarify the text, including perspective drawings that clearly convey what the developed project site would look like.

Information required to support the application for the Licence to Prepare site must clearly cross-reference the EIS where appropriate.

3.1 Environmental Impact Statement Summary

The proponent must prepare a plain language summary of the EIS that provides the reader with a concise but complete overview of the EIS.

4. SCOPE

The following section outlines the scope of the project and the factors to be assessed.

4.1 Scope of the Project

Pursuant to subsections 15(1)(b) and 15(3)(b) of the *Canadian Environmental Assessment Act*, the Minister of the Environment is proposing that the scope of the project include the site preparation, construction, operation, decommissioning and abandonment of the project components and activities proposed by OPG as described in “OPG New Build Project Environmental Assessment – Project Description” [Reference 2].

The scope of the Darlington NNPP Project includes site preparation, construction, operation, decommissioning and abandonment of up to four new nuclear power reactors for the production of up to 4,800 megawatts of electrical generating capacity for supply to the Ontario grid.

Operations would involve activities required to operate and maintain the Darlington NNPP, including management of all conventional and radioactive wastes. The Province of Ontario is considering a range of reactor designs. It is anticipated that each new reactor constructed would have an approximate 60-year operating life and could include a mid-life refurbishment depending on the reactor design technology chosen by the proponent.

The project includes up to four units, consisting of the following principal components:

- Reactor Building – contains the reactor vessel, fuel handling system, heat transport system, moderator, reactivity control mechanisms, shut down systems and containment; and
- Turbine Generator Powerhouse – contains the turbines, generators and related systems and structures that convert steam from the operation into electrical energy.

The project also includes the following shared facilities between reactors:

- Condenser Cooling Systems and Structures: including cooling towers or the once-through cooling system with all of its associated submerged intake, forebay and discharge systems;
- Low and Intermediate Level Waste Management Facility (on or off-site); and
- Expansion of the existing Darlington Waste Management Facility for storage of used nuclear fuel or construction of a new facility.

Ancillary activities that may be required include the transportation of low and intermediate level waste to be managed offsite at an appropriate licensed facility. The following describes activities expected to be undertaken:

Preparation Phase:

Site preparation includes the following activities needed to construct the new nuclear reactors and associated physical works listed above:

- construction and enhancing of on-site roads, which would connect to local roads and provincial highway 401 as appropriate, to provide access to the site;
- re-establishment of a rail line spur if required;
- construction of a wharf if required;
- construction of parking lots and laydown areas;
- construction site fencing;
- removal of existing trees and vegetation if necessary;

- shoreline stabilization and lake infilling, coffer dam construction;
- realigning intermittent stream channels and draining some wet areas across site;
- earthmoving activities including cutting, filling, grading construction areas, creating berms and stockpiles;
- installation of necessary infrastructure such as power, water main, sewage systems, surface water drainage, storm water sewers; and
- bedrock excavation for foundations.

Construction:

Construction includes the following activities needed to construct the new nuclear reactors and associated physical works listed above:

- installation of bedrock piles;
- expansion of the switchyard;
- receipt and management of materials and components for installation;
- installation of the intake and outfall to Lake Ontario;
- construction of cooling towers if required;
- construction of the reactors, power house buildings, structures, and systems;
- removal of construction debris to a licensed facility, including any hazardous waste created during construction;
- testing and commissioning of systems and structures;
- landscaping; and
- final site fencing and security system installation.

Operation and Maintenance Phase:

The operation phase includes all of the work and activities that occur during routine operation and maintenance of the new nuclear reactors and associated buildings, structures and systems. This phase consists of the 60-year timeframe over which the nuclear power station is expected to generate electricity.

Commissioning a new nuclear power plant consists of the following general activities: verification and qualification of systems, pressure testing of vessels, fuelling of reactor; pressure testing of containment building, approach to criticality, approach to full power; testing of the reactor core physics, verification of control systems, connection to the grid, operational testing and full power operation. Some commissioning activities, specifically those that take place without fuel in the reactor core, may be authorized during the construction phase.

Following commissioning, the activities to be undertaken include the operation and maintenance of plant systems including nuclear steam supply systems, turbine generator and feedwater systems, electrical power systems, nuclear safety systems, ancillary systems, systems for maintaining facility security, activities associated with the maintenance program, materials handling systems, solid waste handling systems and administration and support systems.

Operation and maintenance activities can be categorized as follows:

- operation of equipment for production of electricity;
- verification, sampling, testing and maintenance during operation at power;
- maintenance, repairs, cleaning, and decontamination during planned shutdowns and outages;
- on-site transportation and handling of fuel, including defuelling and refuelling of the reactor;
- management of low and intermediate waste and spent fuel waste within the reactor building, and the transfer of wastes and used fuel for interim or long-term storage;
- management of hazardous substances and hazardous waste; and activities relating to environmental protection and radiation protection programs; and
- activities required to achieve a safe state of closure prior to decommissioning.

During this phase, the assessment would include consideration of the effects associated with mid-life refurbishment for CANDU-type reactors as well as the effects relating to outages to refuel or refurbish boiling water and pressurized water-type reactors.

Decommissioning and Abandonment Phase:

Decommissioning activities will commence after the last reactor has permanently ceased operation, all the fuel has been transferred out of the reactor to storage, and the reactor drained and dried. Decommissioning will then begin with a period of safe storage activities to allow the radioactivity of reactor components to decrease. Decommissioning may commence with a period of safe storage activities to allow the radioactivity of reactor components to decrease. Decommissioning activities can be conceptually summarized as follows: transfer of fuel and associated wastes to interim storage; decontamination of plant; flush purging of equipment and systems; removal of surface decontamination of facilities or equipment; dismantling and removal of equipment and systems; demolition of building; and site restoration.

Few activities are expected to be carried out for the abandonment phase of the project, since the purpose of this phase is to move from the achieved “end-state” of the decommissioning phase to the abandonment phase, which is basically an “unlicensed state”. The activities related to this phase are basically to provide the results of the decommissioning and the results of the environmental monitoring programs to demonstrate that the “site” can be made available for re-use and will no longer be under CNSC regulatory oversight.

4.2 Factors to be considered in the EIS

The Minister of the Environment is proposing that the following factors be considered in the EIS in order to adequately understand and assess the potential effects of the project.

a. the environmental effects of the project, including the environmental effects of malfunctions, accidents or malevolent acts that may occur in connection with the project and any cumulative environmental effects that are likely to result from the project in combination with other projects or activities that have been or will be carried out;
b. the significance of the effects referred to in (a);
c. comments that are received during the environmental assessment;
d. measures that are technically and economically feasible and that would mitigate any significant adverse environmental effects of the project;
e. purpose of the project;
f. need for the project;
g. alternatives to the project;
h. alternative means of carrying out the project that are technically and economically feasible and the environmental effects of any such alternative means;
i. measures to enhance any beneficial environmental effects
j. the requirements of a follow-up program in respect of the project;
k. the capacity of renewable resources that are likely to be significantly affected by the project to meet the needs of the present and those of the future; and
l. consideration of community knowledge and Aboriginal traditional knowledge.

PART II – CONTENT OF THE EIS

Part II of the EIS guidelines provides specific instructions for the content of each section in the EIS. The EIS as a whole must reflect the Guiding Principles in Section 2.

5. CONTEXT

This section must orient the reader to the EIS by briefly introducing the geographic setting, the project, the underlying rationale for the project, the proponent, the federal joint review panel process and the content and format of the EIS.

5.1 Setting

This section must provide a concise description of the geographic setting in which the project is proposed to be constructed, describing its proximity to Lake Ontario, any parks or ecologically significant areas, and the Municipality of Clarington. This section must also outline current use of lands, waters and resources, including those used for traditional purposes by Aboriginal persons that may be affected by the project and those lands, waters and resources related to established or asserted Aboriginal rights. Maps at appropriate scales to illustrate the regional setting must be included. The description must be focused on those aspects of the environment important for understanding the potential environmental effects of the Project. A brief description of current regional land and water uses is required to integrate the natural and human elements of the environment in order to explain the interrelationships between the physical and biological aspects and the people and their communities.

5.2 Project Overview and Purpose

The proponent will briefly summarize the Project, its purpose, location, scale, components, activities, scheduling and costs. A more detailed description of the project is provided for in Section 8.

5.3 Proponent

This section must introduce readers to OPG with summary information on the nature of the management structure and organizational accountability for the:

- design, construction, operation and modification, and decommissioning of the project;
- implementation of environmental mitigation measures and environmental monitoring; and
- management of potential adverse environmental effects.

5.4 Environmental Assessment and Regulatory Process and Approvals

For the purposes of the environmental assessment, the proponent must:

- identify the planning context for the environmental assessment of the project;
- discuss government policies, regulations, and land use plans that have a bearing on the project;
- identify the requirements for the environmental assessment under the *Canadian Environmental Assessment Act*, the *Nuclear Safety and Control Act* and Regulations, the *Fisheries Act* and the *Navigable Waters Protection Act*;
- summarize and discuss the approach, including the role of regulatory bodies, to ensure compliance with existing federal and provincial environmental legislation such as the *Nuclear Safety and Control Act*, *Migratory Birds Convention Act*, *Fisheries Act*, *Species at Risk Act*, *Canadian Environmental Protection Act, 1999*, the *Lakes and Rivers Improvement Act* and the *Endangered Species Act*;
- summarize the main steps in the environmental assessment process and the main approvals required to undertake the project; and
- describe the role of the EIS in the overall environmental assessment and regulatory process.

The joint review panel will also be collecting information and evidence to support OPG's application for a Licence to Prepare Site for a Class 1 Nuclear Facility, in accordance with the *Nuclear Safety and Control Act* and its regulations. These requirements are described in Appendix 2 of these guidelines.

5.5 International Agreements

The proponent must summarize and discuss in the EIS the implications of any applicable international agreements, designations, or action plans, their implications and relationships to the planning and regulatory processes described in Section 5.4, and how they may influence the project or its environmental effects.

The location of the facility on the shores of a transboundary watershed requires specific attention be paid to the *Canada-U.S. Air Quality Agreement*, the *Great Lakes Water Quality Agreement* and other such binational treaties and agreements.

6. PUBLIC PARTICIPATION

Involvement of Aboriginal peoples, government agencies, non-governmental organizations, and other interested parties is a central objective of the overall review process. In preparing the EIS, the proponent must demonstrate how it has engaged (i.e., shared information with, and gathered input from) interested parties that may be affected or have an interest in the project, in keeping with the Guiding Principles in Section 2 of the Guidelines. The following key issues must be summarized in the EIS:

- the types of support provided to communities, organizations and individuals involved in the public participation process.
- the role of public engagement in identifying VECs, issues, effect prediction and mitigation.

- an explanation of how the results of that engagement influenced the design of the project; and
- a description of the principles and methods that will be employed to provide information to, obtain input from or otherwise engage communities and groups regarding the project activities over the lifespan of the project.

6.1 Aboriginal People

The EIS must describe the proponent's involvement of any Aboriginal people that may be affected by the project, especially those Aboriginal people claiming Aboriginal rights, title or established treaty rights at the location or in the vicinity of the project.

This description must include a summary of the history of the proponent's relationship with Aboriginal people with respect to the OPG Darlington Nuclear Site in general and the project in specific. The EIS must describe the objectives of and the methods used for Aboriginal group engagement, issues or concerns raised through such engagement and any details not otherwise subject to confidentiality agreements, including a summary of the discussions, paper and electronic correspondence and meetings held. Details may include date and time, agenda, summary of discussions and a description of how the proponent has addressed the issues or concerns raised by Aboriginal people.

6.2 Government Agencies

The EIS must describe the proponent's involvement of provincial and federal government ministries, departments or agencies and local governments which should include the Municipality of Clarington and other communities in Durham Region, Peterborough County, Simcoe County and Northumberland County as appropriate. The EIS must describe the objectives of such engagements, the methods used, issues raised during such engagements and the ways in which the proponent has addressed these issues.

6.3 Stakeholders

The EIS must describe the proponent's involvement of stakeholders (e.g., local businesses, neighbouring residences, cottagers, outdoor recreational interests and environmental non-government organizations). The EIS must describe the objectives of such engagement, the methods used, the issues raised and the ways in which the proponent has addressed these issues.

6.4 Other Public Participation

The EIS must describe any other public engagement undertaken by the proponent prior to submitting the EIS. The *Canadian Environmental Assessment Act* does not exclude the public outside of Canada, thus the EIS should describe any public participation opportunities for non-Canadians. This description must identify the objectives of such engagement, outline the methods used, and summarize the issues raised by the public, and the ways in which the proponent has addressed these issues.

7. PROJECT JUSTIFICATION

7.1 Purpose and Need for the Project

The proponent must clearly describe the need for the proposed new nuclear power plant. This description must define the problem or opportunity the project is intending to solve or satisfy and should establish the fundamental justification or rationale for the project.

The proponent must describe the purpose of the project by defining what is to be achieved by carrying out the project.

The "need for" and "purpose of" the project should be established from the perspective of the project proponent and provide the context for the consideration of alternatives in Sections 7.2 and 7.3 below.

7.2 Alternatives to the Project

An analysis of alternatives to the project must describe functionally different ways to meet the project's need and achieve the project's purpose from the perspective of the proponent. This section must therefore identify and discuss other technically and economically feasible methods of producing electricity other than the construction and operation of the OPG Darlington NNPP that are within the control and/or interests of OPG. As an assessment of provincial energy policy is not within the terms of reference of this joint review panel, the alternatives to the project need not include alternatives that are contrary to Ontario's formal plans or directives. However, the EIS must explain where this rationale has been applied to exclude consideration of possible alternatives to the project.

For each identified alternative to the Darlington NNPP that are within the control and/or interests of OPG, this section of the EIS must explain how the proponent developed the criteria to identify the major environmental, economic and technical costs and benefits of those alternatives, and how the proponent identified the preferred project based on the relative consideration of the environmental, economic and technical benefits and costs. This must be done to a level of detail which is sufficient to allow the joint review panel and the public to compare the project with its alternatives.

7.3 Alternative Means of Carrying out the Project

The EIS must identify and describe alternative means to carry out the project that are, from the perspective of the proponent, technically and economically feasible. The EIS must also describe the environmental effects of each alternative means. In describing the preferred means, the EIS should identify the relative consideration of environmental effects, and technical and economic feasibility. The criteria used to identify alternative means as unacceptable, and how these criteria were applied, must be described, as must the criteria used to examine the environmental effects of each remaining alternative means to identify the preferred alternative.

To the extent that these alternative means are feasible for the proponent, this may include the following:

- siting of new nuclear reactors in different locations within the existing site;
- siting of new nuclear reactors in locations outside the existing site;
- switchyard design;
- reactor design technology, taking into consideration megawatt electrical MWe output, moderator, coolant, and fuel enrichment;
- condenser cooling water system (cooling towers or intake/discharge of lake water through underwater tunnels, including direct and indirect once-through systems and recirculating systems consisting of wet, dry or hybrid system cooling towers with natural or mechanical air circulation);
- waste management strategies for low and intermediate level radioactive waste and used fuel; and
- timing options for various components and phases of the project.

8. DESCRIPTION OF THE PROJECT

The project description must address all phases of the project, within the scope outlined in Section 4, in sufficient detail to allow the assessment of potential adverse environmental effects and take into account public concerns about the project. The proponent must describe the project as it is planned to proceed from site preparation through to construction, operation and maintenance (including any potential modifications or refurbishment that may be required during operation), decommissioning and abandonment. The description must include a timeline for all phases of the project, including preliminary decommissioning and abandonment plans. Where specific codes of practice, guidelines and policies apply to items to be addressed, those documents must be cited and may be included as appendices to the EIS.

The following information addressing the construction and operational phases of the project must be provided in summary form; where applicable, reference may be made to more detailed information.

8.1 General Information and Design Characteristics

Information to be provided in the EIS must include:

- location of the project;
- general description of all reactor design technologies being considered, including associated buildings and infrastructure;
- process and timetable for tender, selection and construction of the proposed reactor, and anticipated operational life;
- detailed siting requirements for the proposed new reactors, including any relevant criteria endorsed by the CNSC, and whether the chosen site meets the criteria of CNSC Regulatory Document RD-346 “Site Evaluation for New Nuclear

Reactors” [Reference 3] and consideration of the applicability of any local, regional and provincial land use or urban development policies, programs and plans to the proposal;

- description of the physical requirements for the proposal, including existing and proposed exclusion zones and the protective zone, general reactor requirements, including for health and safety, nuclear safeguards and security, supply of fuel, spent fuel management and waste management and infrastructure requirements, including roads and car parking, other buildings, water service, wastewater services, electricity, gas, and telecommunications;
- specific locations of proposed reactors and of associated buildings and infrastructure;
- infrastructure requirements and facilities for the site preparation, construction, operation and maintenance of the proposed facility; and
- a description of the relevant organizational and management structure, and staff qualification requirements with emphasis on safety and environmental management programs.

For each reactor design being considered, include information on the:

- basic configuration, layout, shape, size, design and operation of the facility;
- performance specifications, design philosophy, reactor type, plant configuration, and all structures, systems and components important to safety;
- safety characteristics;
- planned operational life;
- description of any special commissioning or 'start-up' procedures and requirements;
- requirements for refurbishment;
- ageing and wear issues and management of these issues, where relevant to future environmental performance and reliability;
- physical security systems (excluding prescribed information), designed specifically to isolate the project from the surrounding environment, or to prevent, halt or mitigate the progress or results of malfunctions, accidents or malevolent acts;
- engineered and administrative controls, including the use of an approved margin of sub-criticality for safety, which assure that the entire (out of reactor) process will be sub-critical under normal conditions and credible abnormal conditions – accidents or accident sequences – that have a frequency of occurrence equal to or more than one in a million years;
- stored inventories of radioactive and other hazardous materials, including locations and storage methods, and criticality control plans;
- sources, types and quantities of radioactive and non-radioactive waste, including hazardous waste, predicted to be generated;

- processes and facilities for the management of radioactive and non-radioactive waste, including low, intermediate and spent fuel waste, conventional, sanitary and hazardous wastes, to be generated by the project, including processes such as collection, handling, storage and transportation;
- sources and characteristics of any fire hazards;
- sources and characteristics of any noise, odour, dust and other likely nuisance effects from the project; and
- sources and characteristics of any potential risks (including radiological risks) to workers, the public or the environment from the project.

8.2 Site Preparation

The EIS must include a description of permanent or temporary structures that will be constructed to support site preparation. Details of general construction practices, hours of operation and proposed construction schedules should also be provided.

Under the *Nuclear Safety and Control Act's Class I Nuclear Facilities Regulations*, a Licence to Prepare Site does not permit physical work activities directly related to construction of nuclear power plant structures, systems and components. Subject to this limitation, the EIS should describe the site preparation phase of the project for the following physical works and associated physical activities:

- clearing of vegetation, grubbing, stripping of top soil, grading;
- excavating, drilling and blasting;
- installing of site services including fencing, exterior lighting and security systems, construction roadways, parking lots and of an area for the management of construction waste;
- installing coffer dams, dewatering, blasting and infilling part of Lake Ontario including the placement of fill and identification of the types of fill proposed for the infilling and shoreline stabilization;
- constructing the docking facility;
- trenching for the installation of service pipelines;
- installing temporary construction support facilities (warehouses, concrete mixing plants);
- developing on-site facilities for the storage and management of construction waste;
- topsoil and overburden storage areas;
- site access roads (including gradient) and linkages to public roadways;
- storage areas for hazardous substances and hazardous waste;
- watercourse crossings and diversions, including wetland alteration;
- visual effect management (e.g., landscaping, screening mounds and plantings, use of existing features, photographic records);
- managing potentially contaminated groundwater produced during excavations and surface runoff management;

- description of any work that will be undertaken outside of normal working hours, including a description of the nature of work and of the machinery that will be required;
- size of construction workforce;
- extent of earthmoving, building demolition/relocation, vegetation clearance and other site preparatory works, including arrangements to minimise unnecessary clearance and disturbance;
- construction standards, techniques and site management arrangements, including for on-site storage and handling of construction and other (e.g., fuel, oil) materials;
- arrangements for disposal of construction wastes during and following site preparation;
- arrangements for storm water and erosion / sedimentation control; and
- risk management (e.g., contingency plans for uncontrolled release of substances, emergency response plans).

To enable consideration of OPG's Application for a Licence to Prepare Site by the joint review panel, the proponent must also provide information in accordance with the *Nuclear Safety and Control Act* and *Regulations* in support of that application. These requirements are listed in Appendix 2 of these guidelines.

8.3 Construction

The proponent must describe all activities to be undertaken during this phase of the project, including timing of work program, duration of construction phase, including lead times, which may include:

- blasting/dredging and redistribution or removal of substrate material associated with construction of the intake/discharge tunnels;
- installation of pilings;
- construction of the switchyard;
- construction of cooling towers;
- noise and dust generation;
- disposal of construction wastes during and following construction;
- arrangements for storm water and erosion / sedimentation control and other environmental protection activities;
- continued installation of site services including plant security fencing and security systems;
- installation of towers and transmission lines between the power block and the switchyard and between the switchyard and the provincial grid system and other associated switchyard gear;

- transportation by road or water of building construction materials and associated installation of plant internal components (e.g., reactor components, steam generators, steam supply piping, turbines, electrical power systems, fire protection system, water piping, sewage handling and treatment equipment, lighting); and
- post-construction site rehabilitation.

This description must include the following:

- an identification of any work that will be undertaken outside of normal construction hours, including a description of the nature of work and of the machinery that will be required;
- the size of construction workforce;
- the extent of earthmoving, building demolition/relocation, vegetation clearance and other site preparatory works, including arrangements to minimise unnecessary clearance and disturbance; and
- the application of construction standards, techniques and site management arrangements, including for on-site storage and handling of construction and other (e.g., fuel, oil) materials.

8.4 Operation and Maintenance

The proponent should describe all activities to be undertaken within this phase of the project, including commissioning activities, approach to full power and planned maintenance outages. Material management plans must also be described, including issues relating to transportation such as mode and route of transport, type of material and quantities to be transported.

Description of the operation and maintenance phase and timeframe of the project and of the associated activities should include, but are not limited to:

- the commissioning activities such as general verification of equipment and systems, fuelling of reactor;
- pressure testing of containment building, approach to criticality and eventually to full power and connection to the grid;
- the operation and maintenance activities required for systems such as the nuclear steam supply system, turbine generator and feed water systems, cooling water systems, electrical power systems, nuclear safety systems, ancillary systems, systems for operating and maintaining facility security, activities associated with the maintenance program, materials handling systems, solid waste handling systems and administration and support systems;
- activities associated with mid-life refurbishment for CANDU-type reactors as well as activities relating to outages to refuel or for the refurbishment of light water reactors;
- operation of equipment for production of electricity;

- verification, sampling, testing and maintenance during operation at power;
- maintenance, repairs, cleaning, and decontamination during planned shutdowns and outages;
- fuelling and refuelling of the reactor; management of low and intermediate waste and used fuel, including transfer to interim or long-term waste storage facilities;
- past events that are relevant to the assessment of future environmental performance and reliability:
- the sources, quantities and points of release from routine radiological and non-radiological emissions and effluents, including thermal (heat) releases;
- the area of exposure to the physical effects of the discharge jet and intake suction;
- where applicable, characterization of the waste, including estimated activity in becquerels, that will be generated and stored at each of the waste management areas as a result of operation and any future refurbishment;
- predictions of future emissions and effluents from the project under normal operating conditions;
- standard design features and key operational procedures relevant to protection of workers, the public and the environment relating to the project, including the nuclear criticality safety program;
- operations workforce, composition of workforce and any infrastructure requirements;
- systems for operating and maintaining the facility security program;
- emission and effluent control, treatment and monitoring and environmental monitoring;
- non-radioactive waste handling, storage and disposal; and
- activities relating to environmental protection and radiation protection.

The end of operational activities to achieve a safe state of closure prior to decommissioning should include, but are not limited to:

- removal of fuel from reactor; and
- draining and drying of reactor

8.5 Modifications

The proponent must describe the management approach to, and conceptual plans for, potential modifications to the project, including expansion or early discontinuation. The proponent must specify the conditions or potential risks which would necessitate modifications to the project. The proposed process to follow when proposing modifications to the project should be described and include a description of plans for informing the public.

8.6 Decommissioning and Abandonment

A preliminary decommissioning plan for the facility must be included in the EIS. The proponent should refer to CNSC Guide G-219, "Decommissioning Planning for Licensed Activities" [Reference 4] for more details.

The discussion should identify the preferred decommissioning strategy, including a justification of why this is the preferred strategy. It must also include end-state objectives, the major decontamination, disassembly and remediation steps; the approximate quantities and types of waste generated; and an overview of the principal hazards and protection strategies envisioned for decommissioning.

The description of decommissioning activities (e.g., planning envelopes and work plans) can be provided at a conceptual level, but this description must include:

- transfer of fuel and associated wastes to interim or long-term licensed storage facilities;
- security measures for alerting against sabotage to hazardous radioactive waste during interim or long term storage
- any flushing/purging of equipment and systems;
- removal of surface decontamination from facilities or equipment;
- dismantling and removal of equipment and systems:
- demolition of buildings;
- management and disposal of conventional, radioactive and other hazardous waste arising from decommissioning; and,
- remediation and restoration of the site.

8.7 Waste and Used Fuel Management

In addition to the project-phase specific requirements for waste provided in the preceding subsections, the EIS must present the proponent's proposed plan for the disposition of all radioactive and hazardous wastes and used fuel. The proponent's activities related to the site preparation, construction, operation, decommissioning and abandonment of low and intermediate level waste management facilities, and used fuel storage facilities, must be described. Where this plan identifies that radioactive or hazardous wastes or used fuel are expected to be managed by an organization other than the proponent, the EIS must describe at a conceptual level the methods that can be used to ensure that these materials are managed in a manner the protects health, safety and the environment.

8.8 Malfunctions, Accidents and Malevolent Acts

Information on accidents and malfunctions, including intentional malevolent acts are necessary to permit consideration of relevant environmental effects in the environmental assessment. A summary of information on malfunctions and accidents should be presented in this section of the EIS. A separate section of the EIS should provide more details regarding the information requirements relating to accidents, malfunctions and malevolent acts as per Section 12.0 of these guidelines.

8.9 Environmental Protection, Policies and Procedures

Paragraph 3(g) of the Class I Nuclear Facilities Regulations stipulates that application for a Licence to Prepare Site shall contain the proposed environmental protection policies and procedures. CNSC Regulatory Standard S-296, “Environmental Protection Policies, Programs and Procedures at Class I Nuclear Facilities and Uranium Mines and Mills” (March 2006) [Reference 5] and Regulatory Guide G-296, “Developing Environmental Protection Policies, Programs and Procedures at Class I Nuclear Facilities and Uranium Mines and Mills” (March 2006) [Reference 6] provide more information regarding these requirements. The fundamental direction of these regulatory documents is towards the establishment, implementation and maintenance of an Environmental Management System (EMS) by the proponent that meets the requirements of ISO 14001-2004 “Environmental Management Systems –Requirements with Guidance for Use” in the context of Canadian environmental protection policy and regulation and the specific environmental protection requirements of the *Nuclear Safety and Control Act* and its regulations.

The proponent must therefore submit its proposed environmental protection policies and procedures (i.e., EMS documentation) and demonstrate that the EMS will carry forward the results of the environmental assessment so that it covers the Site Preparation, Construction and Operational phases of the project. The EIS should describe how the mitigation measures described through Sections 11 through 14 of this document, and the Follow-up Program described in Section 15 of this document would be integrated into the EMS.

9. ENVIRONMENTAL ASSESSMENT BOUNDARIES

Scoping establishes the boundaries of the environmental assessment and focuses the assessment on relevant issues and concerns. By defining the spatial and temporal boundaries, a frame of reference for identifying and assessing the environmental effects associated with the OPG Darlington NNPP Project will be established. Different boundaries may be appropriate for each VEC.

A description of the boundaries of the proposed project in a regional context showing existing and planned future land use, current infrastructure and proposed improvements to these infrastructure, including transportation (all modes), power distribution corridors and lines, urban areas and water supplies (individual and community), must be provided. A description of any traditional land use any established or asserted Aboriginal rights, Aboriginal title or treaty rights from Aboriginal people within the wider regional context should be provided. Sensitive areas including wetlands, critical habitats as defined under the *Species at Risk Act* and archaeological sites found within the regional context must also be described.

9.1 Spatial Boundaries and Scale

In determining the spatial boundaries to be used in assessing the potential adverse and beneficial environmental effects, the proponent must consider, but not be limited to, the following criteria:

a. the physical extent of the proposed project, including any offsite facilities or activities;
b. the extent of aquatic and terrestrial ecosystems potentially affected by the project;
c. the extent of potential effects arising from noise, light and atmospheric emissions;
d. the extent to which traditional land use, asserted or established Aboriginal rights, Aboriginal title or treaty rights could potentially be affected by the project;
e. lands used for residential, commercial, industrial, recreational, cultural, and aesthetic purposes by communities whose areas include the physical extent of the project; and
f. the size, nature and location of past, present and reasonably foreseeable projects and activities which could interact with items b), c), d) and e).

These boundaries must also indicate the range of appropriate scales at which particular baseline descriptions and the assessment of environmental effects are presented. The proponent is not required to provide a comprehensive baseline description of the environment at each scale, but must provide sufficient detail to address the relevant environmental effects of the project and the alternative means. The EIS must contain a justification and rationale for all boundaries and scales chosen.

The geographic study areas for the EIS must encompass the areas of the environment that can reasonably be expected to be affected by the project, or which may be relevant to the assessment of cumulative environmental effects. Study areas must encompass all relevant components of the environment, including people, non-human biota, land, water, air and other aspects of the natural and human environment, notably, current use of land and resources by Aboriginal persons for traditional purposes. Study boundaries must be defined taking into account traditional knowledge, ecological, technical, social and political considerations.

The following geographic study areas should serve as the basis developing project- and effect-specific study areas:

- *Site Study Area:* the Site Study Area includes the facilities, buildings and infrastructure at the OPG Nuclear Site, including the existing licensed exclusion zone for the site on land and within Lake Ontario, and particularly the property where the OPG Darlington NNPP is proposed.
- *Local Study Area*: the Local Study Area is defined as that area existing outside the Site Study Area boundary, where there is a reasonable potential for direct effects on the environment from any phase of the project, either through normal activities or from possible accidents, malfunctions or malevolent acts. The Local Study Area should include all of the OPG Nuclear Site and the lands within the

Municipality of Clarington closest to it, as well as the area of Lake Ontario adjacent to the facility. The boundaries must change if appropriate following an assessment of the spatial extent of potential effects.

- *Regional Study Area*: the Regional Study Area is defined as the area within which there is the potential for cumulative biophysical and socio-economic effects. This area includes lands, communities and portions of Lake Ontario around the OPG Nuclear Site that may be relevant to the assessment of any wider-spread direct and indirect effects of the project.

9.2 Temporal Boundaries

In characterizing the environmental effects of the project, the proponent must consider the current baseline environment and environmental trends within the study area. The description of the existing baseline and the environmental trends should include a consideration of past projects and activities carried out by the proponent and/or others within the regional study area.

In describing and predicting the environmental effects of the project, the proponent must cover the period from the start of any site preparation activity associated with the project through construction, operation, including maintenance and repairs, and refurbishment, where applicable, and eventual decommissioning and abandonment.

In assessing cumulative environmental effects within the study area, the proponent must consider the effects of the project in combination with other past, present and future projects that are either "certain" or "reasonably foreseeable" as defined in CEAA's "Addressing Cumulative Environmental Effects under the Canadian Environmental Assessment Act" [Reference 7].

As is the case for the determination of spatial boundaries, the temporal boundaries must indicate the range of appropriate scales at which particular baseline descriptions and the assessment of environmental effects are presented.
At a minimum, the assessment must include the period of time during which the maximum effect is predicted to occur. "Maximum" refers to the greatest change from baseline conditions to what is predicted and should be bounding across reactor types. The approach taken to determine the temporal boundary of assessment should take into account the following elements:

- hazardous lifetime of the contaminants, including those associated with waste and used fuel, or with releases to the environment during both normal operation and postulated accidents, malfunctions and malevolent acts;
- duration of the operational period;
- design life of engineered barriers;
- duration of both active and passive institutional controls; and
- frequency and duration of natural events and human-induced environmental changes (e.g., seismic occurrence, flood, drought, glaciation, climate change).

9.3 Valued Ecosystem Components

The EIS must describe the general criteria used to identify VECs that may be affected by the project. The EIS must identify the methods used to predict and assess the effects of the project on VECs, and explain the criteria used to assign significance ratings to any predicted adverse effects. The spatial and temporal boundaries used in the assessment may vary as appropriate, depending on the VEC.

Table 1 presents a preliminary list of VECs for each environmental component of the assessment. This list of VECs should be modified as appropriate by the proponent in the EIS, following consultations with the public, Aboriginal people, federal and provincial government departments and relevant stakeholders.

Table 1: Preliminary List of Valued Ecosystem Components by Environmental Component

Environmental Component	VEC	VEC Category
Aquatic Biota/Fish Community	Alewife	Biological
	Lake Trout	Biological
	American Eel	Biological
	White Sucker	Biological
	Round Whitefish	Biological
	Emerald Shiner	Biological
	Benthic Invertebrates (crayfish)	Biological
Aquatic Habitat	Lake Ontario near shore	Physical
	On site aquatic habitat	Physical
Surface Water Environment	Lake water circulation	Physical
	Lake water temperature	Physical
	Lake water quality	Physical
	Lake shoreline processes	Physical
Atmospheric Environment	Air – particulates	Physical
	Air – chemicals	Physical
	Noise	Physical
Geology and Hydrogeology	Shallow groundwater quantity and quality	Physical
	Deep groundwater quantity and quality	Physical
	Soil	Physical
Vegetation and Habitat	Shrub bluff	
	• Grass of Parnassus	Biological
	• Buffalo Berry	Biological
	Wetlands	
	• Bur-reed	Biological
	• Pond Weed	Biological
	Woodlands	

Environmental Component	VEC	VEC Category
	• Cedar	Biological
	• Sugar Maple	Biological
	Migratory bird habitat	
	• Area of woodland habitat	Biological
	Winter raptor feeding and roosting area	
	• Area of meadow	Biological
	• Area of cedar thicket	Biological
Birds	Breeding birds	
	• Yellow Warbler	Biological
	• American Robin	Biological
	Waterfowl	
	• Bufflehead	Biological
	• Mallard	Biological
	Bank Swallow colony	
	• Bank Swallow nest holes	Biological
Amphibians	Amphibians	
	• Northern Leopard Frog	Biological
	• Green Frog	Biological
	• American Toad	Biological
Mammals	Terrestrial mammals	
	• Meadow Vole	Biological
	• Eastern Cottontail	Biological
	• Short-tailed Weasel	Biological
	• Red Fox	Biological
	Aquatic mammals	
	• Muskrat	Biological
Land Use and Visual Setting	Planned land use	Human/Socio-economic
	Land use and development opportunities off-site	Human/Socio-economic
	Nuclear emergency infrastructure /plans & procedures	Human/Socio-economic
	Nuclear emergency infrastructure/equipment	Human/Socio-economic
	Physical features related to the property	Human/Socio-economic
	Major viewpoints	Human/Socio-economic
	Visibility from highway	Human/Socio-economic
	Shoreline visual aesthetics	Human/Socio-economic
Transportation	Road traffic volumes and safety	Human/Socio-economic
	Road system operational efficiency	Human/Socio-economic
	Rail traffic volumes and safety	Human/Socio-economic

Environmental Component	VEC	VEC Category
	Rail system operational efficiency	Human/Socio-economic
	Marine traffic volumes and safety	Human/Socio-economic
	Marine system operational efficiency	Human/Socio-economic
Physical and Cultural Heritage Resources	Aboriginal structural remains or subsurface features	Human/Socio-economic
	Resources from the pre-historic era (11,000 B.C. to A.D. 1680)	Human/Socio-economic
	Aboriginal artifacts	Human/Socio-economic
	Historic architecture or structural remains	Human/Socio-economic
	Historic-period artifacts	Human/Socio-economic
	Resources from the historic period circ (A.D. 1680 to 1900)	Human/Socio-economic
	Historic cemeteries	Human/Socio-economic
	Agricultural landscapes	Human/Socio-economic
Population and Economic Base	Population and demographics	Human/Socio-economic
	Income	Human/Socio-economic
	Employment	Human/Socio-economic
	Business activity	Human/Socio-economic
	Commercially-zoned properties and/or businesses	Human/Socio-economic
	Taxes	Human/Socio-economic
Tourism	Tourism related business	Human/Socio-economic
	Potential for stigma	Human/Socio-economic
	Municipality's vision, strategies, and plans	Human/Socio-economic
Agriculture	Farming activity	Human/Socio-economic
	Availability of agricultural land	Human/Socio-economic
Economic Development	Value of goods and services	Human/Socio-economic
Community Infrastructure	Housing and property values	Human/Socio-economic
	Real property values	Human/Socio-economic
	Municipal infrastructure and services	Human/Socio-economic
	Type and availability of municipal services	Human/Socio-economic
Community Services	Recreational and community features/resource use	Human/Socio-economic
	Community facilities and activities potentially affected by nuisance effects (dust, noise, traffic)	Human/Socio-economic
	Recreational fishing	Human/Socio-economic
	Trails and natural areas	Human/Socio-economic

Environmental Component	VEC	VEC Category
	Educational facilities	Human/Socio-economic
	Educational facilities	Human/Socio-economic
	Educational services and opportunities	Human/Socio-economic
	Health and safety facilities and services	Human/Socio-economic
	Health-related services and facilities	Human/Socio-economic
	Health care facilities and services	Human/Socio-economic
	Social services	Human/Socio-economic
Municipal Finance and Administration	Municipal finance and administration	Human/Socio-economic
	Municipal tax (and other) revenues and expenditures	Human/Socio-economic
Human Health and Radiation and Radioactivity	Members of the public	Human/Socio-economic
	Nearest residents	Human/Socio-economic
	Users of the waterfront trail	Human/Socio-economic
	Users of the soccer fields	Human/Socio-economic
	Users of Darlington Provincial Park	Human/Socio-economic
	Recreational users of surface water (including Lake Ontario)	Human/Socio-economic
	Source drinking water	Human/Socio-economic
	Transportation system safety	Human/Socio-economic
	Workers	Human/Socio-economic
	On-site non-nuclear workers	Human/Socio-economic
	On-site nuclear energy workers	Human/Socio-economic
Residents and Communities	Community character	Human/Socio-economic
	Residency tenure	Human/Socio-economic
	Use and enjoyment of property	Human/Socio-economic
	Potential effects in other environmental components in noise, dust and traffic effects relative to baseline	Human/Socio-economic
Aboriginal Interests	Community characteristics	Human/Socio-economic
	Hunting and fishing for subsistence	Human/Socio-economic
	Fishing, trapping and traditional harvesting and collecting for economic purposes	Human/Socio-economic
	Prehistoric archaeological resources, ceremonial sites, burial mounds or petroglyphs	Human/Socio-economic
	Aboriginal structural remains, artefacts or subsurface features	Human/Socio-economic

10. EXISTING ENVIRONMENT

This section of the EIS must provide a baseline description of the environment, including the components of the existing environment and environmental processes, their interrelations and interactions as well as the variability in these components, processes and interactions over time scales appropriate to this EIS. The proponent's description of the existing environment must be in sufficient detail to permit the identification, assessment and determination of the significance of potentially adverse environmental effects that may be caused by the project, to adequately identify and characterize the beneficial effects of the project, and provide the data necessary to enable effective testing of predictions during the follow-up program.

The baseline description must include characterization of environmental conditions resulting from historical and present activities in the local and regional study area (see Section 13 Cumulative Effects). The EIS must compare baseline data with applicable federal, provincial, municipal or other legislative requirements, standards, guidelines or objectives.

This description must include, but not necessarily be limited to, those VECs, processes, and interactions that either were identified to be of concern during any workshops or meetings held by the proponent, or that the proponent considers likely to be affected by the project. In doing so, the proponent must indicate to whom these concerns are important and the reasons why, including social, economic, recreational, and aesthetic considerations. The proponent must describe the nature and sensitivity of the area within and surrounding the project and any planned or existing land and water use in the area. The proponent must also indicate the specific geographical areas or ecosystems that are of particular concern, and their relation to the broader regional environment and economy. This includes, but is not limited to, a detailed description of those areas of Lake Ontario potentially affected by the project. Relevant information about the VECs is to be presented graphically to document physical and biological (e.g., home range) characteristics.

In describing the physical and biological environment, the proponent must take an ecosystem approach that considers both scientific and traditional knowledge and perspectives regarding ecosystem health and integrity. The proponent must identify and justify the indicators and measures of ecosystem health, social health and integrity it uses. These must be related to project monitoring and follow-up measures.

For the biological environment, baseline data in the form of inventories alone is not sufficient for the joint review panel to assess effects. The proponent must consider the resilience of species populations, communities and their habitats. The proponent must summarize all pertinent historical information on the size and geographic extent of animal populations as well as density. Habitat at regional and local scales should be defined in ecological mapping of aquatic and terrestrial vegetation types and species (e.g., ecological land classification mapping). Habitat use should be characterized by type of use (e.g., spawning, breeding, migration, feeding, nursery, rearing, wintering), frequency and duration. Emphasis must be on those species, communities and processes identified as VECs. However, the interrelations of these components and their relation to the entire ecosystem and communities of which they are a part must be indicated. The proponent must address issues such as habitat, nutrient and chemical cycles, food chains, productivity, to the extent that they are appropriate to understanding the effect of the project on ecosystem health and integrity. Range and probability of natural variation over time must also be considered.

In describing the socio-economic environment, the proponent must provide information on the functioning and health of the socio-economic environment, encompassing a broad range of matters that affect the people and communities in the study area in a way that recognizes interrelationships, system functions and vulnerabilities. A description of the rural and urban settings likely to be affected by the project should be provided.

Information on existing and projected population densities and distributions in the region, including resident populations and transient populations, must be provided by project phase, and for the entire life of the project. Information such as present and future use of land and resources, including transportation infrastructure, public health infrastructure and services (municipal water treatment for domestic use or human consumption, wastewater treatment, landfill), housing and housing values, commercial fisheries in the area, recreation and tourism should also be provided to the extent that this information is required to assess potential adverse effects of the project on human health and socio-economic conditions in the area, and to assess the effects of the environment on the project. The proponent must also describe any agreements with the surrounding municipalities or other jurisdictions regarding emergency plans or protective actions.

Traditional activities carried out by Aboriginal people must be described by the proponent. The proponent should provide information that would include a description of traditional dietary habits and dependence on country foods and harvesting for other purposes, including harvesting of plants for medicinal purposes. The analysis should focus on the identification of potential adverse effects of the project on the ability of future generations of Aboriginal people (up to seven generations) to pursue traditional activities or lifestyle.

If the background data have been extrapolated or otherwise manipulated to depict environmental conditions in the study areas, modeling methods and equations must be described and must include calculations of margins of error and other relevant statistical information, such as confidence intervals and possible sources of error.

The proponent should refer to CNSC Regulatory Document RD-346, “Site Evaluation for New Nuclear Reactors” [Reference 3], for more examples on the type of information which would be required in this section of the EIS.

10.1 Biophysical Environment

10.1.1 Geology and Geomorphology

The EIS must describe the bedrock and quaternary/surficial geology, geomorphology (including coastal processes), topography, petrology, geochemistry, hydrogeology and geomechanics for the region and the area that will be disturbed by the Project. The EIS must also examine the global catalogue of earthquakes in stable continental regions, with specific emphasis on eastern Canada. The EIS must describe the structural geology, such as fractures and faults, at the site and within the local and regional study areas. Geotechnical properties of the overburden must also be provided, including shear strength and liquefaction potential, to allow the assessment of slope stability and bearing capacity of foundations under both static and dynamic conditions. The geological model of all overburden and bedrock units through to the uppermost Precambrian unit should be described for the regional, local and site scales. When extrapolation is required in order to derive these stratigraphic sequences, the degree of uncertainty and the need for additional field investigations to reduce this uncertainty should be discussed.

The EIS must describe and assess any geotechnical and geophysical hazards within the study areas, including consideration of subsidence, uplift, seismicity and faulting, as well as consideration of the possibility of movements of the ground surface (including co-seismic rupture) and earthquake ground motions. The EIS must also assess these hazards by extrapolating the risk of an earthquake near the site from the risk of an earthquake in similar stable continental regions worldwide. Specific information on the effects of past earthquakes on existing nuclear power plants in Canada is to be provided. Where appropriate, the narrative descriptions should be supplemented by illustrations such as maps, figures, cross sections and borehole logs.

10.1.2 Surface Water

This section of the EIS must describe all surface water features, surface water quality, hydrology and sediment quality at the site, local and regional study areas.
The description must include delineation of drainage basins at the appropriate scales and include a description of hydrological data such as water levels and flow rates collected over the years. The proponent must describe hydrological regimes, including seasonal fluctuations and year-to-year variability of all surface waters and assess normal flow, flooding, and drought properties of water bodies as well as the interactions between surface water and groundwater flow systems. The proponent must describe all surface water sources used for drinking water in the area, including source water intakes for drinking water treatment facilities. Coastal geomorphology should be documented including lakefront bluffs, the characteristics of the shoreline, near-shore zone, off-shore zone and coastal currents.

The proponent must adequately document the water quality of all surface water demonstrating the use of appropriate sampling and analytical protocols, for the range of analytical parameters with the potential to be influenced by the project. This information should be presented using tables, maps and figures to provide an appropriate understanding of surface water characteristics and conditions at the site, local and regional scales.

10.1.3 Groundwater

This section of the EIS must describe hydrogeology at the site, local and regional study areas. The description should characterize the physical and geochemical properties of all hydrogeological units in the overburden and the bedrock (from the ground surface down through to the uppermost Precambrian unit). Units should be characterized as aquifers or aquitards, and the description of each unit should include its geochemistry as well as the delineation of vertical and lateral permeabilities and directions of groundwater flow. Groundwater recharge and discharge areas should be identified (including discharge areas in Lake Ontario), and groundwater interactions with surface water should be described in detail.

A conceptual and numerical hydrogeologic model that discusses the hydrostratigraphy and groundwater flow systems should be presented. The assessment must describe anticipated or potential changes to groundwater flow and quality related to any interactions with surface waters.

The EIS must provide a description of baseline ground water quality at the site and local study area. The EIS must also describe local and regional potable groundwater supplies, including their current use and potential for future use.

10.1.4 Terrestrial Environment

This section of the EIS must describe the terrestrial species at the site and within the local and regional study areas, including flora, fauna and their habitat. The EIS must describe any wildlife corridors and physical barriers to movement that exist within the project area. Any biological species of natural conservation status at a federal, provincial, regional or local level and their critical habitats should be identified.

All protected and conservation areas established by federal, provincial and municipal jurisdictions (e.g., wilderness areas, parks, sites of historical or ecological significance, nature reserves, federal migratory bird sanctuaries and wildlife management areas, and municipal protected water supply areas) must be identified.

Sites within the local or regional study area subject to contamination from previous nuclear or non-nuclear industrial activities may require baseline characterization of radionuclide and hazardous substance levels within soil, vegetation and non-human biota.

Field surveys should be described in terms of representativeness of the target populations, the design for allocation of samples in space and time, measurement methods and results.

10.1.5 Aquatic Environment

This section of the EIS must describe the aquatic and wetland species at the site and within the local and regional study areas, including a description of the flora, fauna and their habitat. The proponent should seek from relevant authorities, such as DFO and the

Ontario Ministry of Natural Resources, any available information on aquatic and wetland species and habitat for the local and regional study areas. In addition, the proponent will need to undertake independent studies to gather the necessary information as necessary.

The description of the existing aquatic environment should include observed changes to food chain and food web dynamics as a habitat component as this relates to fish populations as a result of existing operations. In addition, the description should include how these impacts have affected fish movement, migration, spawning and nursery periods on a local and regional level.

The proponent must provide detailed habitat mapping in order to understand habitat usage by fish within the study area. This information must include depth profiles, substrate mapping, water temperature profiles, and a description of potential and known habitat usage (i.e., nursery, rearing, feeding and migratory) by fish that occur in the study areas.

The fish habitat assessment and inventory must include the area below the High Water Mark, as detailed in *DFO Factsheet - Fish Habitat and Determining the High Water Mark*, as this area functions as fish habitat seasonally and in years of higher water levels in Lake Ontario.

The EIS must identify any biological species of natural conservation status (e.g., rare, vulnerable, endangered, threatened, and uncommon) at a federal, provincial, regional or local level and their critical habitats.

A summary of results and interpretation must be provided for the on-going monitoring of entrainment and impingement of aquatic biota at the existing stations.

10.1.6 Ambient Radioactivity

The EIS must describe the ambient radiological conditions at the site and within the local and regional study areas. The EIS must provide information on the existing conditions in this regard, including an inventory of sources, their activity levels, and their origin (natural or anthropogenic), for all environmental media including air, soil, food, water, aquatic sediments, plant and animal tissue in the appropriate subsections of the EIS.

Humans and non-human biota exposed to ambient radioactivity must be assessed for all relevant routes of exposure (both internal and external exposure scenarios). Information on radiation levels to which workers and members of the public are exposed to must be provided. This must also include consideration of consumers of country food whose exposure pathways may differ due to cultural norms, including any dietary characteristics of Aboriginal peoples.

A description of the current radiological monitoring, management programs, and special studies including a detailed summary of the results of those programs, must be provided in the EIS.

10.1.7 Climate, Weather Conditions and Air Quality

The EIS must describe the climate conditions at the site, local and regional study areas. The EIS must also provide a description of seasonal variations in weather conditions within the above-noted study areas, to allow the assessment of effects on the project. Meteorological information provided should include air temperature, relative humidity, precipitation, wind speed and direction, atmospheric pressure, solar radiation, and describe the occurrence of weather phenomena including events such as tornadoes, lightning, temperature inversions and fog. Special consideration must be given in the analysis of extreme and rare meteorological phenomena. Uncertainties must be described and taken into account when discussing the reliability of the information presented.

The influence of regional topography or other features that could affect weather conditions in the study areas must be described.

A description of the ambient air quality in the study areas must be provided, with emphasis on those parameters for which there will be radiological and non-radiological emissions resulting from the project.

10.1.8 Noise

The EIS must describe current ambient day time and night time noise levels at the site, in the local study areas, and include information on its source(s), geographic extent and temporal variations. The description must also provide ambient noise levels for other areas which could be affected by the project, such as through increased traffic along transportation corridors to and from the site during construction, particularly at residences and sensitive sites (e.g., hospitals, schools, day-cares, seniors' residences, and places of worship).

10.2 Socio-economic Conditions

In describing the socio-economic environment, the proponent must provide information on the functioning and health of the socio-economic environment, encompassing a broad range of matters that affect the people and communities, including Aboriginal communities, in the study area.

10.2.1 Economy

The EIS must describe the general socio-economic conditions at the local and regional study areas. The proponent should describe population and community distribution and density in the regional study area. The description should include the proximity of the project to affected communities, fluctuations in population and population attributes (age groups, employment).

A description of the local and regional economies should also be provided, including workforce and employment. Information must be provided on the available labour supply and rates of employment in the surrounding communities and region.

10.2.2 Land Use and Value

The EIS must describe land use in the local and regional study areas. The proponent should identify past, current and planned land use(s) of the study areas or beyond, that may be affected by the project. This must include a description of the current and planned operations on the OPG Nuclear Site, and a discussion of existing land-based infrastructure that is likely to be affected by the project, such as sewer and water treatment distribution systems, wells and waste management areas.

A description of commercial fisheries that could be affected by the project should be provided.

Estimates of the current and projected value of the recreational and tourist industry (e.g., hunting, fishing, hiking, parks, kayaking, cottages along the shores of Lake Ontario) for the study areas should be provided.

A description of current or of proposed future local, regional or provincial land use or urban development policies, programs and plans should also be provided.

10.2.3 Aboriginal Land, Aquatic Area and Resource Use

In keeping with the Guiding Principles in Section 2 of these guidelines, the EIS must describe land use at the site and within the local and regional study areas. The proponent should identify the lands, waters and resources of specific social, economic, archaeological, cultural or spiritual value to Aboriginal people, including Métis that assert Aboriginal rights or title or treaty rights or in relation to which Aboriginal rights or title or treaty rights have been established and that may be affected by the project. The EIS must identify traditional activities, including activities for food, social, ceremonial and other cultural purposes, in relation to such lands, waters and resources with a focus on the current use of lands, waters and resources for traditional purposes.

Traditional land use may include areas where traditional activities such as camping, travel on traditional routes, gathering of country foods (hunting, fishing, trapping, planting and harvesting) activities were carried out. Spiritual sites should also be considered as a traditional use activity of significance to Aboriginal people.

10.2.4 Land-based Transportation

The EIS must describe the existing conditions of the proposed modes and routes of transportation (e.g., provincial highways, arterial highways, on-site access roads, railways) that will be used throughout the development. The EIS must provide information on the existing types and volumes of traffic and a description of the areas through which trucks will travel, in particular residential or school areas.

10.2.5 Navigable Waters

This section of the EIS must identify any navigation use or issues along Lake Ontario, or any other waterbodies that may be affected by the project. Information on location (latitude and longitude), width, and depth must be provided where appropriate.

10.2.6 Human Health

This section of the EIS must describe the current health profiles of the communities likely to be affected by the project. The proponent should examine the aspects of human health that are defined by the World Health Organization, and include consideration of physical health and well-being and associated emotional, social, cultural, and economic aspects.

The EIS must provide information on population health of the communities in the regional study area. A description of community and public health services available to the residents of communities and to Aboriginal people in the regional study area must also be included.

In keeping with the Guiding Principles in Section 2 of these guidelines, a discussion on Aboriginal people's health-related traditional activities, including the accessibility to spiritual sites within regional study area, should also be included. Health-related traditional activities could include gathering of country foods for consumption (hunting, fishing, trapping, planting and harvesting of plants for medicinal purposes) and activities of spiritual significance. Information on current consumption of country foods and its quality by food type, amounts consumed, parts consumed (whole body as opposed to a specific organ) by Aboriginal people must be provided where available.

10.2.7 Physical and Cultural Heritage Resources

The EIS must identify any terrestrial and aquatic areas containing features of historical, archaeological, paleontological, architectural or cultural importance. A description of the nature of the features located in those areas must be provided. Particular attention must be given to Aboriginal cultural, archaeological and historical resources since there is documented evidence of the presence of such resources in the study areas.

11. EFFECTS PREDICTION, MITIGATION MEASURES AND SIGNIFICANCE OF RESIDUAL ADVERSE EFFECTS

11.1 Effects Prediction

This section must contain a description of any changes in the environment caused by the project, including the effects of these environmental changes on health and socio-economic conditions, physical and cultural heritage, current use of lands and resources for traditional purposes by Aboriginal persons, and any structure, site or thing that is of historical, archaeological, paleontological or architectural significance. Specific attention must be given to interactions between the project and the identified VECs. This section must also include changes to the project caused by the environment.
Each environmental change must be described in terms of whether it is direct or indirect and positive or adverse. Where no change is predicted, this should be noted.

The EIS must describe comprehensive analyses of both the short and long term effects of the project on the environment. The proponent must indicate the degree of uncertainty in predicting the environmental effects identified. When numerical models are used (e.g., a quantitative ecological risk assessment model, a population level ecological risk assessment model) scientific defensibility must be demonstrated by performing model verification (e.g., peer review of model theory), calibration (e.g., adjusting key parameters to site-specific data), validation (e.g., comparison of predicted to observed), sensitivity and uncertainty analysis. Risk modelling of VEC exposure to releases of radionuclides, or hazardous substances (including thermal) shall be determined through the use of upper bounding scenarios or a combination of expected average releases and an upper bounding scenario.

The proponent is expected to employ standard ecological risk assessment frameworks that categorize the levels of detail and quality of the data required for the assessment. These tiers are as follows:

- Tier 1: Qualitative (Expert opinion, literature review, and existing site information);
- Tier 2: Semi-quantitative (Measured site-specific data and existing site information); and
- Tier 3: Quantitative (Recent field surveys and detailed quantitative methods).

Thus, if the Tier 2 assessment still indicates a potential for effects for valued receptors then a Tier 3 assessment would need to be conducted to reduce the level of uncertainty. If the risk characterization component is uncertain this may necessitate the probabilistic modeling of the population level consequences of the proposed project.

An accepted approach to population-level ecological risk assessment and it use in environmental decision-making has been developed through recent scientific work. This approach includes a determination of when a population-level risk assessment is warranted (Tier 1 and Tier 2 assessments), the consideration of exit criteria, and a determination of the value of the assessment [Reference 8].

The consideration of views from the public and Aboriginal groups, including any perceived changes attributed to the project, must be recognized and addressed in the assessment method.

When completing effects predictions, the potential for climate change influences over the predicted 60 year of operations should be considered (e.g., influence on thermal effects from cooling water releases).

11.2 Mitigation Measures

Mitigation is the elimination, reduction or control of the adverse environmental effects of the project, and includes restitution for any damage to the environment caused by such effects through replacement, restoration, compensation or any other means. The proponent must describe general and specific measures intended to mitigate the potentially adverse environmental effects of the project. The proponent must indicate which measures respond directly to statutory or regulatory requirements.

All proposed mitigation must be described by project phase, timing and duration. Information must be provided on methods, equipment, procedures and policies associated with the proposed mitigation. The proponent must discuss and evaluate the effectiveness of the proposed measures and assess the risk of mitigation failure and the potential severity of the consequences of such failures. Information must be provided on similar mitigation methods used with similar projects and the degree of success achieved.

The proponent must indicate what other mitigation measures were considered, including the various components of mitigation and explain why they were rejected. Trade-offs between cost savings and effectiveness of the various forms of mitigation must be justified. The proponent must identify who is responsible for the implementation of these measures and the system of accountability.

For species at risk defined by the federal *Species at Risk Act*, pursuant to subsection 79(1) of that Act, Responsible Authorities under the *Canadian Environmental Assessment Act* must notify the appropriate federal Minister if any listed wildlife species, its critical habitat or the residences of individuals of that species may be adversely affected by the project. Pursuant to subsection 79(2) of the *Species at Risk Act*, if the project is carried out, Responsible Authorities must also ensure that measures are taken to avoid or lessen those effects and to monitor them; these measures must be taken in a way that is consistent with any applicable recovery strategy and action plans. Therefore, the proponent must include information in the EIS that will allow the Responsible Authorities to meet this requirement.

Compliance monitoring verifies whether required mitigation measures were implemented. Compliance monitoring on its own does not satisfy the requirements for a follow-up program described in Section 15, but serves to track conditions or issues during the project lifespan or at certain times. For each environmental component potentially affected by the project, the EIS must describe any proposed monitoring programs that will be designed.

11.3 Significance of Residual Adverse Effects

The proponent is expected to take all reasonable precautions to protect the environment. Hence, all reasonable means (e.g., best available technology economically achievable and keeping radiation doses as low as reasonably achievable) are expected to be used to eliminate or mitigate adverse environmental effects. Any residual adverse effects persisting despite proposed mitigative activities are to be assessed as to their significance.

The EIS must identify the criteria used to assign significance ratings to any predicted adverse effects. The EIS must contain a detailed analysis of the significance of the potential residual adverse environmental effects it predicts. It must contain clear and sufficient information to enable the joint review panel and the public to understand and review the proponent's judgment of the significance of effects. The proponent must define the terms used to describe the level of significance.

The proponent must assess the significance of predicted effects according to the following categories:

- magnitude of the effect;
- geographic extent of the effect;
- timing, duration and frequency of the effect;
- degree to which effects are reversible or mitigable;
- ecological and social/cultural context; and
- probability of occurrence.

In assessing significance against these criteria, the EIS must, where possible, employ relevant existing regulatory documents, environmental standards, guidelines, or objectives such as prescribed maximum levels of emissions or discharges of specific hazardous agents into the environment or maximum acceptable levels of specific hazardous agents in the environment. If the level of an adverse environmental effect is less than the standard, guideline, or objective, it may or may not be significant.
The EIS must avoid repetition by identifying the potential adverse environmental effects, the proposed mitigation measures and the significance of the effects after mitigation measures have been taken into account, on each VEC, both biophysical and socio-economic, in the same discussion. A summary of the effects, mitigation and significance associated with each VEC should be provided in tabular format to provide clarity and ease of reference.

The EIS must clearly explain the method and definitions used to describe the level of the adverse (e.g., low, medium, high) for each of the above categories and how these levels were combined to produce an overall conclusion on the significance of adverse effects for each VEC. This method should be transparent and reproducible.

11.4 Biophysical Environment

11.4.1 Geology and Geomorphology

The EIS must describe any changes to the environment resulting from the removal of bedrock, unconsolidated deposits, soils or sediments that are disturbed, and stockpiled, or used for construction purposes.

The EIS must also include an assessment of changes to coastal processes and features (e.g., changes to shoreline morphology due to construction as well as changes through erosion and sediment transport) with a particular focus on potential effects of the increased flow from condenser cooling water or other discharges to surface waters and the proposed infilling of Lake Ontario.

11.4.2 Surface Water

The EIS must identify and characterize all liquid emissions, including but not limited average and maximum emissions from point sources, planned discharges, fugitive releases, deposition from airborne particulates, and surface runoff, which have the

potential to be generated during any phase of the project. A description of how these emissions could affect surface water quality and an indication of what will be done to avoid or mitigate adverse environmental effects must be provided.
The proponent is to document the proposed monitoring or follow-up programs designed to assess the effects of the project on surface water features, including measured parameters, sampling methodologies, locations and frequencies, and performance criteria against which the impacts of the site activities will be evaluated.

11.4.3 Groundwater

For all phases of the project, the EIS must describe and assess any effects the project may have on the groundwater regime including the quantity and quality of groundwater, and provide details of how the effects on groundwater will be avoided or mitigated. Modeling should be used as required to develop and support effects predictions.
The proponent is to document the proposed monitoring or follow-up programs designed to assess the effects of the project on groundwater, including measured parameters, sampling methodologies, locations and frequencies, and performance criteria against which the impacts of the site activities will be evaluated.

11.4.4 Terrestrial Environment

For all phases of the project, the EIS must describe the effects of the project on terrestrial fauna and flora and include a full accounting of effects on species of natural conservation status and their habitat. This effects evaluation should be based on results of field monitoring studies and predictions from an ecological risk assessment. It must be clear how predicted effects to the biota exposed to the project stressor compare to the expected “reference condition” for unexposed biota on a biological population basis taking into account natural variation. Potential effects may include but are not limited to:

- effects of loss of terrestrial habitat and the quality of lost habitat for relevant species;
- disturbance of feeding, nesting or breeding habitats;
- physical barriers to wildlife;
- disruption, blockage, impediment and sensory disturbance (e.g., noise and light effects) of daily or seasonal wildlife movements (e.g., migration, home ranges);
- direct and indirect wildlife mortality;
- reduction in wildlife productivity; and
- contaminant exposures through environmental and food-chain transport.

The proponent is to document the proposed monitoring or follow-up programs designed to assess the effects of the project on the terrestrial environment including potential sampling media and/or indicator species, measured parameters, sampling methodologies, locations and frequencies, and performance criteria against which the impacts of the site activities will be evaluated.

11.4.5 Aquatic Environment

For all phases of the project, the EIS must describe the effects of the project on aquatic fauna and flora and include a full accounting of effects on species of natural conservation status and their habitat. This effects evaluation should be based on results of field monitoring studies and predictions from an ecological risk assessment. Potential effects may include but are not limited to:

- effects on habitat, including aquatic vegetation and sensitive areas such as spawning grounds, nursery areas, winter refuges and migration corridors;
- effects on aquatic species, including rare and/or sensitive species;
- effects of blasting on fish and fish habitat on local aquatic systems;
- contaminant exposures through environmental and food-chain transport;
- effects of impingement/entrainment on biota;
- effects of infilling on loss of fish habitat and changes to productive capacity;
- effects of thermal plume(s) on fish habitat, health and behaviour;
- effects from the release of potential contaminants within cooling water such as blowdown constituents, biocides or anti-corrosion chemicals on aquatic biota;
- a description of mitigation/compensation options; and
- effects on wetlands.

Results of historical baseline studies and on-going monitoring of events with respect to the changes observed in aquatic species as a result of current and past operations of existing nuclear reactors will play a key role in determining future effects of new reactors. Description of potential effects must include changes to food chain and food web dynamics as a habitat component as this relates to fish populations. Particular attention must be placed on the effects to any existing sport fishing and Aboriginal commercial fishing industry.

Any works that involve significant infilling into Lake Ontario require an assessment of alternatives to avoid the infill as per the 'Hierarchy of Preferences' direction in the DFO's Policy for the Management of Fish Habitat. Any works that will result in a harmful alteration, disruption or destruction of fish habitat will be required to have a fish habitat compensation plan to meet the 'no net loss' policy objectives. The assessment of potential effects to fish and fish habitat arising from the lake filling must be done using DFO's Habitat Alteration and Assessment Tool (HAAT). The HAAT model must also be used as part of the assessment to evaluate if the compensation plan meets DFO's long term policy objective to achieve a net gain in productive capacity of fish habitat.

The proponent must describe proposed mitigation measures to reduce or eliminate effects from impingement and entrainment of aquatic biota through water withdrawal, and from subsequent release of a heated effluent, in consideration of the requirements to assess alternative means of undertaking the project. The assessment of the possible mitigation measures must include the use of closed-cycle cooling systems and the application of a standard approach velocity at the intake screens (e.g., as applied at Canadian hydroelectric facilities).

11.4.6 Radiological Conditions

For all phases of the project, the EIS must describe, in the appropriate sections, any changes to radiation and radioactivity present in the terrestrial and aquatic environment, the atmosphere, and to workers and members or nearby communities as a result of the project. Any mitigation measures to reduce adverse environmental effects must also be described.

The proponent is to document the proposed monitoring or follow-up programs designed to assess the effects of the project related to the releases of radionuclides to the environment, including potential sampling media and/or indicator species, measured parameters, sampling methodologies, locations and frequencies, and performance criteria against which the impacts of the site activities will be evaluated.

11.4.7 Atmosphere

The EIS must identify and characterize all atmospheric emissions, including but not limited to average and maximum emissions from point sources, planned discharges, and fugitive emissions, including greenhouse gases, expected to be generated during any phase of the project. Modelling incorporating site-specific atmospheric characteristics (e.g., shoreline fumigation) is to be completed to assess potential influences on air quality, and the transport of atmospheric contaminants and any associated exposure of humans and non-human biota. The EIS is to indicate what will be done to avoid or mitigate any potential adverse environmental effects and assess the risks associated with any residual emissions. A comparison of the Project's incremental contribution to total national and provincial emissions on an annual basis is to be provided.

The proponent is to document the proposed monitoring or follow-up programs designed to assess the effects of the project related to atmospheric releases and associated air quality, including measured parameters, sampling methodologies, locations and frequencies, and performance criteria against which the impacts of the site activities will be evaluated.

11.4.8 Noise and Vibrations

For all phases of the project, the EIS must describe the predicted effects (with rationale) of any change in day time or night time noise or vibration levels on terrestrial and aquatic species and on workers and nearby residents and communities for all phases of the project. Include a description of any tonal or impulsive noise that may occur, particularly during construction. The methods to be used to monitor noise and vibration levels must also be described.

11.4.9 Effects of the Environment on the Project

The EIS must describe the potential effects that the environment may have on the project. The assessment must take into account how local lake conditions and natural hazards, such as severe weather conditions and external events (e.g., flooding, tornado, fire and seismic events) could adversely affect the project. Longer-term effects of climate change must also be discussed up to the projected abandonment phase of the project.

Consideration of applicable climate elements must include, but not be limited to:

- an estimate of its importance to the project;
- an estimate of how sensitive the project is to variations of this element;
- a discussion of climate data used; and
- change in lake level.

The sensitivity of the project to long-term climate variability and effects must be identified and discussed. The CEAA Procedural Guide, "Incorporating Climate Change Considerations in Environmental Assessment: General Guidance for Practitioners",

[Reference 9] provides guidance for incorporating climate change considerations in an environmental assessment.

11.5 Socio-economic Effects

This section of the EIS must describe the predicted changes to health and socio-economic conditions, physical and cultural heritage and current use of lands and resources, including those used for traditional purposes by Aboriginal people that result from any changes the project may cause in the environment.

11.5.1 Economy

For all phases of the project, the EIS must describe the expected effects on the regional study area's economy, including effects on employment and economic sectors such as commercial, retail and recreational sectors. It should also describe what measures are within the proponent's control to avoid or mitigate adverse economic effects.

11.5.2 Land Use and Value

This section of the EIS must describe the predicted effects (with rationale) that the proposed development will have on the existing and planned operation on the Darlington Nuclear Site as well as on other land and water uses, including tourism, changes in aesthetics, education, and recreational opportunities caused by the construction, operation and modification of the project in terms of increased noise levels, lowered air and water quality, alteration or visual and topographic characteristics of the area.

For all phases of the project, the EIS must describe the expected effects or pressures on, but not limited to, land use, the housing market (including local and regional residential rental market), property taxes, and property values within the Local and Regional Study Areas, as well as any additional areas that might be defined by the Protective Zone.

11.5.3 Aboriginal Traditional Land Use

The EIS must identify any change that the project is likely to cause in the environment and any effect of any such change on the use of lands and resources for traditional purposes by any Aboriginal group including, but not limited to, effects to hunting, trapping, fishing and gathering. For each effect, the EIS must specify, where possible, the particular area that may be affected. The EIS must identify any concerns raised by Aboriginal people about the project or other past or present means of storing or disposing of nuclear waste, and regarding the cumulative effects of the project in combination with any other over these areas.

11.5.4 Land-based Transportation

For all phases of the project, the EIS must describe the expected effects on transportation infrastructure in the regional study area. The discussion on the predicted effects (with rationale) to local and regional traffic volumes and road conditions, including provincial highways, arterial highways, on-site access roads and railways, should be provided. Information on the potential effects on the areas, through which trucks will travel, such as residential or school areas, should also be included. The proposed methods for avoiding effects on the existing transportation infrastructure should be described.

11.5.5 Navigable Waters

The EIS must identify potential effects on navigability on Lake Ontario and other water bodies that may be affected by the project.

11.5.6 Human Health

The EIS must provide a discussion on the potential effects of the project on the physical, mental, and social well-being of workers, the public and communities.

The information must include, but not be limited to, the following:

- an analysis of the effects of the project on the health and safety of all workers, including the possible effects from malfunctions or accidents;
- the predicted doses to workers, including doses to contract workers, and to members of the project resulting from activities within the scope of this project;
- a description of quantitative risk assessment modeling conducted, where necessary, for any malfunctions and accidents;
- an assessment of the project's potential effects on human health from all contaminants or other substances released from the project, as well as direct exposure to radiation, through all potential exposure pathways; and
- potential effects of noise generated from the project on human receptors within the study area.

The effects of the project on local and regional health services and public health infrastructure (water supplies for domestic use and sewage treatment) must also be described.

11.5.7 Physical and Cultural Heritage Resources

If it has been determined that sites of historical, archaeological, paleontological or architectural importance exist, the potential effects of the project on these sites and on any physical and cultural heritage resources must be identified and discussed. The proposed measures to preserve, protect or recover these resources must be described.

11.5.8 Natural Resources

The workforce required for this project, especially during the construction phase, would be considerable; therefore, the likely effects of the workforce on the biological environment must be discussed. Increased sport fishing pressure and increased traffic raising wildlife road kill rates should be taken into consideration.

12. ACCIDENTS, MALFUNCTIONS AND MALEVOLENT ACTS

12.1 General Considerations

For the purposes of the assessment, accidents and malfunctions may be separated into three categories and defined as follows:

- *Nuclear accidents*, consisting of all accidents and malfunctions with radiological consequences. These accidents may be further subdivided into nuclear accidents directly involving the reactor core (such as serious damage to the reactor core), nuclear accidents involving other on-site nuclear power plant facilities that contain radiological substances (including the storage of spent fuel waste and radioactive waste handling facilities), and nuclear accidents related to the off-site transportation of low and intermediate-level radioactive wastes. Accidents that do not directly involve the reactor core include criticality events associated with the nuclear fuel.
- *Conventional accidents,* consisting of all other accidents and malfunctions resulting in releases of non-radiological contaminants and other materials.
- *Malevolent acts*, consisting of those physical initiating events or forces (e.g., theft, diversion, civil disorder, fires, explosions, aircraft crashes) that could result from acts of sabotage or terrorist acts.

For each category of accidents and malfunctions, one or more limiting source terms must be defined. Sufficient quantitative information must be provided on all radioactive and hazardous substances that could be released to the environment in significant quantities.

The description must include the safeguards that have been established by the proponent to protect against such occurrences and the contingency procedures in place. Accident management typically relies heavily on the evacuation of personnel and of the population, as required. The proponent must demonstrate that the requirements for adequate infrastructure to support evacuation of personnel and the population can be met. The need for any necessary administrative measures must also be identified together with the responsibilities of organizations other than the proponent.

The proponent must provide a description of any contingency, clean-up or restoration work in the surrounding environment that would be required during, immediately following or in the long-term after, the postulated malfunctions and accidents, including the manner in which the related costs would be covered.

12.2 Nuclear Accidents

The EIS must identify and describe the probability of possible malfunctions or accidents associated with each reactor design considered and with other facilities in the nuclear power plant that contain radiological substances and must consider the potential adverse environmental effects of these events.

The proponent must credibly demonstrate that it meets the safety goals defined in CNSC Regulatory Document RD-337, "Design of New Nuclear Power Plants", [Reference 10], with some margin on frequency, consequence or both. These safety goals are meant to ensure that the risk posed by a nuclear power plant to members of the public living near the plant is small compared with the risks to which they are normally exposed, and the releases they describe are bounding for all designs.

Two safety goals are defined in CNSC Regulatory Document RD-337, to protect the environment and the health and safety of workers and public:

- a small release frequency (SRF). The SRF addresses releases of radioactive material that would trigger temporary evacuation of the population within a few kilometres of the plant in order to prevent unacceptable health effects as a result of limited reactor core damage with impaired containment; and
- prevent unacceptable health effects as a result of severe reactor core damage and failure of containment.

Each safety goal comprises a limit, as follows:

- SRF - The sum of frequencies of all event sequences that can lead to a release to the environment of more than $1x10^{15}$ Bq of I-131 is less than 1:100,000 per reactor year.
- LRF - The sum of frequencies of all event sequences that can lead to a release to the environment of more than $1x10^{14}$ Bq of Cs-137 is less than 1:1,000,000 per reactor year.

The proponent must provide a high-level safety analysis supported by sufficient design information to demonstrate to the satisfaction of the joint review panel or its technical support staff that the accident behaviours of the various designs being proposed are understood, such that their consequences can be predicted with sufficient confidence. The required level of design information is:

- site characteristics including natural hazards;
- technical outline of the nuclear power plant including:
- plant layout;
- qualitative descriptions of all major systems, structures and components (SSCs) that could significantly influence the course or consequences of principal types of accidents and malfunctions;
- qualitative descriptions of the functionality of the SSCs important to safety;
- quantitative information on the performance and reliability characteristics;
- qualitative descriptions of principal types of accidents and malfunctions to identify limiting credible sequences including external hazards (natural and human-induced), design basis accidents and beyond design basis accidents, including severe accidents;

- scoping calculations of limiting accident sequences to provide estimates of impact; and
- system level probabilistic safety assessment, or an equivalent level and type of information.

The limiting source terms must consider accident sequences that could occur with a frequency greater than 10^{-6} per year. For those sequences having frequencies less than 10^{-6} per year but sufficiently close to this frequency, the proponent should provide the rationale for screening them out from further analysis. For nuclear accidents directly involving the reactors, the frequencies denote the frequencies per reactor year of operation.

A description of specific (out of reactor) criticality events must be provided along with a demonstration that consequences of the events do not violate criteria established by international standards [Reference 11] and national guidance [Reference 12] as a trigger for a temporary public evacuation.

12.3 Conventional Accidents

The EIS must identify and describe the probability of possible malfunctions or accidents associated with the project, and describe the potential adverse environmental effects of events which result in non-radiological releases. The proponent must provide, for all phases of the project, the following information on conventional accidents:

- an identification and discussion of any past abnormal plant operations, accidents and spills to the extent that they are relevant to the current assessment;
- a description of specific malfunction and accident events that have a reasonable probability of occurring during the life of the project, including an explanation of how these events were identified for the purpose of this environmental assessment; and
- a description of the source, quantity, mechanism, rate, form and characteristics of non-radiological contaminants and other materials (physical and chemical) likely to be released to the surrounding environment during the postulated malfunctions and accidents, including a description of emissions originating from the operation of emergency back-up diesel generators during prolonged outages.

12.4 Malevolent Acts

The EIS must address potential environmental effects that could result from intentional malevolent acts. While intentional malevolent acts are not accidents, the proponent must compare the environmental effects resulting from malevolent acts with the environmental effects identified for both accidents involving radiological substances (Section 12.2) and conventional accidents (Section 12.3). The EIS must describe the consequences of malevolent acts as either bounded by environmental effects of nuclear and conventional accidents described in the EIS, or where necessary identify where the consequences of the malevolent act are greater.

13. CUMULATIVE EFFECTS

The proponent must identify and assess the cumulative adverse and beneficial environmental effects of the project in combination with other past, present or reasonably foreseeable projects and/or activities within the study areas. The approach and methods used to identify and assess cumulative effects must be explained. The CEAA Operational Policy Statement OPS-EPO/3- 2007, "Addressing Cumulative Environmental Effects under the *Canadian Environmental Assessment Act*" [Reference 7], provides further guidance for conducting cumulative effects assessment.

The assessment of cumulative environmental effects of the project must include the following, but may also address other items:

- Identify the VECs, or their indicators, on which the cumulative effects assessment is focused, including the rationale for their selection. Present spatial and temporal boundaries for the cumulative effect assessment for each VEC selected. Emphasize VECs with special environmental sensitivities or where significant risks are involved.

- Identify the sources of potential cumulative effects. Specify other projects or activities that have been or will be carried out that could produce environmental effects on each selected VEC within the boundaries defined, and whose effects would act in combination with the residual adverse effects of the project.

- Evaluate the likelihood of development by the proponent or others that may appear feasible because of the proximity of the project's infrastructure. Limit assessment to cumulative effects on the physical, biological, and human environments that are likely and for which measurable or detectable residual adverse effects are predicted.

A reasonable degree of certainty should exist that proposed projects and activities will actually proceed for them to be included. Projects that are conceptual in nature or limited as to available information may be insufficiently developed to contribute to this assessment in a meaningful manner. In either case, provide a rationale for inclusion or exclusion.

The EIS must describe the analysis of the total cumulative effect on a VEC over the life of the project, which requires knowledge of the incremental contribution of all projects and activities, in addition to that of the project. The EIS must include different forms of effects (e.g., synergistic, additive, induced, spatial or temporal) and identify impact pathways and trends.

Potential environmental effects on a VEC are not necessarily the result of one project. While a project-specific assessment of cumulative effects is not responsible for assessing all external environmental effects; the cumulative effects assessment must consider how a project-specific environmental effect, or suite of project-specific environmental effects, would interact with these external factors. The EIS must make clear the contribution of the project to a total potential cumulative effect, and place potential cumulative project effects in an appropriate regional context, considering regional plans, community conservation plans, species recovery plans, management plans, objectives and/or guidelines in an integrated manner in order to understand the aspirations of people and communities in the region.

In assessing the cumulative environmental effects of this project in combination with other projects and/or activities, the proponent must identify any changes in the original environmental effects and significance predictions for the project. The proponent must also discuss the effectiveness of the proposed mitigation and/or other restitution measures and the response to such changes, as well as the implications for monitoring and follow-up programs as described in section 15.

This section must provide a brief historical overview of the timelines of the construction, commissioning and operating periods of various facilities at the OPG Darlington Nuclear Site beginning with the first construction in 1981. An example is available on pages 8-9, figure 10 of the December 2000, "Bruce Ecological Effects Review Summary" (OPG 2000), [Reference 13].

14. CAPACITY OF RENEWABLE RESOURCES

The EIS must describe the effects of the project on the capacity of renewable resources to meet the needs of the present and those of the future. The EIS must identify those resources likely to be impacted by the project, and describe how the project could affect their sustainable use. The EIS must also identify and describe any criteria used in considering sustainable use. Sustainable use may be based on ecological considerations such as integrity, productivity, and carrying capacity.

15. FOLLOW UP PROGRAM

The proponent must include a framework upon which environmental monitoring, including environmental effects monitoring where relevant, and follow-up actions will be based throughout the life of the project, should the project proceed.

A follow-up program must be designed to verify the accuracy of the environmental assessment and to determine the effectiveness of the measures implemented to mitigate the adverse environmental effects of the project. The follow-up program must be designed to incorporate pre-project information which would provide the baseline data, compliance data such as established benchmarks, regulatory documents, standards or guidelines, and real time data which would consist of observed data gathered in the field. As part of the follow-up program, the proponent must describe the compliance reporting methods to be used, including reporting frequency, methods and format.

Environmental assessment effects predictions, assumptions and mitigation actions that are to be tested in the follow-up and monitoring programs must be converted into field-testable monitoring objectives. The monitoring design must include a statistical evaluation of the adequacy of existing baseline data to provide a benchmark against which to test for project effects, and the need for any additional pre-construction or pre-operational monitoring to establish a firmer project baseline.

The proponent must propose a schedule for the follow-up program. The schedule should indicate the frequency and duration of any required environmental effects monitoring. This schedule would be developed after statistical evaluation of the length of time needed to detect effects given estimated baseline variability, likely environmental effect size and desired level of statistical confidence in the results (Type 1 and Type 2 errors).
The description of the follow-up program must include any contingency procedures/plans or other adaptive management provisions as a means of addressing unforeseen environmental effects or for correcting exceedances as required to comply or to conform to benchmarks, regulatory standards or guidelines.

The follow-up program must describe roles and responsibilities for the program and its review process, by both peers, the public and Aboriginal people.

The EIS must provide a discussion on the need for, and requirements of, a follow-up program and include:

- the need for such a program and its objectives;
- a tabular summary and explanatory text of the main components of the program including:
  - a description of each monitoring activity under that component;
  - which of the three follow-up program objectives the activity is fulfilling (1. confirm mitigation, 2. confirm assumptions, 3. verify predicted effects);
  - the specific statement from the environmental assessment that goes along with that generic objective and will be the focus for that activity (e.g., follow-up objective: verify predicted effects; environmental assessment effect: no adverse effects at the population level for white-tailed deer because of vehicle strikes due to increased traffic within the site study area); and,
  - the specific monitoring objective for that activity (e.g., record occurrence of vehicular collisions with deer on-site to verify predicted environmental effects).
- how it would be structured;
- roles to be played by the proponent, regulatory agencies, government representatives, Aboriginal people, non-government organizations, citizens' groups and others in such a program;
- possible involvement of independent researchers;
- the sources of funding for the program; and
- information management and reporting.

The follow-up program plan must be described in the EIS in sufficient detail to allow independent judgment as to the likelihood that it will deliver the type, quantity and quality of information required to reliably verify predicted environmental effects (or absence of them), confirm environmental assessment assumptions and confirm the effectiveness of mitigation.

16. ASSESSMENT SUMMARY AND CONCLUSION

This section of the report must summarize the overall findings with emphasis on the main environmental issues identified.

17. REFERENCES

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Energy Agency, International Labour Organization, OECD Nuclear Energy Agency, Pan American Health Organization, United Nations Office for the Co-Ordination of Humanitarian Affairs, World Health Organization, “Preparedness and Response to Nuclear or Radiological Emergency, Safety Requirements”, Safety Standards Series No. GS-R-2, IAEA, Vienna, Austria, 2002.

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APPENDIX 1

Glossary and Acronyms

Abandon – The act of a nuclear facility moving from a licensed to unlicensed state.

Aboriginal Peoples – Defined in Section 35 of the *Constitution Act*, 1982 as including Indian, Inuit and Métis people

Aboriginal Rights - Those rights of Aboriginal peoples which are not found in treaties or land claims agreements.

Aboriginal Title - The form of land ownership belonging to Aboriginal people and the rights coming from the aboriginal relationship with land.

Aboriginal Traditional Knowledge - Aboriginal traditional knowledge (ATK) is knowledge that is held by, and unique to Aboriginal peoples. It is a living body of knowledge that is cumulative and dynamic and adapted over time to reflect changes in the social, economic, environmental, spiritual and political spheres of the Aboriginal knowledge holders. It often includes knowledge about the land and its resources, spiritual beliefs, language, mythology, culture, laws, customs and medicines. It may be considered in the environmental assessment of a proposed project. The term traditional ecological knowledge (TEK) is often used interchangeably with the term Aboriginal traditional knowledge (see, ATK). However, TEK is generally considered to be a subset of ATK that is primarily concerned with knowledge about the environment.

Aquatic Environment – The components related to, living in, or located in or on water or the beds or shores of a water body, including but not limited to all organic and inorganic matter, and living organisms and their habitat, including fish habitat, and their interacting natural systems.

Beyond Design Basis Accident (BDBA) - An accident less frequent and more severe than a design basis accident.

CEAA - The Canadian Environmental Assessment Agency.

Country Food - A diet of local meat and fish and wild plants gained through subsistence harvest.

Darlington New Nuclear Power Plant (Darlington NNPP) - the new nuclear reactors proposed by OPG.

Design Basis Accident (DBA) - Accident conditions against which a nuclear power plant is designed according to established design criteria, and for which the damage to the fuel and the release of radioactive material are kept within authorized limits.

Ecological Risk Assessment -The process that evaluates the likelihood that adverse ecological effects may occur or are occurring as a result of exposure to one or more stressors. This definition recognizes that a risk does not exist unless: (1) the stressor has an inherent ability to cause adverse effects, and (2) it is coincident with or in contact with the ecological component long enough and at sufficient intensity to elicit the identified adverse effect(s).

Entrainment - Occurs when fish (as defined in the *Fisheries Act*) are drawn into a water intake and cannot escape.

Environmental Assessment - Environmental assessment is a process for identifying project and environment interactions, predicting environmental effects, identifying mitigation measures, evaluating significance, reporting and following-up to verify accuracy and effectiveness. Environmental assessment is used as a planning tool to help guide decision making, as well as project design and implementation.

Environmental Effect - As defined in the *Canadian Environmental Assessment Act*.

Exclusion Zone - A parcel of land within or surrounding a nuclear facility on which there is no permanent dwelling and over which a licensee has the legal authority to exercise control. (from *Class I Nuclear Facilities Regulations*).

Impingement - Occurs when entrapped fish (as defined by the *Fisheries Act*) are held in contact with the intake screen and are unable to free itself.

Joint Review Panel - A Review Panel appointed pursuant to the *Canadian Environmental Assessment Act*.

NSCA - the *Nuclear Safety and Control Act*.

OPG - Ontario Power Generation

Project - The proposal to construct and operate up to four new nuclear reactors.

Proponent - Ontario Power Generation.

Protective Zone - The area beyond the exclusion zone that needs to be considered with respect to implementing emergency measures. This includes consideration of such matters as population distribution and density, land and water use, roadways, and consequence and evacuation planning (from RD-346)

Species at Risk – As defined in the federal *Species at Risk Act*.

Terrestrial Environment – The components related to, living on, or located on the Earth's land areas, including but not limited to all organic and inorganic matter, living organisms and their habitat, and their interacting natural systems.

Treaty Rights - Rights arising from the terms of a treaty.

VEC - Valued Ecosystem Component.

APPENDIX 2

Nuclear Safety and Control Act and its Regulations

High Level Guidelines for Applications for Licence to Prepare Site

The proponent must provide all information required under the *Nuclear Safety and Control Act and Regulations* relating to an application for a Licence to Prepare Site. The proponent must demonstrate compliance with the following and with any other requirements cross-referenced in the provisions outlined below.

***Nuclear Safety and Control Act* –** Subsection 24(4) (available at http://laws.justice.gc.ca/en/showdoc/cs/N-28.3/bo-ga:s_8-gb:s_24//en#anchorbo-ga:s_8-gb:s_24)

24(4) No licence may be issued, renewed, amended or replaced unless, in the opinion of the Commission, the applicant:

(*a*) is qualified to carry on the activity that the licence will authorize the licensee to carry on; and

(*b*) will, in carrying on that activity, make adequate provision for the protection of the environment, the health and safety of persons and the maintenance of national security and measures required to implement international obligations to which Canada has agreed.

General Nuclear Safety and Control Regulations

All regulations serve to address Subsection 24(2) of the NSCA.

Information in the application shall demonstrate compliance with the NSCA and associated Regulations.

Although the application is for a *Licence to Prepare Site*, the application should also show high level planning information towards Construction and Operation activities since a large number of related activities have either long lead times or direct ties back to site preparation activities.

The following table outline, to the applicant, CNSC's expectations for information to be submitted to meet the requirements of the *Nuclear Safety and Control Act* via the *General Nuclear Safety and Control Regulations* and the *Class I Nuclear Facilities Regulations*.

Note that further guidance on the *Nuclear Security Regulations* is not included here due to its potentially prescribed nature. Applicants must approach the CNSC separately on this issue.

Where the information provided to meet these expectations is contained in a part of the Environmental Impact Statement, reference may be made to the relevant section(s) in order to avoid duplication.

General Nuclear Safety and Control Regulations (GNSCR)		
Section	**Requirement**	**Expectations**
3(1)(a)	the applicant's name and business address	Self explanatory.
3(1)(b)	the activity to be licensed and its purpose	The activity is "Site Preparation". 'Purpose' provides high level description of the planned NPP including: • number of units, • capacity, • type(s) / make(s) of reactor being considered, and • ultimate purpose(s) of the plant (e.g., electrical power production, hydrogen, desalination, process steam for external process use) If subsurface preparation[2] of the plant footprint will be executed under the *Licence to Prepare Site*, sufficiently detailed information about the plant footprint is submitted in order to demonstrate adequate preparation of the subsurface against the human-induced and external hazards assessed during the site evaluation phase.
3(1)(c)	the name, maximum quantity and form of any nuclear substance to be encompassed by the licence	Typically, there is no handling of radioactive substances during site preparation activities except for any construction-related tools that would be under existing CNSC nuclear substance and device licences.
3(1)(d)	a description of any nuclear facility, prescribed equipment or prescribed information to be encompassed by the licence	The plant description should include: • list of plant types/designs under consideration[3]; • the scheduled completion date and anticipated commercial operation date of

[2] Subsurface preparation does not include installation of pilings or other structures meant to support or add strength to future NPP foundational structures. Drainage trenches and cable tunnels may be permitted with the provision that additional reviews will be required for the *Licence to Construct* stage if the structures will be credited in NPP safety analyses.

[3] Not mandatory information for the *Licence to Prepare Site.* This information is expected by CNSC as part of the Environmental Assessment process.

General Nuclear Safety and Control Regulations (GNSCR)		
Section	**Requirement**	**Expectations**
		each unit; • for each of the above designs, total estimated capacity to be considered in the Environmental Assessment including core thermal power levels (both rated and design[4]), the corresponding net electrical output (if applicable) for each thermal power level; • the type(s) of primary reactor coolant system and ultimate heat sink types(s) being considered; • the type(s) of cooling systems, intakes, and outflows being considered; • the type of containment structure(s) being considered. NOTE: per Sections 19, 20 and 21 of the *General Nuclear Safety and Control Regulations*: For prescribed equipment or prescribed information to be encompassed by the licence, everything that currently exists or will be kept for the duration of the licence is described in the application. Note that 21 (1) (c) includes security-related information whether kept on site or not.
3(1)(e)	the proposed measures to ensure compliance with the *Radiation Protection Regulations* and the *Nuclear Security Regulations*	Activities under a *Licence to Prepare Site* should not involve radioactive dose to either workers or the public with exception to work done with tools that would be under existing CNSC nuclear substance and device licenses. *Nuclear Security Regulations* apply to activities under a *Licence to Prepare Site*. Per *Nuclear Security Regulations* Section 2:

[4] Rated power is defined as the power level at which the plant would operate if licensed. Design power is defined as the highest power level that would be permitted by the plant design and that is used in some safety evaluations.

General Nuclear Safety and Control Regulations (GNSCR)

Section	Requirement	Expectations
		This Part applies in respect of: (*a*) category I, II and III nuclear material, and (*b*) a nuclear power plant.
3(1)(f)	any proposed action level for the purpose of section 6 of the *Radiation Protection Regulations*	Site specific: "Green-field" sites that are not in proximity to other nuclear facilities, and where there will be no handling of radioactive materials during site preparation activities have no need to establish Action Levels.
3(1)(g)	the proposed measures to control access to the site of the activity to be licensed and the nuclear substance, prescribed equipment or prescribed information	The following information is included in a Nuclear Security Implementation Plan submission: • Physical access control plans (e.g., fence type and height, types of alarms etc.); • Security organization information; • Program for control of prescribed information (e.g., security drawings); • Program for developing and implementing a site access clearance system for individuals requiring unescorted access to areas/processes where prescribed information is used or stored; • Program for security of information technology; • Security Threat Assessment studies / reports; • Security response plans, including interfaces with outside agencies (e.g., local police, OPP, RCMP); • security personnel training plan.
3(1)(h)	the proposed measures to prevent loss or illegal use, possession or removal of the nuclear substance, prescribed equipment or prescribed information	
3(1)(i)	a description and the results of any test, analysis or calculation performed to substantiate the information included in the application	Generally, all data submitted in an application for *Licence to Prepare Site* supports the site evaluation process and will be evaluated during the Environmental Assessment process.
3(1)(j)	the name, quantity, form, origin and volume of any radioactive waste or hazardous waste that may result from the activity to	The following information is submitted: • hazardous waste management program details specific to site preparation activities;

General Nuclear Safety and Control Regulations (GNSCR)		
Section	**Requirement**	**Expectations**
	be licensed, including waste that may be stored, managed, processed or disposed of at the site of the activity to be licensed, and the proposed method for managing and disposing of that waste	• a statement of commitment, with project timelines, to develop Radioactive and Hazardous Waste programs with a long-term view to NPP operation, decommissioning and abandonment. Programs are developed and reviewed during early plant construction, however environmental risks from Radioactive and Hazardous Waste will be evaluated during the Environmental Assessment process)
3(1)(k)	the applicant's organizational management structure insofar as it may bear on the applicant's compliance with the Act and the regulations made under the Act, including the internal allocation of functions, responsibilities and authority	The application demonstrates that there are sufficient competent resources in the Applicant's organization to ensure compliance with the NSCA and associated Regulations. **For Site Preparation activities:** The application should demonstrate: • the applicant's organization has demonstrated project process ownership and adequate project oversight; and • the relationship between the applicant's organization and contracting companies performing site preparation activities is clearly described. The following site preparation organizations are adequately described: • Project Office (site preparations project oversight and regulatory compliance); • Health and Safety; • Security; • Environmental Assessment and Compliance Assurance; • Quality Assurance and Auditing; • Training (qualification of site preparation staff).

General Nuclear Safety and Control Regulations (GNSCR)		
Section	**Requirement**	**Expectations**
		P**lanning for future licensing phases:** The future Operating Organization is named and described for the purposes of the Environmental Assessment. High level descriptions of the planned formation and development of construction and operating organizations and a statement of commitment, with project timelines, to provide more organizational details as the project progresses are required. In addition, the primary agents or contractors for the design, construction, and operation of the nuclear power plant are identified. The principal consultants and outside service organizations (such as those providing audits of the QA program) are listed. The division of responsibility is delineated among the reactor/facility designer, architect-engineer, constructor, and operator.
3(1)(l)	a description of any proposed financial guarantee relating to the activity to be licensed	The Financial Guarantee under the Licence to Prepare Site adequately addresses restoration of the site required as a result of the proposed activities should the project be abandoned.
3(1)(m)	any other information required by the Act or the regulations made under the Act for the activity to be licensed and the nuclear substance, nuclear facility, prescribed equipment or prescribed information to be encompassed by the licence	Information may be requested by CNSC staff the Commission Secretariat and / or the Review Panel Secretariat to support the application for *Licence to Prepare Site.*
3(1)(n)	at the request of the Commission, any other information that is necessary to enable the Commission to determine	

General Nuclear Safety and Control Regulations (GNSCR)		
Section	**Requirement**	**Expectations**
	whether the applicant (i) is qualified to carry on the activity to be licensed, or (ii) will, in carrying on that activity, make adequate provision for the protection of the environment, the health and safety of persons and the maintenance of national security and measures required to implement international obligations to which Canada has agreed.	
15(a)(b)(c)	Every applicant for a licence and every licensee shall notify the Commission of (*a*) the persons who have authority to act for them in their dealings with the Commission; (*b*) the names and position titles of the persons who are responsible for the management and control of the licensed activity and the nuclear substance, nuclear facility, prescribed equipment or prescribed information encompassed by the licence; and (*c*) any change in the information referred to in paragraphs (*a*) and (*b*), within 15 days after the change occurs.	Self explanatory.

<table>
<tr><th colspan="3">Expectations for Contents of an Application for Licence To Prepare Site</th></tr>
<tr><th colspan="3">Class I Nuclear Facilities Regulations</th></tr>
<tr><th>Section</th><th>Requirement</th><th>Expectations</th></tr>
<tr><td>3(a)</td><td>a description of the site of the activity to be licensed, including the location of any exclusion zone and any structures within that zone</td><td rowspan="2">The application includes the following information (diagrams as appropriate):
• Survey diagrams / descriptions of the land on which the site will exist (e.g., province, county / town, lot #, proximity to highways, distance from nearest town(s));
• Proximity to bodies of water and other landforms of note;
• Proximity to large man-made structures (e.g., rail lines, major highways, other nearby commercial facilities);
• Layout(s) of plant, large cooling structures, switchyard and support buildings within an exclusion zone.</td></tr>
<tr><td>3(b)</td><td>plans showing the location, perimeter, areas, structures and systems of the nuclear facility</td></tr>
<tr><td>3(c)</td><td>evidence that the applicant is the owner of the site or has authority from the owner of the site to carry on the activity to be licensed</td><td>Acceptable evidence includes proof of ownership (copy of land title / deed) or a letter of permission from the owner of the land for eventual construction and operation of the facilities described per 3(b) of Class I Nuclear Facilities Regulations in the application for Licence to Prepare Site.</td></tr>
<tr><td>3(d)</td><td>the proposed quality assurance program for the activity to be licensed</td><td>The application includes a comprehensive submission showing quality assurance plans and program covering all activities to be performed under the Licence to Prepare a Site, including the implementation plan, a detailed scope of activities, a schedule for the activities and encompasses a demonstration that the applicant's service providers and vendors have an acceptable QA program /meet the requirements for an acceptable QA program;</td></tr>
<tr><td>3(e)</td><td>the name, form, characteristics and quantity of any hazardous substances that may be on the site while the activity to be licensed is carried on</td><td>This requirement is specific to the activities proposed to be performed under the Licence to Prepare Site. See Section 1 of Class I Nuclear Facilities Regulations for definition of hazardous substances. The effects of these substances are considered in the environmental assessment.</td></tr>
</table>

Expectations for Contents of an Application for *Licence To Prepare Site*		
Class I Nuclear Facilities Regulations		
Section	**Requirement**	**Expectations**
3(f)	the proposed worker health and safety policies and procedures	The application contains program details such as a high level program implementation plan. The application demonstrates that: • the site health and safety program is under the direct oversight of the proponent; • the program will be managed by an adequately staffed and competent health and safety organization; • the program development and implementation plan will be complete and processes, procedures and auditing can be executed if the *Licence to Prepare Site* is granted.
3(g)	the proposed environmental protection policies and procedures	The application contains policy and procedure that demonstrate: • the program is under the direct oversight of the proponent; • the program will be managed by an adequately staffed and competent organization; • processes, procedures and auditing can be executed if the *Licence to Prepare Site* is granted.
3(h)	the proposed effluent and environmental monitoring programs	The proposed effluent and environmental monitoring programs for site preparation activities are to be aligned with the environmental protection program. The program demonstrates: • the program is under the direct oversight of the proponent; • the program will be managed by an adequately staffed and competent organization; • support of mitigation strategies dispositioned in the Environmental Assessment process; • compliance with accepted quality assurance standards.

Expectations for Contents of an Application for *Licence To Prepare Site*

Class I Nuclear Facilities Regulations

Section	Requirement	Expectations
3(i)	if the application is in respect of a nuclear facility referred to in paragraph 2(*b*) of the *Nuclear Security Regulations* (see below), the information required by section 3 of those Regulations; 2 (*b*) a nuclear facility consisting of a nuclear reactor that may exceed 10 MW thermal power during normal operation.	Self explanatory.
3(j)	the proposed program to inform persons living in the vicinity of the site of the general nature and characteristics of the the anticipated effects on the environment and the health and safety of persons that may result from the activity to be licensed	The application demonstrates that: • the program is under the direct oversight of the proponent; • the program is managed by an adequately staffed and competent organization; • the program development and implementation plan is complete and processes, procedures and auditing are being executed prior to the Commission hearing for the *Licence to Prepare Site*. The program implementation plan includes: • population to be covered by the program, • methods of consultation, and • methods of establishing and maintaining quality assurance of data. Evidence and data shall been submitted showing open consultation with all representatives of the community. In addition, all comments captured (resolved and unresolved) and strategies for addressing the comments are documented.

Expectations for Contents of an Application for *Licence To Prepare Site*		
Class I Nuclear Facilities Regulations		
Section	**Requirement**	**Expectations**
3(k)	the proposed plan for the decommissioning of the nuclear facility or of the site	A submission showing detailed decommissioning strategies and plans (including budgets) for all activities to be performed under the *Licence to Prepare Site* such that the site can be returned to a green or brown field state (as appropriate) in the event the project is cancelled.
4 (a)	a description of the site evaluation process and of the investigations and preparatory work that have been and will be done on the site and in the surrounding area	The application needs to contain: • a comprehensive description of the methods used to determine the suitability of the site. • a clear description of activities proposed to be completed under the *Licence To Prepare Site*, including proposed mitigation strategies to be considered in the Environmental Assessment • program implementation plans for all programs • consideration is given to site preparation activities that may have a negative affect on site characteristics or intensify the effects of natural external and human induced events evaluated during the site selection process. • a program for evaluating physical characteristics that may be discovered during site preparation activities and may differ from assumptions or research presented during the Environmental Assessment phase. • all site preparation activities and mitigation measures will conform with the outcomes of the Environmental Assessment.
4 (b)	a description of the site's susceptibility to human activity and natural phenomena, including seismic events, tornadoes and floods	These effects are considered as part of the site evaluation process and in the Environmental Assessment.

Expectations for Contents of an Application for *Licence To Prepare Site*		
Class I Nuclear Facilities Regulations		
Section	**Requirement**	**Expectations**
4 (c)	the proposed program to determine the environmental baseline characteristics of the site and the surrounding area	A program for determining environmental baseline characteristics of the site and the surrounding area is implemented for the Environmental Assessment. A connection between the Environmental Assessment baseline program and the long term environmental monitoring program is demonstrated to determine environmental effects during both site preparation activities and succeeding licensing phases.
4 (d)	the proposed quality assurance program for the design of the nuclear facility	At the time of initial application for a *Licence to Prepare Site*, the application includes the quality assurance program that was used, or that will be used for the design of each reactor type being considered.
4 (e)	the effects on the environment and the health and safety of persons that may result from the activity to be licensed, and the measures that will be taken to prevent or mitigate those effects	The effects and mitigation strategies are considered as part of the site evaluation process and are reviewed during the Environmental Assessment. Effects and mitigation strategies are required for the physical activities to be carried out under the Site Preparation licence.