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Chalk River 2028 Licence Renewal Application Supporting Documents Part B

CRL-508760-160-002

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Fitness for Duty

900-510000-STD-013

Revision 1.2

Information Use

Approved by:	Sarah Epps	2026/02/02
	Director, Labour Relations	Date

Effective Date: 2026/02/02
Mandatory Review by Date: 2029/02/02

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Revision History

Rev. No.	Date	Details of Rev.	Authored By	Reviewed By	Approved By
1.2	2026/01/28	Issued for "Approval". Minor Change • Section 1: clarified which section does not apply to safety-sensitive or safety-critical • Section 4: Removed definition for Broad Population, Safety-Critical and Safety Sensitive. • Section 4: Removed CBOP from acronym list (not used in document). • Section 6.1: added note for safety-sensitive and safety-critical workers. • Appendix A: Added summary of broad population safety-sensitive and safety-critical positions.	E. Enright	A. Coulas R. Swartz S. Epps	S. Epps
1.1	2026/01/12	Issued for "Approval".	S. Epps	A. Coulas	S. Epps
1.1D1	2025/12/18	Issued for "Review and Comment". Minor Change: Added: - definition of broad population - Clarity on Safety-Sensitive for the purposes of REGDOC 2.2.4 Fatigue Management - Updated References to correct versions	S. Epps	A. Coulas W. Patey R. Swartz	
1	2021/07/09	Issued as "Approved for Use". Direct to new revision to align with Regulatory requirements Removed: - Injury /Illness Management as it is within the OSH Function	E. Edwards	S. Epps N. Caloren T. Cook T. Purcell	T. Cook

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		under 900-510400-MCP-009, Reporting Injuries and Illnesses (affects Section 1 and 6.4) - Requirements from Purpose section Added: - Safety-Sensitive and Safety Critical Terms - Changed psychological "fitness" to wellness - updated narrative for 6.2 psychological wellness and 6.3 fatigue management to describe available options for supervisors - Section 5.5 added liaison with Fitness for Duty Program Administrator - Section 6 FFD PA arranges drug and alcohol testing - Updated Documented Information and Reference List			
0	2018/03/14	Issued as "Approved for Use". Cancels and supersedes CW-510300-PRO-003, Fitness for Duty		M. Mantha	M. Mantha
D1	2018/02/09	Issued for "Review and Comment".		L. Schryer T. Purcell M. Wagner E. Edwards Y. Dube S. Mistry C. Clark A. Rehman K. Summers J. Gibb D. Hill D. Laxton	

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1. Scope and Applicability

This Standard applies to CNL employees, save and except those identified below, contractors (including subcontractors, regardless of level), and visitors at workplaces or work sites controlled by CNL, save where a contractor has expressly assumed responsibility for Fitness for Duty under contract for a particular workplace or work site. It also applies to CNL employees performing work at workplaces or work sites not controlled by CNL.

This document applies to the management of fitness for duty, including:

- Alcohol and drugs
- Psychological wellness
- Fatigue management

The provisions in Section 6.1 of this Standard do not apply to CNL employees occupying safety-sensitive or safety-critical positions as defined by REGDOC-2.2.4*, Fitness for Duty, Volume II: Managing Alcohol and Drug Use Version 3* [1]. CNL employees occupying these safety-sensitive and safety-critical positions are subject to the provisions of *Fitness for Duty: Policy on Managing Alcohol and Drug Use* [2]. See Appendix A for a summary of applicable positions.

2. Purpose

CNL is committed to providing a safe environment for all employees, contractors, and visitors. Employees, contractors, and visitors who are not fit for duty may present a safety hazard to themselves, to other persons on site, to CNL facilities, or to the public.

This document establishes CNL's standard for identifying, evaluating, and managing conditions that may result in employee impairment, including use of alcohol or drugs, psychological wellness, and fatigue.

3. Prerequisites

Employees are able to perform their job duties in a safe, secure, productive and effective manner and remain able to do so throughout their entire workdays or shifts.

To ensure the safety and health of individuals at CNL, all employees must be physically and mentally capable of safely performing their job duties in a safe, secure, productive, and effective manner; and must remain able to do so throughout their entire workdays or shifts.

Factors which may affect fitness for duty, including use of drugs or alcohol, psychological wellness, and fatigue, are pro-actively managed.

Alcohol or drug related Fitness for Duty assessments [3] are required under the following circumstances:

- In a reasonable-cause evaluation (if a supervisor, through observed behaviour, has reasonable grounds to believe a worker is unfit for duty).
- If the result of an investigation into a significant event reveals that post-incident testing is warranted.

- As follow-up, to confirm abstinence after the completion of a treatment program for substance abuse or addiction.

Fitness for duty assessments [3] may also be completed when the testing is specifically referenced in an agreement between the employee and CNL. If the employee is unionized, the Union must be a party to the agreement as well.

4. Definitions and Acronyms

This document relies primarily on word meaning as found in common dictionaries. The current *Glossary of Controlled Terms and Acronyms* [4] contains specific meanings for those words that require further clarification.

4.1 Definitions

Addiction	A cluster of behavioural, cognitive, and physiological phenomena that develop after repeated substance use and that typically include a strong desire to take the drug, difficulties in controlling its use, persisting in its use despite harmful consequences, a higher priority given to drug use than to other activities and obligations, increased tolerance, and sometimes a physical withdrawal state.
Continuous Behavioural Observation Program	A course for managers and supervisors, designed to help prevent and manage insider threats by developing the supervisor's ability to recognize and respond to behaviours that may indicate a risk to the security, safety or health of employees, facilities and the public.
Fatigue	A state of reduced mental or physical performance capability resulting from sleep loss, extended wakefulness, phase of the circadian rhythm, or workload.
Fitness for Duty (Fit for duty)	A condition in which workers are physically, physiologically, and psychologically capable of performing the tasks of their assigned jobs within the required standards of safety, attendance, quality, efficiency and behaviour. This includes fatigue considerations.
Impairment	A deterioration of an individual's judgment or a decrease in their physical ability.
Substance Abuse	The harmful or hazardous use of psychoactive substances, including alcohol and drugs.

4.2 Acronyms

EFAP	Employee and Family Assistance Program

FFD PA	Fitness for Duty Program Administrator

5. Roles and Responsibilities

5.1 Managers / Supervisors

Managers and Supervisors are responsible for:

- Completing Continuous Behavioural Observation Program training.
- Creating a schedule for on-call shifts that balances operational needs with employee wellness.
- Promoting a safe and healthy work environment.
- Guiding employees who seek assistance for a personal problem to appropriate resources (e.g. *Employee Family Assistance Program* (EFAP) [6], Health Centre) while maintaining confidentiality.
- Observing the attendance, performance, and behaviour of the employees they supervise.
- Reporting as required when presented with circumstances or knowledge that indicates that an employee may be unfit for duty.
- Ensuring employees, including those in the Broad Population, have sufficient recovery periods to safeguard against fatigue.
- Maintaining records of shift worked and non-compliance(s) with the limits on hours of work and recovery periods, including those that occur during exceptional circumstances for employees filling safety-sensitive positions in regards to managing worker fatigue.

5.2 Employees

All employees are expected to perform their jobs in a safe manner and consistently with established CNL rules, procedures, policies and/or practices. Employees are responsible for:

- Reading, understanding and adhering to CNL policies, programs and procedures governing fitness for duty, and meet their associated responsibilities.
- Reporting fit for duty for any and all scheduled or unscheduled duty and remain fit for duty while on Company business, premises, and worksites.
- Remaining fit for duty for the entirety of on call periods.
- Disclosing at any time, including if called at home unexpectedly and requested to attend work, if unfit for duty as defined by this procedure.
- Taking appropriate action to minimize any safety risk and advise their supervisors if they believe they are unfit for duty for any reason.
- Seeking advice and follow appropriate treatment if they have a current or emerging alcohol or drug problem or any other personal problem that may impact their abilities at work.
- Following agreed-upon monitoring programs after attending treatment for a personal or medical condition.

- Co-operating with any work modification related to safety concerns.
- Encouraging a co-worker to access assistance for any problem that impacts performance or safety.
- Not transferring any work responsibilities, including control of any machinery, vehicle or equipment to any individual suspected of being unfit for duty and promptly report their concerns to their supervisors.
- Notifying their supervisors or a management representative immediately if they believe a co-worker, supervisor/manager, another employee, a contract worker or a visitor is not fit for duty when on Company business, premises or a worksite.
- Co-operating with an investigation into a violation of the policies, programs and procedures governing fitness for duty.

5.3 Sponsors

Sponsors are responsible for interfacing with contractors.

5.4 Health Centre

Health Centre personnel are responsible for:

- Maintaining records of all required medical assessments and any restrictions required.
- Maintaining copies of all medical policies and guidelines used by CNL for examination or assessment.
- Performing/arranging chemical testing as deemed appropriate.

Note: Any document containing medical information about an employee is considered a medical record and is regarded as confidential. The Health Centre maintains medical records in a file separate from all other employee records.

5.5 Human Resources

Human Resources personnel are responsible for:

- Promoting a safe and healthy work environment.
- Promoting this document and encouraging employees to participate in awareness sessions.
- Providing advice to management in addressing contraventions of this document.
- Providing advice to managers/supervisors in addressing job performance issues related to employees who may have a substance use or abuse problem.
- Advising employees and management concerning intervention, the accommodation procedure, and CNL's Benefits Plans.
- Providing information regarding the EFAP [6] to current and new employees.
- Providing support to the Health Centre.
- Liaising with the Fitness for Duty Program Administrator (FFD PA) to arrange referral appointments and providing information on available resources if requested by an employee.

5.6 Union

Unions may be involved by:

- Promoting a safe and healthy work environment.
- Generally promoting this document and encouraging employees to participate in awareness sessions.
- Encouraging and advocating accommodation options (e.g., *Disability Management* [7] in conformity with existing legislation and jurisprudence.
- Participating in a representation role during the investigation of incidents and/or interviews with employees.
- Encouraging and supporting employees to access Employee and Family Assistance Program (EFAP) services and/or Health Centre before performance deteriorates and before violations of this Procedure occur.

6. Standards

6.1 Alcohol and Drugs

Note: This section is not applicable to safety-sensitive and safety-critical workers as defined by REGDOC-2.2.4*, Fitness for Duty, Volume II: Managing Alcohol and Drug Use Version 3* [1]. These workers are subject to requirements in *Fitness for Duty: Policy on Managing Alcohol and Drug Use* [2]. See Appendix A for summary of applicable positions.

It is a violation of CNL's *Code of Conduct* [8] for employees to be under the influence of alcohol, drugs or chemical substances during work hours or when conducting CNL business or representing CNL. It is also a violation to use, possess, or distribute alcohol, drugs or chemical substances on company premises. Over the counter or prescription chemical substances which do not cause an adverse effect to fitness for duty are not subject to this Procedure, provided they are taken as directed.

Should an employee need assistance or advice regarding alcohol or substance abuse, CNL encourages them to seek help by consulting:

- Employee and Family Assistance Program (1-800-387-4765)
- Health Centre (ext. 46643, CRL & PHAI, ext. 62216 WL)
- Renfrew County Addiction Treatment System (613-423-9855)
- Haliburton, Kawartha, Pine Ridge District Health Unit (1-866-888-4577)
- Durham Region Health Department (1-800-841-2729)
- Addictions Foundation of Manitoba (1-800-841-2729)

6.1.1 Determination of the Need to Test

In situations wherein an employee is suspected of being under the influence of alcohol, drugs or chemical substance, immediately notify the employee's supervisor or manager (if known), the Health Centre (FFD PA), Human Resources (Labour Relations), or Security.

Employees who have disclosed a diagnosis of alcohol, drug or chemical dependency to the Health Centre are subject to testing at CNL's discretion. The duration of time for which testing will be conducted is determined upon the employee's return to work and is at CNL's discretion. In all cases CNL's *Workplace Accommodation* [9] procedure is adhered to.

In situations wherein alcohol or drug use is suspected, best practices dictate that more than one person observe and document more than one sign of impairment. Signs of impairment include but are not limited to:

- The smell of alcohol or drugs
- Slurred or other affect to speech
- Abnormal behaviour
- Uncharacteristically impaired judgement
- Affect to motor skills
- Dilated pupils

Following a significant event, if there are concerns regarding fitness for duty, all involved parties are required to immediately undergo alcohol or drug testing as part of the investigation process.

Observed signs of impairment are not required in post incident testing, or when alcohol or drug dependency has been disclosed to the Health Centre. In cases wherein testing is conducted solely as a follow up to a disclosure of dependency, all such testing is done in consultation with the Health Centre.

6.1.2 Attendance at Testing

The FFD PA is notified of the decision to test at >CNL Fitness for Duty and will arrange testing. Outside of regular office hours, the FFD PA on-call is also contacted directly by phone (contact numbers accessed on myCNL), to arrange testing. The employee's supervisor accompanies the employee to testing (other than that based on self-disclosure of addiction).

Union representation is afforded to any unionized employee who requests it or who may be sufficiently impaired so as to be unable to request representation and is subject to alcohol or drug testing, provided that a representative is on site and available to attend within a reasonable time period.

6.1.3 Testing Devices and Operators

The primary device used at CNL for alcohol testing is the Lifeloc Phoenix 6. Other test methods are used in situations wherein the primary testing device is not available or is not functional. Testing for drugs is normally conducted through urine testing.

All testing for the presence of alcohol or drugs is done in accordance with equipment manufacturer's instructions, and only by a test administrator who has been trained, qualified, and authorized to perform such testing.

Health Centre staff at Whiteshell and Chalk River locations, are trained, qualified and authorized to perform all alcohol or drug testing during times at which the Health Centre is operational. For all other CNL locations, during regular office hours, testing is arranged by the FFD PA through the Third-Party Administrator (Driver Check).

Any after-hours, testing is arranged by the FFD PA on-call, through Driver Check.

6.1.4 Results of Tests

A positive result on the device is presumed to be an accurate indicator both of the presence of the substance being tested for and of impairment. If the affected employee wishes to dispute the results, then they may direct their split sample ("B" Sample) be tested at CNL's expense.

An employee who tests positive for alcohol or drugs is placed on investigatory leave, pending the outcome of further investigation. Any person who tests positive for drugs or above a 0.049 blood alcohol content is provided with transportation home by taxi, after providing their vehicle keys to the test administrator. In the event that such person refuses the transportation arrangement and indicates a desire to drive off site, Security is notified and instructed to call 911, provide the name of the individual and a description of the vehicle, and report that the employee is suspected of being impaired.

6.2 Psychological Wellness

Employees who are experiencing or who have questions regarding psychological, emotional, or cognitive impairment are encouraged to seek help by consulting:

- Health Centre (ext. 46643 (CRL & PHAI), ext. 62216 (WL))
- Employee and Family Assistance Program (1-800-387-4765) [6]

Dramatic and sudden changes in normal behaviour may be signs than an employee is experiencing stress, personal or workplace problems, or medical or psychological issues which may affect psychological fitness for duty.

If it is determined that the individual does not present an immediate threat to themselves or others, then the following course of action is taken when the Supervisor or Manager addresses the concern with the employee:

1. Complete the *Fitness for Duty Assessment* [3].
2. Approach your concern as a workplace performance issue (if appropriate).
3. Raise the possibility of providing accommodation [9] if needed.
4. Refer the Worker to the *Employee Family Assistance Program* (EFAP) [6].
5. Assure the employee that conversations or meetings with the EFAP are confidential.
6. Set a time to meet again to review the employee's performance.

7. Document this meeting fully and send completed *Fitness for Duty Assessment* [3] to the FFD PA at >CNL Fitness for Duty.

Should questions arise concerning an employee's ability to perform the essential duties of the employee's position because of apparent psychological or cognitive impairment, an assessment is conducted to determine whether the employee presents an imminent danger to themselves or to others. In such cases, a licensed healthcare professional is contacted (Health Centre, or 911 (if outside of CRL or Whiteshell)), as is situationally appropriate to conduct a psychological assessment. The confidential details of the psychological assessment are not disclosed to CNL but a recommendation of overall fitness for duty is provided as well as any workplace limitations or restrictions.

If the assessment determines the observed workplace behaviours or conduct are not the result of underlying psychological issue and the employee is deemed psychologically fit for duty, then the behaviour or conduct is addressed through remedial or disciplinary action as necessary (See steps 1-7 above).

If the assessment determines an underlying psychological issue contributed to workplace behaviours or conduct and the employee is deemed psychologically unfit for duty, then limitations and restrictions identified following assessment by a licensed healthcare professional are addressed through *Disability Management* [7] and *Workplace Accommodation* [9].

Although the presence of one or more abnormal behaviours does not necessarily indicate that a Worker is psychologically unfit for duty, abnormal behaviours should not be ignored as they may be precursors to a more serious event. Consult with the Health Centre to assist in determining how to proceed.

6.3 Fatigue Management

Worker fatigue is managed with the aim of minimizing the potential for errors that could affect nuclear safety and security by managing the risks associated with fatigue, managing the level of fatigue Workers experience at work, and reducing the likelihood and consequences of fatigue related errors. Worker fatigue is a state of reduced mental or physical performance capability resulting from sleep loss, extended wakefulness, phase of the circadian rhythm or workload.

Work hours are in accordance with CNL's *Standard Hours of Work* procedure [10]. Shifts are designed, implemented, and tracked in accordance with Section 4 of *REGDOC-2.2.4 Fitness for Duty: Managing Worker Fatigue* [5]as appropriate. Safety-sensitive positions as defined in *REGDOC-2.2.4 Fitness for Duty: Managing Worker Fatigue* [5], have additional hours of work controls as defined in *Standard Hours of Work* [10]. See Appendix A for a summary of applicable positions.

The management of fatigue is a shared responsibility between CNL and all employees. All employees must be well rested and physically, emotionally, and mentally capable for safely performing the essential functions of their job, ensuring the safety and health of individuals, equipment, and facilities. Employees who feel they are not physically or mentally fit to perform

their duties due to fatigue must immediately disclose this fact to their Supervisor prior to the commencement of their shift, or at the first opportunity thereafter.

Supervisors oversee employees and monitor for signs that indicate an employee's fitness for duty due to fatigue may be in question. In either case (self-disclosure or observed behaviour), the Supervisor and employee discuss options to assist the employee in regaining alertness which may include standing up, walking around, or a short rest. If an employee is deemed not fit to safely and competently perform their duties due to fatigue even after offered options, then, during regular work hours the employee is sent to the Health Centre for assessment with the *Fitness for Duty Assessment* [3]. Outside regular hours, notification is sent by email to >CNL Fitness for Duty, and a taxi is provided to take the employee home safely. The Supervisor contacts the employee prior to their next scheduled shift to verify fitness for duty.

Employees on a 24-hour shift do not require supervisory approval to sleep during designated rest times. In the event of an emergency on site or the requirement to provide emergency support to another organization, employees are assigned time to rest or sleep as deemed appropriate by management.

When an act or omission by a Worker may have caused or contributed to a safety significant incident, a *Fitness for Duty Assessment* [3] is completed.

6.4 Contractors

Contractors who are not physically, mentally and emotionally fit for duty at all times while on CNL property may present a safety hazard to themselves, to other employees and contractors, to CNL facilities, or to the public.

In situations wherein a contractor is observed to be exhibiting signs of impairment, there is a presumption of impairment until such time as documentation of testing is provided to CNL by their employer demonstrating fitness for duty.

In all cases wherein a contractor is unfit for duty, the contract sponsor works with the contractor's employer to ensure that such individual is removed immediately from CNL property and alerts Procurement.

7. Documented Information

Creation, Capture and Use of Information Assets [11] provides current information on the storage, preservation, turnover and retention requirements for records.

- *Fitness for Duty Assessment* [3]

8. References

[1] *Fitness for Duty, Volume II, Managing Alcohol and Drug Use, Version 3,* REGDOC-2.2.4, Canadian Nuclear Safety Commission, January 2021.

[2] *Fitness for Duty: Policy on Managing Alcohol and Drug Use*, 900-510000-STD-015,

[3] *Fitness for Duty Assessment*, 900-510000-FM-008114, 71952246.

[4] *Glossary of Controlled Terms and Acronyms*, https://cnllnc.sharepoint.com/sites/TermsandDefinitions

[5] *Fitness for Duty: Managing Worker Fatigue, REGDOC-2.2.4,* Volume I, Canadian Nuclear Safety Commission, March 2017.

[6] *Employee Family Assistance Program*, 900-510900-MCP-001, 40863551.

[7] *Disability Management,* 900-510900-MCP-002, 40863548.

[8] *Code of Conduct,* 900-513700-STD-009, 47089167.

[9] *Workplace Accommodation,* 900-510000-MCP-003, 12605704.

[10] *Standard Hours of Work,* 900-510000-STD-000606, 59952492.

[11] *Creation, Capture and Use of Information Assets,* 900-511300-STD-003, 50746207.

Appendix A Summary of CNL Safety-sensitive and Safety-Critical Positions

Broad Population: Population of workers who have the potential through their work activities to pose a risk to nuclear safety or security. [5]			
Safety-sensitive: A position that has a role in the operation of a high-security site, where impaired performance could result in a significant incident affecting the environment, the public, the health and safety of workers and others at the site, or the safety and security of the facility. This definition applies to all workers who are regularly required to rotate through or regularly relieve others in safety-sensitive positions. Those who directly supervise working-level positions, or who may perform the same duties or exercise the same responsibilities as safety-sensitive positions, are deemed to hold safety-sensitive positions. [REGDOC-3.6]			
Safety-critical: With respect to fitness for duty, a position certified or authorized by the CNSC that requires workers to make decisions and take actions that have a direct and immediate impact on nuclear safety and security of a high-security site. [REGDOC-3.6]			
REGDOC Identified Positions	**CNL Broad Population Positions**	**CNL Safety-sensitive Positions**	**CNL Safety-critical Positions**
REGDOC-2.2.4 Fitness for Duty: Managing Worker Fatigue **[5]**			
Safety-sensitive positions shall include: 1. certified workers 2. the following security personnel: nuclear security officers, onsite nuclear response force (NRF) members and designated non-NRF personnel	Firefighter Armourer Operating Engineer (Powerhouse)	Nuclear Security Officer (NSO) Nuclear Response Force Officer (NRF) Tiered Response Force (TRF)	N/A

***REGDOC-2.2.4 Fitness for Duty Volume II: Managing Alcohol and Drug Use* [1]**			
Safety-critical positions shall include: 1. workers certified under Class I Nuclear Facilities Regulations subsection 9(2) excluding certified health physicists 2. onsite nuclear response force (NRF) members **For the purposes of alcohol and drug testing, safety-sensitive positions shall include:** 3. certified health physicists 4. the following security personnel: nuclear security officers (NSOs), and designated non-NRF personnel 5. emergency response teams / fire brigade	N/A	NRU Certified Health Physicist NSO Security Training Officer Armourer Dedicated Control Room Operator (CRL) Emergency Operations Centre Commander Firefighter Fire Training Officer Fire Prevention Officer	Nuclear Response Force Officer (NRF) Tiered Response Force (TRF)

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Fitness for Duty - Policy on Managing Alcohol and Drug Use

900-510000-STD-015

Revision 1.0

Information Use

Approved by:	Sarah Epps	2026/03/24
	Director, Labour Relations	Date

Effective Date: 2026/03/24
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Revision History

Rev. No.	Date	Details of Rev.	Authored By	Reviewed By	Approved By
1	2025/02/28	Issued for Approval. Major changes include: Section 1 & Section 2 – updated the wording. Section 4.1 - minor changes to definition wording. Section 5 – updated roles & responsibilities • 5.2 – Bullet added - participating in supervisory awareness training, including the Continuous Behaviour Observation Program; • 5.4 Medical Review Officer (MRO) responsible: o for receiving and reviewing laboratory results generated by an employee's drug testing program; o evaluating medical explanations for certain drug test results. • 5.5 Substance Abuse Professional (SAP) responsible for: o evaluating Workers in Safety Sensitive and Safety-Critical positions for a substance use disorder including, making recommendations for treatment and	S. Epps	A. Coulas	S. Epps

		post-treatment follow up care and testing; ○ determining if the Worker can safely return to duties; ○ communicating recommendations with the Fitness for Duty Program Administrator • 5.6 Collectors responsible for: ○ Collection and processing of alcohol and drug samples as per the Standard. • 5.7 Escorts responsible for: ○ ensuring the Worker(s) are escorted directly to the designated onsite testing location and maintaining supervision; ○ ensuring oversight of the Worker(s) at all times until collection is completed. • Section 6 renumbered and broke out additional sub-headings • Section 8 updated References			
D1D	2024/09/25	Issued for “Review and Comment”.	S. Epps	S. Epps A. Coulas	

0	2021/07/09	Issued as “Approved for Use”. Note: The contents of this document cannot be altered without consultation with the CNL Legal and LR to ensure continued alignment with REGDOC-2.2.4 Fitness for Duty: Managing Alcohol and Drug Use, requirements.	E. Edwards	N. Caloren	T. Cook

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1. Scope and Applicability

Workers: The provisions in this Standard apply to all workers employed in Safety-Sensitive or Safety-Critical positions at all times while they are engaged in Company Business, when on Company Premises and Worksites, and/or when operating vehicles and equipment in the course of their duties for the Company.

Union Representation: In certain circumstances, Workers may be subject to a collective agreement and may be entitled to union representation. Canadian Nuclear Laboratories, (CNL) shall comply with all collective agreement rights and obligations when applying this Standard.

This Standard is subject to periodic review and assessment, and modifications will be made as deemed appropriate by CNL to ensure effectiveness of this Standard and to respond to evolving needs. This review will include a review of trends which will inform potential modifications.

2. Purpose

Canadian Nuclear Laboratories (CNL or the Company) is committed to protecting workers, contractors, the public and property from safety concerns at CNL premises and worksites. Safety is of central importance in a nuclear environment and is a primary and core value for CNL.

Stakeholders in the nuclear industry recognize that the promotion of safe workplaces must involve the constant identification of safety concerns and effective safety protocols through which to address those concerns.

The use of illicit drugs and other mood-altering substances, and the inappropriate use of alcohol, cannabis, and medications, can adversely impact the safety and well-being of Workers, the work environment, and job performance. Therefore, a fitness for duty program that addresses alcohol and other drug use, and possession is not only required by *REGDOC-2.2.4, Fitness for Duty, Volume II, Managing Alcohol and Drug Use* [1] as a condition of licence, but is consistent with the “defence-in-depth” concept that underpins and informs all effective nuclear safety programs.

This Standard (also referred to as Policy) forms one part of our overall approach to managing fitness for duty at CNL Premises and Worksites.

3. Prerequisites

There are no general requirements applicable to this document.

4. Definitions and Acronyms

This document relies primarily on word meaning as found in common dictionaries. The current *Glossary of Controlled Terms and Acronyms* [2] contains specific meanings for those words that require further clarification.

4.1 Definitions

Alcohol	Refers to beer, wine and distilled spirits, and includes medications or other products that contain alcohol.
Cannabis	Refers to any product containing Tetrahydrocannabinol (THC) whether in smokable, vaporized, edible or other form.
Company Business	Refers to all business activities undertaken by Workers during Company operations, whether conducted on or off Company Premises or Worksites and whether during or outside of regular working hours.
Company Premises or Worksites	Include but are not necessarily restricted to all land, facilities and worksites where Company Business is conducted regardless of whether owned, leased or otherwise controlled by the Company. This includes all surrounding ground, parking lots and leased or rented space.
Drug	Means cannabis, illicit drugs, medications, or other mood-altering substances. For the purposes of this Policy, drugs are those substances that have the potential to cause impairment that may impact fitness for duty.
Drug Paraphernalia	Refers to any object of material which, for the purposes of this Policy, is associated with the use of any drug and includes any product or device that may be used to tamper with a drug testing sample.
Escort	Refers to the individual designated by CNL to escort a Worker to be tested once the decision to test has been made.
Fitness for Duty/Fit for Duty	Is the condition in which Workers are physically, physiologically, and psychologically capable of competently and safely performing their job tasks.
Fitness for Duty Program Administrator	Refers to the worker designated by CNL as responsible for the overall administration and management of this Policy.
High-Security Site	Means a nuclear power plan or a nuclear facility where Category I or II nuclear material is processed, used, or stored.
Illicit Drug	Means any drug or impairing substance, the use, sale, possession, purchase, or transfer of which is restricted or prohibited by law.

Medical Review Officer (MRO)	Refers to a person who is a licensed physician and board-certified as a medical review officer responsible for receiving and reviewing laboratory results generated by an employer's drug testing program and evaluating medical explanations for certain drug test results.
Medication	Refers to a drug obtained legally, either over the counter or through a duly qualified health professional's prescription or appropriate authorization, the use of which has the potential to cause impairment that may negatively impact fitness for duty.
Mood-Altering Substance	Refers to any product that is legally or illegally used, which has the potential to cause impairment that may negatively impact fitness for duty.
Safety-Critical Position	Refers to a nuclear position certified (see *REGDOC-2.2.3 Volume III, Certification of Persons Working at Nuclear Power Plants* [3]) or authorized (see *REGDOC-2.12.1, High-Security Sites: Nuclear Response Force* [4]) by the Canadian Nuclear Safety Commission that requires workers to make decisions and take actions that have a direct and immediate impact on nuclear safety and security of the High Security Site. For the purposes of this Policy, Safety-Critical positions are: 1. Workers certified under Class 1 Nuclear Facilities Regulations subsection 9 (2), excluding Certified Health Physicists 2. Onsite Nuclear Response Force (NRF) members
Safety-Sensitive Position	Refers to a position that has a role in the operation of a High Security Site, where impaired performance could result in a significant incident affecting the environment, the public, the health and safety of Workers and others at site, or the safety and security of the facility. This includes all Workers who are regularly required to rotate through or regularly relieve in Safety-Sensitive Positions. Those who directly supervise working-level positions, or who may perform the same duties or exercise the same responsibilities as Safety-Sensitive Positions, are deemed to hold Safety-Sensitive Positions. For the purposes of this Policy, Safety-Sensitive Positions are: 1. Certified Health Physicists 2. Nuclear Security Officers (NSOs), and designated non-NRF personnel 3. Emergency Response Teams (ERTs) / fire brigade

Substance Abuse Professional	Refers to an individual trained, and with expertise and clinical experience, in the diagnosis and treatment of alcohol and drug related disorders.
Supervisor or Manager	Refers to a Worker designated by CNL as a Supervisor or Manager who, as part of their duties, is typically responsible for overseeing the performance of other Workers.
Worker	Refers to all employees employed in safety-sensitive and safety-critical positions, including temporary, term, part-time, and casual employees, who are on the CNL payroll.
Unfit for Duty	A condition in which Workers are not physically, physiologically, or psychologically capable of competently and safely performing their job tasks.

4.2 Acronyms

BAC	Blood Alcohol Content
GC/MS	Gas Chromatography/Mass Spectrometry
LC/MS	Liquid Chromatography-tandem Mass Spectrometry
MRO	Medical Review Officer
POCT	Point of Collection Test
SAP	Substance Abuse Professional

5. Roles and Responsibilities

Responsibility for ensuring the success of this Policy and for maintaining productive and secure operations is shared between Workers, Supervisors and Managers, the Fitness for Duty Program Administrator and CNL.

5.1 Workers

Workers are required, at all times, to perform their job in a manner that is safe and consistent with established Company policies, procedures, and practices.

Workers' responsibilities include, but are not limited to the following:

- reading, understanding and complying with this Policy;
- reporting and remaining fit for duty while conducting Company Business;

- disclosing a substance use disorder or suspected substance use disorder to the CNL Health Centre and seeking appropriate treatment;
- exploring with their duly qualified health professional or pharmacist whether medications have the potential to cause impairment that may negatively impact the Worker's fitness for duty after explaining their job functions and the fitness for duty requirements of this Policy;
- following appropriate treatment, where recommended or prescribed by the Worker's duly qualified health professional(s), as contemplated in this Policy;
- complying with modified work where restrictions have been identified;
- immediately reporting any situation in which another Worker does not appear fit for duty while conducting Company Business; and
- co-operating with investigations under this Policy.

In addition, Workers are encouraged to intervene as appropriate to encourage a co-Worker to access assistance before a substance use disorder impacts a Worker's fitness for duty.

5.2 Supervisors and Managers

Supervisors and Managers' responsibilities include but are not limited to, those listed above and the following:

- participating in supervisory awareness training, including the Continuous Behaviour Observation Program (SECU-1001-ONLINE);
- guiding Workers who seek assistance for a substance use disorder or for alcohol or drug use to appropriate resources (e.g., the Employee and Family Assistance Program (EFAP) [5], /Substance Abuse Professional (SAP) or resources available in the community);
- advising the Fitness for Duty Program Administrator or Health Centre when they become aware that a Worker may have a problem with a substance use disorder or with alcohol or drug use so that an appropriate assessment may be arranged; and
- taking appropriate steps to investigate possible violations of this Policy.

5.3 Fitness for Duty Program Administrator

Fitness for Duty Program Administrator's responsibilities include, but are not limited to, the following:

- ensuring consistent administration of this Policy;
- resolving questions related to the interpretation of this Policy;
- coordinating development and delivery of Worker education and Manager and Supervisor training programs to support this Policy;
- supporting Managers and Supervisors in meeting their responsibilities under this Policy;
- where deemed appropriate by CNL, making arrangements for an assessment with a SAP as required under this Policy; and

- ongoing management of this Policy.

5.4 Medical Review Officer (MRO)

A Medical Review Officer is responsible:

- for receiving and reviewing laboratory results generated by an employee's drug testing program;
- evaluating medical explanations for certain drug test results.

5.5 Substance Abuse Professional (SAP)

A Substance Abuse Professional is responsible for:

- evaluating Workers in Safety Sensitive and Safety-Critical positions for a substance use disorder including, making recommendations for treatment and post-treatment follow up care and testing;
- determining if the Worker can safely return to duties;
- communicating recommendations with the Fitness for Duty Program Administrator

5.6 Collectors

Collectors are responsible for:

- Collection and processing of alcohol and drug samples as per the Standard.

5.7 Escorts

Escorts are responsible for:

- ensuring the Worker(s) are escorted directly to the designated onsite testing location and maintaining supervision;
- ensuring oversight of the Worker(s) at all times until collection is completed.

6. Standards

Workers are required to report for work fit for duty and to remain so while conducting Company Business.

6.1.1 Illicit Drugs and Mood-Altering Substances

The following are prohibited:

- the consumption, possession, distribution, offering or sale of illicit drugs or related drug paraphernalia while conducting Company Business or on Company premises;
- the distribution, offering or sale of mood-altering substances while conducting Company Business or on Company premises; and
- reporting for work, conducting Company Business or being on Company premises while unfit for duty due to the use of illicit drugs or other mood-altering substances.

6.1.2 Alcohol and Cannabis

The following are prohibited:

- the consumption, possession, distribution, offering or sale of alcohol or cannabis while conducting Company Business or on Company premises;
- consumption of any product containing alcohol or cannabis while conducting Company Business or on Company premises, including during meals and breaks; and
- reporting for work or conducting Company Business while unfit for duty due to the use of alcohol or cannabis.

The only exceptions are in respect of the first and second bullets above for alcohol at CNL social functions where approved (refer to 6.4 Hosting Situations).
Cannabis use is not permitted at CNL social functions.

6.1.3 Medications

Workers are required to responsibly use medications, including those that are prescribed and those that are over the counter. Medications of concern are those that have the potential to cause impairment that may negatively impact fitness for duty. The following are prohibited:

- reporting for work or conducting Company Business while unfit for duty due to the use of medications;
- the intentional misuse of medications prior to reporting for work or while conducting Company Business; and
- distribution, offering or sale of prescription medications while conducting Company Business or on Company premises.

It is incumbent upon Workers who need to use a medication to:

- explore with their duly qualified health professional or pharmacist whether the medication can negatively impact fitness for duty after explaining their job functions;
- act responsibly and use a safe alternative medication choice that will not negatively impact fitness for duty, when available; and
- advise the Health Centre of restrictions caused by the medication without delay and comply with appropriate Company-approved modified duties or other course of action to minimize safety risk if the medication being used has the potential to cause impairment that may negatively impact fitness for duty.

6.1.4 On Call Shift/Standby Duty

Workers who are on call or standby to work are responsible to be fit for duty consistent with these Policy standards for the entirety of their assigned on call shift/standby duty.

6.1.5 Unexpected Call

If unexpected circumstances arise where a Worker is requested to perform unscheduled services, the requirement to report for work fit for duty continues to apply. If the called Worker

is unfit for duty, they must declare that this is the case when called to perform unscheduled services and are prohibited from attending at Company premises or performing Company Business until fit for duty.

6.2 Prevention, Assistance, and Rehabilitation

Workers who seek assistance or declare a substance use disorder are not relieved from their obligations related to fitness for duty.

6.2.1 Prevention

CNL recognizes that a substance use disorder is often a treatable illness and that early intervention greatly improves the probability of a lasting recovery. Prevention and early detection of potential problems relating to alcohol or drug use is a key objective of this Policy. Workers experiencing substance use disorders are encouraged to access assistance through the Company *Employee and Family Assistance Program (EFAP)* [5], by working with a SAP, or through their duly qualified health professional or appropriate community services.

6.2.2 Managing Performance

Workers are subject to normal performance monitoring and management. Alcohol or drug use and substance use disorders can have significant impact upon job performance and, as such, Workers whose fitness for duty is being compromised by a substance use disorder or suspected substance use disorder should raise this with the Company's Health Centre at the earliest opportunity so that appropriate assistance can be sought as soon as possible.

6.2.3 Reporting Requirements for Workers

Workers are required to contact the CNL Health Centre and report their concern if they believe they have a substance use disorder that impacts or that may impact their fitness for duty so that assessment and appropriate treatment may be arranged. Where deemed appropriate by CNL, Workers are supported through a treatment and aftercare program consistent with the SAP's recommendations and the applicable benefit coverage. The Worker is expected to attend the assessment and comply with the resulting recommendations.

6.2.4 Post-Treatment Care

Workers who are absent from work in order to complete primary treatment (e.g., residential or out-patient treatment) for substance use disorders are required to comply with the aftercare program, if any, recommended by a duly qualified health professional affiliated with the program as a condition of returning to work and may be required to enter into a written agreement outlining the conditions governing their return to work and the consequences for failing to meet those conditions.

6.2.5 Modified Work

Where a duly qualified health professional, SAP, or other counselling professional identifies limitations, restrictions and/or safety risks directly or indirectly related to a Worker's alcohol or drug use, modified work may be assigned to the Worker. Workers are expected to comply with the modified work program.

6.2.6 Confidentiality

Medical privacy is respected, and confidentiality is maintained as appropriate.

6.3 Investigation Procedures

6.3.1 Unfit for Duty Situations

Where there are reasonable grounds to believe that a Worker is unfit for duty, the Worker is taken to a private place. A Supervisor or Manager attends at the private place.

The Worker is advised by the Supervisor or Manager as to why they appear to be unfit for duty and is given the opportunity to explain why they appear to be unfit for duty.

If there are immediate medical concerns, arrangements are made for appropriate medical attention to be provided.

Based on all the circumstances, if a Supervisor or Manager concludes the Worker may be unfit for duty, appropriate action is taken, which may include any or all of:

- removal from duty pending further investigation, including where there are grounds to believe alcohol or drug use may be a factor in the Worker's fitness for duty;
- referral for an alcohol and drug test if there are reasonable grounds to believe alcohol or drug use may be a factor in the Worker's fitness for duty (refer to Section 6.6Alcohol and Drug Testing Procedure);
- the need for a referral for an alcohol or drug test is verified by at least two people (one of whom is a Supervisor or Manager);
- assigning an individual to act as an escort; and
- any other action appropriate to the situation.

6.3.2 Possession of Alcohol or Drugs

In addition to existing CNL policies regarding searches on Company premises, CNL may investigate any situation in respect of which there are grounds to believe that illicit drugs or related drug paraphernalia, cannabis or alcohol are in a Worker's possession or control while present on Company premises or worksites.

6.4 Hosting Situations

6.4.1 Social Events

Responsible alcohol use may be permitted at CNL social functions, where approved by CNL. In the case of any such social events, appropriate measures are taken for the safety and well-being of individuals present and the community. No alcohol may be consumed by Workers who will be attending to Company Business following the social event on the same day.

6.4.2 Business Hosting

If alcohol is made available to CNL guests in the course of Company Business (e.g., restaurant meetings), Workers are expected to use prudent judgment, and hosts are expected to act responsibly in hosting others.

6.5 Consequences of a Policy Violation

6.5.1 General Requirements

Workers must comply with the Policy. If a Worker is found to have violated this Policy, they may be subject to discipline up to and including termination of employment. Workers may be suspended with pay pending the outcome of an investigation into whether a Policy violation has occurred.

All Workers are accountable for their conduct, including Workers who may suffer from substance use disorders.

CNL complies with applicable human rights legislation in applying this Policy.

6.5.2 Conditions for Continued Employment

Workers who are found to have violated the Policy but whose employment is not terminated as a result, may be required to enter into an agreement governing their continued employment, where appropriate, in consultation with the Worker's duly qualified health professional(s).

Before resuming Safety-Sensitive or Safety-Critical duties following a positive alcohol or drug test, Workers are referred for a mandatory substance abuse evaluation and will not be reinstated until a recommendation for reinstatement is received from a duly qualified health professional.

Workers assessed as having a substance use disorder may not resume their duties until they have met conditions for reinstatement, as recommended by the duly qualified health professional.

6.6 Alcohol and Drug Testing Procedure

6.6.1 Application

The following table sets out the **mandatory** alcohol and drug testing categories.

Table 1 Mandatory Alcohol and Drug Testing Categories

Workgroup	Pre-Placement	For-Cause Reasonable Grounds	Post-Incident	Return to Duty/Follow Up	Random
Workers in Safety-Sensitive Positions	NO	YES	YES	YES	NO
Workers in Safety-Critical Positions	YES	YES	YES	YES	YES

6.6.2 Alcohol and Drug Testing

6.6.2.1 Pre-Placement Testing

All applicants subject to mandatory Pre-Placement Testing must pass an alcohol and drug test as a condition of placement to the position. This requirement applies to external applicants who have been extended offers of employment for, and to Workers currently not but who are seeking to be placed in, a Safety-Critical Position.

6.6.2.2 For-Cause Reasonable Grounds Testing

For-Cause Reasonable Grounds is used when there are reasonable grounds to believe, through observed behaviour, physical condition, or after receiving credible information, that an individual is unfit to perform his or her duties due to the adverse effects of alcohol or drug use. The For-Cause Reasonable Grounds testing decision is verified by at least two people (at least one of whom is a Supervisor). The basis for the decision to test is documented as soon as practicable. If there are immediate medical concerns, arrangements are made for appropriate medical attention to be provided. The Fitness for Duty Assessment [7] is based on specific observations of indicators, including but not limited to the following:

- observed use or evidence of use of alcohol or drugs;
- erratic or atypical behaviour or changes in behaviour;
- changes in physical appearance or speech patterns;
- physical indicators of impairment; and
- any other observations that suggest alcohol or drug use is impacting fitness for duty.

Once the decision to test is made, the individual to be tested must remain under constant supervision until escorted by an Escort to the sample collection site.

6.6.2.3 Post-Incident Testing

Alcohol and drug testing is required after a significant work-related incident or accident in which an act or omission may have caused or contributed to the incident or accident. The determination of what constitutes a significant work-related incident or accident that will attract testing is based on the specific circumstances of the situation, including the nature and significance of the incident and the explanation given by individuals involved. The decision to engage testing is made by the Supervisor investigating the incident, after consultation with a Manager.

An incident or accident for the purposes of this Policy, is any unintended event, including operating errors, equipment failures, initiating events, accident precursors, near misses or other mishaps, or unauthorized acts, malicious or non-malicious, the consequences or potential consequences of which are not negligible from the point of view of protection or safety. An incident or accident has safety significance where it has a detrimental impact on protection or safety and includes, but is not limited to:

- reducing margins to (or exceeding) the accepted limits;
- increasing risk to the health, safety and security of persons, property or the environment;
- impairing special safety systems or safety functions for accident mitigation;
- reducing defence in depth; and causing radioactive releases and spills of hazardous substances, injuries to workers or the public, including an event that results in a dose of radiation being received by a person, organ or tissue in excess of the applicable limits prescribed by the *Radiation Protection Regulations* [8].

Failure to report a significant work-related incident or accident is a violation of this Policy.

The following process applies:

- the decision to test is made as soon as possible after the work-related incident or accident;
- testing may not be required if there is immediate evidence that the actions or omissions of the individuals involved in the incident or accident were not a contributing factor to the event (e.g., structural or mechanical failure or environmental factors);
- testing is conducted as soon as possible;
- only individuals who are identified as having been involved in the chain of acts or omissions leading up to the event are tested;
- once the decision is made to test, those to be tested must remain under constant supervision until escorted by an Escort to the sample collection site;
- the need for a test is documented [7] as soon as is practicable after the decision to test has been made; and
- should there be a delay in testing (e.g., because of the need for medical attention), those to be tested must not consume alcohol, drugs, or any other substance or product that would impact testing results until after the test has been completed or they are

advised that a test is not required. Exceptions are made for previously prescribed medications (which must be declared during the testing process prior to consumption), and medication administered in the treatment of an acute injury resulting from the incident.

6.6.2.4 Return-To-Duty Testing

Return-To-Duty alcohol and drug testing is required prior to the return to duties after confirmation of a substance use disorder by a duly qualified health professional. For this purpose, a negative drug test and an alcohol test with an alcohol concentration below 20 mg/100mL is required before returning to a Safety-Sensitive or Safety-Critical Position.

6.6.2.5 Follow-up Testing

Follow-up alcohol and drug testing is required after confirmation of a substance use disorder by a duly qualified health professional for those in Safety-Sensitive or Safety-Critical Positions. Follow-Up Testing is done in an unannounced and random fashion at a minimum of every 3 months for a minimum period of 2 years. Where appropriate, additional testing beyond these minimum requirements may be conducted to ensure abstinence.

6.6.2.6 Random Testing

Unannounced and random alcohol and drug testing for those occupying Safety Critical Positions includes the following features:

- all individuals in the population subject to testing are subject to random testing, each having an equal probability of being selected for testing;
- those in the population subject to testing who are offsite when selected for testing, or who are onsite and are not reasonably available for testing when selected, are tested at the earliest reasonable opportunity when both the individual subject to testing and collectors are available to collect specimen(s) for testing and without prior notification to the individual that they have been selected for testing;
- the number of Random tests performed at least every 12 months is equal to at least 25% of the population subject to testing;
- testing is conducted on a random and unpredictable schedule, including weekends, night shifts and holidays, and at various times during a shift;
- once tested, an individual in the population subject to testing is immediately eligible for another unannounced test; and
- individuals who are selected for random testing are required to report to the collection site as soon as reasonably practicable after notification and, in any event, within a prescribed time-frame.

6.7 Testing Standards

The following are the standards for positive alcohol and drug tests. Testing standards and methodologies are subject to change at CNL's discretion.

- A **positive alcohol test** is one that yields a result of 40mg/100mL or greater Blood Alcohol Content (BAC). An alcohol test result of 20 to 39mg/100mL BAC is considered an action level and will result in the Worker being removed from duty until it is determined that the Worker is fit for duty.
- A **positive urine drug test** is one that yields a result that is confirmed positive after exceeding the screening and confirmation thresholds for one or more of the following substances:

Table 2 Urine Analysis Drug Panel and Associated Cut-offs Used for Immunoassay Screening

Drug / Drug Class / Metabolite	Cut-off (ng/mL)
Cocaine metabolite (benzoylecgonine)	150
Opiates:	
Morphine, codeine	2,000
Hydromorphone and hydrocodone	300
Oxymorphone and oxycodone	100
6-acetylmorphine	10
Amphetamines	500
Cannabinoids	50
Benzodiazepines	100
Methadone metabolite (EDDP)	100

Table 3 Urine Analysis Drug Panel and Associated Cut-offs Used for GC-MS and LC-MS/MS Confirmation

Drug / Drug Class / Metabolite	Cut-off (ng/mL)
Amphetamines (amphetamine, methamphetamine, MDMA, MDA)	250
Cannabinoids (as 11-nor-Δ-9 THC COOH)	15
Cocaine metabolite (benzoylecgonine)	100
Methadone metabolite (EDDP)	100
Opiates:	
Morphine, codeine	2,000
Hydromorphone, hydrocodone, oxymorphone and oxycodone	100
6-monoacetyl morphine (6-AM, heroin metabolite)	10
Benzodiazepines (LC-MS/MS):	
Oxazepam, temazepam, diazepam, nordiazepam	50
Alprazolam, lorazepam, triazolam, clonazepam	50
Bromazepam, flurazepam	50

- A **positive oral fluid Drug test** is one that yields a result that is confirmed positive after exceeding the screening and confirmation thresholds for one or more of the following substances:

Table 4 Oral Fluid Analysis Drug Panel and Associated Cut-offs Used for Immunoassay Screening

Drug / Drug Class / Metabolite	Cut-off (ng/mL)
Amphetamines	50
Cannabinoids	10
Cocaine	20
Opiates:	
Morphine, codeine	30
Hydromorphone and hydrocodone	30
Oxymorphone and oxycodone	30
6-acetylmorphine	4
Benzodiazepines	10
Methadone	20

Table 5 Oral Fluid Analysis Drug Panel and Associated Cut-offs Used for GC-MS and LC-MS/MS

Drug / Drug Class / Metabolite	Cut-off (ng/mL)
Amphetamines (amphetamine, methamphetamine)	25
Cannabinoids (THC)	5
Cocaine and its metabolite (benzoylecgonine)	8
Opiates:	
Morphine, codeine	15
Hydromorphone, hydrocodone, oxymorphone and oxycodone	15
6-monoacetyl morphine	2
Benzodiazepines (LC-MS/MS)	3
Methadone and its metabolite (EDDP)	15

6.8 Refusal to Test

It is a violation of this Policy for Workers to refuse to submit to an alcohol or drug test administered under this Policy. Such refusal is deemed to be a positive test for the purposes of this Policy.

Refusal to submit to an alcohol or drug test includes:

- failure of a Worker to report as required for a test;
- refusal to submit to a test;
- failure to provide a valid specimen unless acceptable proof of a relevant medical condition is provided by the Worker;
- tampering or a confirmed attempt to tamper with a test sample;
- refusal to agree to disclosure of a test result to CNL's Fitness for Duty Program Administrator;
- evading a test by failing to report involvement in an incident which may require testing or by evading management following involvement in an incident;
- failure to advise of release from a medical center or hospital if testing is delayed for medical reasons; and
- disrupting or any attempt to disrupt the testing process set out in this Policy.

6.9 Characteristics of Alcohol and Drug Testing Procedures

Alcohol and drug testing processes are based on rigorous collection, analysis and reporting procedures designed to ensure the accuracy and integrity of the results. Characteristics of the testing process are highlighted below.

6.10 Third Party Provider

CNL has engaged a third-party provider of workplace medical testing and assessments who will follow appropriate testing procedures.

6.10.1 Sample Collection

- Following a decision to test by CNL, the Worker to be tested is accompanied at all relevant times until the sample collection is completed.
- Collection of samples for alcohol and drug testing is performed by trained collection agents. Appropriate chain of custody and specimen integrity protocols is followed.
- In Post-Incident and For-Cause Reasonable Grounds testing, samples are collected as soon as possible after the Company's decision to test, but collection attempts end after eight (8) hours for an alcohol test and twenty-four (24) hours for a drug test.
- Processes and procedures are established by the third-party provider to address shy lung, shy bladder, dry mouth and collection errors.

6.10.2 Alcohol Testing

- Where an alcohol test is 20 mg/100 mL BAC or greater a confirmatory test for alcohol is performed.
- Alcohol tests are administered using a calibrated evidential breath analyzer.

6.10.3 Point of Collection Testing

In Random or Post-Incident testing circumstances Point of Collection Test (POCT) devices may be used as a screening tool and/or to assess the risk of having a Worker return to duties pending the MRO's report on the urine or oral-fluid-based laboratory test. Where a POCT screening is non-negative, the Worker is subject to regular lab testing protocols. POCT devices are not used in pre-placement, reasonable grounds, follow-up or return to duty testing circumstances.

6.10.4 Drug Testing (other than for THC)

Drug tests (other than for the presence of THC) are administered in accordance with applicable procedures employed by the third-party provider which include the following:

- the Worker provides a urine sample and/or an oral fluid sample as determined by CNL;
- if applicable, a POCT is conducted on the sample; where samples are collected for transfer to the laboratory,
    - for urine:
        - the sample is split into an A sample and B sample for transfer to the laboratory;
        - at the laboratory, an initial immunoassay test is performed on the A sample;
    - for oral fluid:
        - a primary and secondary sample of oral fluid is collected for transfer to the laboratory;
        - at the laboratory, an initial immunoassay test is performed on the primary sample;

- Where the immunoassay test is non-negative, a confirmation analysis is performed by gas chromatography/mass spectrometry (GC/MS) or liquid chromatography-tandem mass spectrometry (LC/MS).

6.10.5 Drug Testing for THC

Drug tests for testing of the presence of THC are administered in accordance with applicable procedures employed by the third-party provider which include the following:

- in Random and Post-Incident testing the Worker may be required to provide an appropriate sample for POCT testing;
- in the event of a non-negative POCT test result for cannabinoids or where no POCT test is conducted, a primary and secondary sample of oral fluid is collected for transfer to the laboratory;
- where samples are collected for transfer to the laboratory an initial immunoassay test is performed on the primary sample;
- where the immunoassay test is non-negative, a confirmation analysis is performed by GC/MS or LC/MS.

6.10.6 Results and the MRO

- For all drug testing other than THC, the urine sample will be used to determine a Policy violation. For THC, the oral fluid sample will be used to determine a Policy violation.
- Laboratory confirmed positive, adulterated, and/or invalid test results are forwarded to and reviewed by an MRO who will discuss the results with the tested Worker. The tested Worker is given an opportunity to provide an explanation for the results.
- The MRO determines the result to be reported to CNL's Fitness for Duty Program Administrator.
- Within seventy-two hours of receiving their results, any Worker who has a verified positive test result may request the MRO to direct the split sample/secondary sample to be tested by an accredited laboratory of the Worker's choice. If a second confirmed positive test is reported, the Worker is responsible for the associated costs of testing the split sample/secondary sample. If the second confirmed test is negative, this is the final test result that is used.

6.10.7 Quality Assurance

For a minimum of 5% of negative POCT tests, negative POCT results are anonymously compared with laboratory-based results on the same type of biological sample (urine or oral fluid), for quality assurance purposes.

7. Documented Information

Creation, Capture and Use of Information Assets [9] provides current information on the storage, preservation, turnover and retention requirements for records.

Administered test results will be maintained for workers holding safety-critical or safety-sensitive positions, within a dedicate file in the Health Centre.

8. References

[1] REGDOC-2.2.4, Fitness for Duty, Volume II: Managing Alcohol and Drug Use, Version 3, https://www.cnsc-ccsn.gc.ca/eng/acts-and-regulations/regulatory-documents/published/html/regdoc2-2-4-v2-version3/

[2] *Glossary of Controlled Terms and Acronyms*, https://cnllnc.sharepoint.com/sites/TermsandDefinitions

[3] *REGDOC-2.2.3 Volume III, Certification of Persons Working at Nuclear Power Plants,* Canadian Nuclear Safety Commission, 2019, https://www.nuclearsafety.gc.ca/eng/acts-and-regulations/regulatory-documents/published/html/regdoc2-2-3-v3/

[4] *REGDOC-2.12.1, High-Security Sites Volume I: Nuclear Response Force,* Canadian Nuclear Safety Commission, 2018, https://www.cnsc-ccsn.gc.ca/eng/acts-and-regulations/regulatory-documents/history/regdoc2-12-1/

[5] *Employee & Family Assistance Program (EFAP),* https://mycnl.corp.cnl.ca/employee-family-assistance-program-efap

[6] *Fitness for Duty Assessment*, https://mycnl.corp.cnl.ca/hsse/health-centre/management-system-and-other-documents

[7] *Fitness for Duty Assessment*, 900-510000-FM-008114, 71952246

[8] *Radiation Protection Regulations (SOR/2000-203),* dated 2026-02-18, https://laws-lois.justice.gc.ca/eng/regulations/sor-2000-203/index.html

[9] *Creation, Capture and Use of Information Assets,* 900-511300-STD-003, 50746207

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

Corporate Policy

Safety and Health

1. Purpose

Canadian Nuclear Laboratories Ltd. (CNL) is committed to the prevention of work place injury and health events while working to continually improve our safety and health performance. The purpose of this Policy is to establish standards and expectations with respect to safety and health.

2. Roles and Responsibilities

It is the responsibility of all employees to understand and implement this Policy at CNL.

Executives, managers, and supervisors have key roles in leading by example and ensuring that standards relating to Safety and Health apply to all workers, regardless of title or position within CNL. Anyone who violates this Policy or any other safety rules, causes dangerous or hazardous situations, or who fails to report or remedy such situations may be subject to disciplinary action. All employees are ultimately accountable through their behaviours, attitudes and actions related to their safety and that of their coworkers.

The *Canadian Nuclear Laboratories Management System Manual* defines the organizational responsibilities, authorities, and accountabilities.

The establishment and annual review of this Policy is the responsibility of the President and Chief Executive Officer.

The President and Chief Executive Officer will ensure appropriate supervision of its Implementation by CNL's Executive Management team.

The Board of Directors is responsible for the authorization of this Policy.

3. Policy

CNL and all its workers are committed to provide a safe and healthy working environment for all its employees, contractors and other persons who access our sites in order to prevent accidents, occurrences of harassment and violence and physical or psychological injuries and occupational illnesses, in accordance with the *Canada Labour Code Part II* and its associated regulations.

CNL also recognizes the importance of psychological health and safety in the work place and promotes a positive working environment where executives, management and employees collaborate to achieve CNL’s goals while also supporting the mental health of all employees.

CNL's approach to Safety and Health is based on a 'safety management system' approach (e.g. *CSA ISO 45001:2018, Occupational health and safety management systems – Requirements with guidance for use*.) whereby emphasis is placed on continual improvement of its Safety and Health management and performance. To this end, CNL has established a clear vision of safety excellence which includes the core aspects of compliance, protection, and improvement.

While CNL's primary focus is prevention, we also provide and maintain robust processes for emergency response and mitigation.

CNL understands the value of consultation, collaboration and involvement with employees and employee representatives in identifying opportunities to improve all aspects of the health and safety of its employees and strive toward a world class health and safety program.

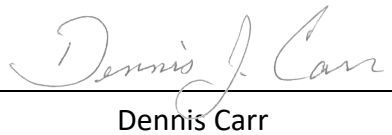
CNL expects all employees to be engaged and consulted in the work planning process, with open and transparent communication that includes sharing of new ideas that will contribute to a safer outcome. Every employee at CNL is both empowered and responsible to stop/pause work, including that of others, when they feel it is not safe to proceed. Employees have the authority to stop work without fear of reprisal.

Safety and Health is actively promoted through the provision of information, training, instruction, and supervision. Employees are required to participate, and to report concerns (e.g. unsafe conditions, non-compliances, or events) in order to identify hazards and ensure measures are put in place to prevent injury or illness.

Emphasis is placed on a systematic approach to the identification of hazards and the allocation of resources to control them. In order to deliver these responsibilities CNL undertakes to:

- Maintain a safe and healthy work place.
- Promote mental health and psychological well-being through appropriate polices, programs and services.
- Perform inspections and evaluations on an on-going basis to assist in the identification and assessment of hazards and the setting of prioritised objectives for elimination and reduction of risk.
- Provide sufficient information, instruction, training, and supervision to enable employees to recognize hazards, avoid injury and contribute to the health and safety of themselves and others at work.
- Consult with employees on issues relating to Safety and Health.
- Ensure access to competent advice relating to Safety and Health.
- Apply a 'hierarchy of controls' approach to minimize Safety and Health risk.
- Ensure compliance with legislative and other requirements.
- Arrange for the effective planning, organisation, control, monitoring, and review of preventative and protective measures.
- Commit to reporting Safety and Health performance within its annual report.

This Policy will be communicated to all persons working under the control of the organization and will be made available to interested parties on request.



Dennis Carr

President and Chief Executive Officer

2026 May 21

Authorized by the CNL Board of Directors as of 2026 May 21.

Revision History

Rev. No.	Date	Details of Rev.	Authored By	Reviewed By	Approved By
4.4	2026/05/21	Issued as "Approved for Use." *The content in this document was reviewed for accuracy and applicability at the 2026 May 21st CNL Board of Director's meeting*.	M. Mitchell	M. Proctor	D. Carr
4.4D1	2026/04/07	Issued for "Review and Comment." Minor change: • Updated to new template to be endorsed by the New President and Chief Executive Officer. • No changes to content.	M. Mitchell	M. Proctor CNL Policy Committee	
4.3	2025/11/19	Issued as "Approved for Use". *The content in this document was reviewed for accuracy and applicability at the 2025 November 19th CNL Board of Director's meeting.*	E. Broughton	M. Proctor	J. Craig
4.3D1	2025/10/09	Issued for "Review and Comment" Minor Change: • Updated to new template to be endorsed by the President and Chief Executive Officer. • No changes to content	E. Broughton	M. Proctor CNL Policy Committee	J. Craig
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Rev. No.	Date	Details of Rev.	Authored By	Reviewed By	Approved By
		by the New President and Chief Executive Officer. • Section 2. Roles and Responsibilities to align with other CNL Corporate Policies. • Section 3 aligned sentence with the Canada Labour Code language.			
4.1	2023/11/15	Issued as "Approved for Use". *The content in this document was reviewed at the 2023 November CNL Board of Director's meeting.*	E. Broughton	E. Broughton J. Willman	J. McBrearty
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4	2022/11/16	Issued as "Approved for Use". *The content in this document was reviewed at the 2022 November CNL Board of Director's meeting.*		E. Broughton J. Willman	J. McBrearty
4D1	2022/09/01	Issued for "Review and Comment" The Safety and Health Policy has been updated to: • clarify roles and responsibilities of employees and set expectations for leaders • expand CNL's wellness program to incorporate psychological health and safety in the workplace		E. Broughton J. Willman	

Rev. No.	Date	Details of Rev.	Authored By	Reviewed By	Approved By
		• incorporate CNL's vision of safety excellence and • Align with the detailed requirements of CSA ISO 45001:2018.			
3	2021/11/10	Issued as "Approved for Use". *The content in this document was reviewed at the 2021 November CNL Board of Director's meeting.*		L. Nel J. Willman	J. McBrearty
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2	2020/11/11	Issued for "Approved for Use". *The content in this document was reviewed at the 2012 November CNL Board of Director's meeting.*		L. Nel	J. McBrearty
2D1	2020/09/23	Issued for Review and Comment". • Minor administrative update to new template to be endorsed by the new President and Chief Executive Officer. • No changes to content.		L. Nel	
1	2018/11/29	Issued for "Approved for Use". Minor administrative updates. *The content in this document was reviewed at the 2018 November CNL Board of Director's meeting.*		J. Gibb SSHC	M. Lesinski
0	2017/11/09	Issued for "Approved for Use".		K. Daniels D. Murphy	M. Lesinski

Rev. No.	Date	Details of Rev.	Authored By	Reviewed By	Approved By
		Removed from 900-510400-PDD-001 as a stand-alone document.			

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

Corporate Policy

Environment

1. Purpose

Canadian Nuclear Laboratories Ltd. (CNL) is committed to environmental protection and sustainable development. The purpose of this Policy is to contribute to CNL's commitment to corporate social responsibility.

CNL includes protection of the environment and sustainable development as an integral component of our decision-making in all phases of our business activities and processes. We also focus our environmental efforts on minimizing nuclear legacy obligations for future generations. The Environment Policy applies to all aspects of CNL's activities.

2. Roles and Responsibilities

It is the responsibility of all CNL employees to understand and implement this Policy at CNL.

Employees shall conduct their work such that all reasonable precautions are implemented to ensure the protection of the environment and that sustainable development practices are followed.

Executives, managers, and supervisors have key roles in leading by example and ensuring that standards related to the environment apply to all employees, regardless of title or position within CNL. This includes ensuring that potential environmental impacts associated with their operations, activities, products, and services are assessed and managed to be as low as reasonably achievable. In addition, they shall ensure that employees under their authority comply with the requirements set out by this Policy, as well as environmental protection program procedures.

The *Canadian Nuclear Laboratories Management System Manual* defines the organizational responsibilities, authorities, and accountabilities.

The establishment and annual review of this Policy is the responsibility of the President and Chief Executive Officer.

The President and Chief Executive Officer will ensure appropriate supervision of its implementation by CNL's Executive Management team.

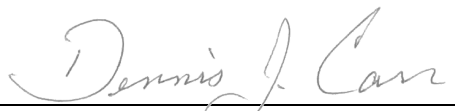
The Board of Directors is responsible for the authorization of this Policy.

3. Policy

CNL and all its workers are committed to the protection of the Environment and continual improvement of environmental performance through the effective and efficient application of CNL's management system.

CNL commits to the following:

- We practice responsible environmental management.
- We are committed to pollution prevention[1].
- We set environmental sustainability objectives and targets to address climate change, energy management, waste management and conservation of resources to support continual improvement and enhance our performance.
- We fulfill compliance obligations (including federal and provincial requirements) applicable to our activities and processes.
- We review, monitor, and manage the impacts of our activities, facilities, projects, services, and products on the environment.
- We seek to develop and improve technologies to advance environmental protection and clean air solutions.
- We engage with the public and Indigenous communities and promote awareness of this policy and our environmental performance.



Dennis Carr

President and Chief Executive Officer

2026 May 21

Authorized by the CNL Board of Directors as of 2026 May 21.

[1] Pollution prevention is defined as the use of processes, practices, materials, products, substances, or energy that avoid or minimize the creation of pollutants and waste and reduce the overall risk to the environment or human health

Revision History

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3.4	2026/05/21	Issued as "Approved for Use." *The content in this document was reviewed for accuracy and applicability at the 2026 May 21st CNL Board of Director's meeting.*	C. De Waele	M. Proctor	D. Carr
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Rev. No.	Date	Details of Rev.	Authored By	Reviewed By	Approved By
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3D1	2022/09/01	Issued for "Review and Comment." • Updated to new template to be endorsed by the President and Chief Executive Officer. • Addressed changes in CSA ISO 14001:2015, and the expectations around sustainability and indigenous engagement.	L. Theil	G. Dolinar J. Willman	
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Rev. No.	Date	Details of Rev.	Authored By	Reviewed By	Approved By
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0	2017/06/29	Issued as "Approved for Use." Minor changes to introduce energy efficiency. This document cancels and superseded *Environmental Policy* found in 900-509200-PDD-001.		G. Dolinar	K. Daniels

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

CRL Non-Radioactive Effluent and Emissions Verification Monitoring Plan

CRL-509200-PLA-003

Revision 2.1

REDACTED

Approved by: George Dolinar — 2025/03/31

Director, Corporate Environmen — Date

Effective Date: 2025/03/31
Expiry Date: 2030/03/31

Refer to ATOM for current version. Printed copies should not be considered current without first consulting ATOM.

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Revision History

Rev. No.	Date	Details of Rev.	Authored By	Reviewed By	Approved By
2.1	2025/03/27	Issued as "Approved for Use". Effective Date: 2025/03/31	K. Lambert	C. De Waele	G. Dolinar
2.1D1	2025/03/07	Issued for "Review and Comment": Minor changes including: 1. New template/format 2. Updated non-rad liquid monitoring to reflect current monitoring schedule. 3. Updated to reflect latest ERA (2024). **4.** Included the word "Emissions" to the title.	K. Lambert	C. De Waele L. Ogilvie A. Mantifel	
2	2022/03/31	Issued as "Approved for Use" Effective Date 2022/05/13	K. Lambert	C. De Waele	G. Dolinar
2D1	2022/02/18	Issued for "Review and Comment": • New template/format • Updated to reflect changes to monitoring since Rev 1 was issued. • Removed Storm Outfall monitoring locations: [redacted] • Added Monitoring station Storm Outfall [redacted] Added airborne emission detailed tables	K. Lambert	C. De Waele C. Matasich Information Management	
1	2014/11/26	Issued as "Approved for Use"	K. Lambert	C. Gallagher	G. Dolinar
1D1	2014/11/11	Removed term "AECL" where possible. Replaced CA1 and CA2 with Supervised Area and Controlled Area. Changed TRCl and ETB sampling and analysis from STP to ETB.	K. Lambert	C. Gallagher A. Ethier	

REDACTED

		Updated Appendix C to reflect current labs used and their analyses. Included comparison of analysis methods used to that recommended by MISA (Appendix C) and an expanation for deviations. Updated to reflect 2012 ERA instead of 2005 EER (included requirement for construction dust monitoring and Chlorine monitoring at PRO). Included the requirement of Toxicity Testing at IMH. Minor editorial changes and reference updates.			
0	2013/12/23	Issued as “Approved for Use”.	K. Lambert	C. Gallagher	G. Dolinar
D1	2013/12/20	Issued for “Review and Comment”.	K. Lambert	C. Gallagher	

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1. Purpose and Scope

The purpose of this monitoring plan is to document the decision for the need of a Non-Radioactive Effluent Verification Monitoring Program (EVMP) for the Chalk River Laboratories (CRL). It also provides justification for the individual monitoring activities that are part of this EVMP.

The CRL Non-Radioactive EVMP was developed and is executed in such a way as to conform with the *Municipal/Industrial Strategy for Abatement (MISA)* program [1] and to comply with:

- Conditions in the CRL Operating Licence [2] and Licence Conditions Handbook [3];
- *Chalk River Laboratories Integrated Environmental Monitoring Framework* [4];
- *Management and Monitoring of Effluents and Emissions* [5];
- CSA N288.5:22 [6];
- Other applicable regulations and standards; and
- CNL policies.

Common elements among all of the CRL monitoring components such as auditing and training are not included in this specific plan but instead are in *Chalk River Laboratories Integrated Environmental Monitoring Framework* [4].

This plan addresses only non-radioactive airborne and waterborne effluent verification monitoring. It does not address:

- Effluent Verification Monitoring of radioactive contaminants or physical stressors: These are covered in a separate site-specific document, *CRL Radioactive Effluent and Emission Verification Monitoring Plan* [7];
- Environmental Monitoring (EM): There are a number of contaminated groundwater plumes emanating from certain waste management areas that are (or could) surface to above-ground waters. The need to monitor these surface waters and the airborne fugitive emissions from contaminated surface waters is assessed in the *CRL Environmental Monitoring Plan* [8]. Note that a subset of these surface waters discharge directly to the Ottawa River and these are considered 'waterborne effluent' and as such are assessed within this document;
- Groundwater Monitoring: The monitoring of controlled and uncontrolled releases to the ground are conducted under the site's Groundwater Protection Program. The need to monitor these releases is assessed in the *CRL Groundwater Protection and Monitoring Plans* [9]; and,
- Operational Control Monitoring: This is covered in facility-specific documentation.

This document is primarily intended for use by EnvP staff as well as other groups or laboratories which are directly involved in the CRL's Non-Radioactive EVMP.

Note that the EVMP is dynamic in nature and is continually evolving. As a result, this plan is current as of its issuance but does not necessarily completely reflect the program after this date. The most current monitoring schedule should always be consulted [10].

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2. Definitions and Acronyms

This document relies primarily on word meaning as found in common dictionaries. The current *Glossary of Controlled Terms and Acronyms* [**11** contains specific meanings for those words that require further clarification. For environmental definitions commonly used, refer to the *Environmental Protection Program Description Documentation* [**12**.

3. Need for a Non-Radioactive Effluent and Emission Verification Monitoring Program

The criteria used to determine whether there was a need for CRL to establish a Non-Radioactive EVMP as outlined in the EnvP Program procedure, *Management and Monitoring of Effluents and Emissions* [**5** are duplicated in Table 1 below. The criteria which were met by CRL, thereby requiring the need to establish CRL's Non-Radioactive EVMP, are identified. An EVMP is needed if one or more of the criteria is met. As indicated in Table 1, more than one criterion is met, thus necessitating the establishment of a Non-radioactive EVMP.

Table 1: Need for a Non-Radioactive EVMP at CRL

Criteria for Establishing an EVMP [5]	Criteria Met at CRL? (Yes/No & Justification)
(shall) An EVMP for monitoring of non-radioactive effluents and emissions for the CRL site shall be established if:	
a) An Authority Having Jurisdiction (AHJ) requires it;	Yes: 1. CNSC-granted CRL Operating Licence Handbook [3]: "The licensee shall control, monitor and record releases of hazardous substances such that the releases do not exceed the reference levels (limits) specified in Tables 9-1. "And "*Compliance Monitoring: Annual Reporting:* The licensee shall prepare and submit to the CNSC staff … written reports that cover: the results of environmental monitoring for nuclear substances and hazardous substances". 2. Public Information and Disclosure REGDOC-3.2.1 [13]. 3. Environment Canada requires reporting on: a) National Pollutant Release Inventories as per the *NPRI Notices* [14], b) Greenhouse Gases (GHG) emissions as per the *GHG Notices* [15] and, c) Halocarbon releases as per the *Federal Halocarbon Regulations* [16]. 4. Domestic wastewater emissions as per the *Wastewater System Effluent Regulations* [17]
b) The results of an Environmental Risk Assessment (ERA) (or equivalent) indicate potential concern;	Yes: The *Environmental Risk Assessment of CRL* [18], identified a number of Contaminants of Potential Concern (COPC). These contaminants are considered to have a potential risk above acceptable exposure thresholds for on-site ecological receptors and are therefore deemed appropriate to be monitored under the routine non-radiological EVMP.
c) There is a need for having the capability of identifying an unplanned emission; or	Yes: Although the CRL site has extensive process monitoring managed by various facilities, the EVMP parallels a defense-in-depth approach by providing a redundant and independent means of identifying unplanned emissions.

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Criteria for Establishing an EVMP [5]	Criteria Met at CRL? (Yes/No & Justification)
d) The EVMP would support a radiation dose assessment or assessment of potential exposure to hazardous substances.	Yes: The results of the EVMP are used for input into the site's regular Environment Risk Assessments which identify potential exposure to hazardous substances as the result of CRL operations.

4. Systematic Planning Process

As determined in Section 3, a site-wide Non-radioactive Effluent and Emission Verification Monitoring Program (EVMP) is required for the CRL. In this section, a systematic planning process is used, as per the guidance of the CSA N288.5:22 Standard [6], to determine the breadth and scope of the EVMP. The results of this process is a determination of which effluent and emission streams to monitor, what contaminants to monitor for, which monitoring strategy to use, and any performance or acceptance criteria to be applied to the collected data. As defined in the CSA N288.5:22 Standard [6], this systematic planning process consists of five steps:

STEP 1: Define the objectives of the CRL Non-Radioactive EVMP (Section 4.1).

STEP 2: Identify the information required to meet the defined objectives (Section 4.1).

STEP 3: Determine how the data collected will be used to achieve the defined objectives (Section 4.1).

STEP 4: Specify performance and acceptance criteria (Section 4.2).

STEP 5: Develop the detailed design of the EVMP that will be implemented to obtain the required data (Section 4.3).

The same systematic planning process is also applied when making changes to the EVMP.

4.1 Effluent and Emission Verification Monitoring Program Objectives and How They Are Met

This Section covers the first three steps of the Systematic Planning Process:

Step 1: Define the objectives of the CRL Non-Radioactive EVMP;

Step 2: Identify the information required to meet the defined objectives; and,

Step 3: Determine how the data collected will be used to achieve the defined objectives.

Table 2 outlines both the primary and secondary objectives of the CRL Non-Radioactive EVMP which were established in the procedure *CRL's Integrated Environmental Monitoring Framework* [4]. The primary being those objectives that "shall be considered" under the program according to the CSA N288.5:22 Standard [6] and the secondary are those which could be included. Table 2 also provides an explanation for any objectives listed in the Standard that are not part of the CRL Non-Radioactive EVMP.

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Defining the information required to meet each CRL Non-Radioactive EVMP objective is a useful pre-cursor step to deciding on the detailed design of the CRL Non-Radioactive EVMP and is also outlined in Table 2 below. It is clear that knowledge of contaminant concentrations and/or contaminant loadings to the environment from significant airborne emission and waterborne effluent streams constitutes a great part of the information required to meet CRL Non-Radioactive EVMP objectives.

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Table 2: The Required Information to be Collected and How the Data will be used to Achieve the CRL Non-Radioactive EVMP Objectives

EVMP Monitoring Objective [4]	Details on Objective (Explanation)	Information Required to Meet Objective	How Collected Data will be used to Achieve Objective
Primary Monitoring Objectives ("licencees shall consider")			
a) To demonstrate compliance with regulatory release limits and any other regulatory requirements (e.g., Action Levels) concerning the emission of nuclear/hazardous substances from the source	An objective of the CRL Non-Radioactive EVMP is to demonstrate compliance with:		
	CNSC issued Operating Licence Handbook **[3]**		
	• The requirement to control, monitor and record liquid effluent releases from PRO (pH) and the WTC_LWE (Phosphorus, TSS, Oil/Grease. Chromium, Copper, Lead, mercury, Nickel and Zinc) maintaining releases below defined Reference Limits.	For PRO liquid effluent, need knowledge of monthly average pH. For WTC_LWE liquid effluent, need knowledge of the monthly average concentrations (mg/L) of defined hazardous substances in effluent stream.	*Did the site release hazardous substances which are reportable under the operating licence?* Compare release concentrations to the Reference Limits in the licence and report, if required.
	• The licensee shall implement and maintain an environmental protection program, which includes a set of Action Levels in compliance with N288.8 [19].	Need knowledge of non-radiological effluent monitoring results (contaminant concentrations).	*Do any site emissions exceed Action Levels?* Routinely compare non-radiological EVMP results against program's Action Levels.
	Public Information and Disclosure REGDOC-3.2.1 [13] [20]		
	• To improve the level of understanding by the public of information about proposed or licensed nuclear facilities and activities, licensees are required to develop and	As outlined in Public Information Program for CNL, [20] need knowledge of: • Annual Airborne emissions of NO_x and SO_x; and, • Any loss of refrigerant as listed under the *Federal Halocarbon*	Collect and maintain results of reportable emissions and report through CNL's external website as required.

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EVMP Monitoring Objective [4]	Details on Objective (Explanation)	Information Required to Meet Objective	How Collected Data will be used to Achieve Objective
	implement a public information program that includes a disclosure protocol.	*Regulations* [16] greater than 100 kg.	
	Federal Legislation: *Canadian Environmental Protection Act (CEPA)* [21]		
	• *National Pollutant Release Inventory* (NPRI) reporting Notices [14]	Need knowledge of the site's manufacturing, production or otherwise use and releases of any substances in Parts 1 to 5 of the NPRI.	*Are any NPRI substances reportable for the site*? Compare site's manufacturing, production or otherwise use and releases of any substances in Parts 1 to 5 of the NPRI to NPRI reporting thresholds and report, if required.
	• Green House Gases (GHG) Emissions reporting Notices [15].	Need knowledge of the site's GHG emissions (quantities).	*Are the site's GHG emissions reportable?* Compare site's GHG emissions to Environment Canada yearly reporting threshold and report annually, if required.
	• *Federal Halocarbon Regulations* [16].	Need knowledge of any halocarbon releases greater than 10 kg from refrigeration systems, air-conditioning systems, and fire-extinguishing systems.	*Were there any reportable halocarbon release events?* Compare each individual event (halocarbon release quantity) to FHR reporting threshold of 10 kg or more. For all releases >10kg, report these collectively on a semi-annual basis. For each individual release greater than 100 kg, report immediately (in addition to semi-annually).
	Federal Legislation: *Fisheries Act* [22]		
	• *Wastewater System Effluent Regulations* [17]	Need knowledge of Sanitary Sewage Treatment Facility releases (effluent quality and volume).	*Did the STP discharge effluent during the year?* Compare quarterly average concentrations of CBOD, TSS and unionized ammonia to regulatory limits. On a quarterly basis, report all months when STP discharges took place, the # of days when discharges took place, the total volume of effluent discharged and the average concentration of CBOD and TSS (not unionized ammonia).

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EVMP Monitoring Objective [4]	Details on Objective (Explanation)	Information Required to Meet Objective	How Collected Data will be used to Achieve Objective
b) To demonstrate adherence to internal levels set on effluent amounts (Administrative Levels) for purposes of effluent control.	Internal Administrative Levels are set for specific contaminants in specific effluent streams. CRL's EVMP data is routinely compared to these internal limits, as appropriate.	Need knowledge of non-radiological effluent monitoring results (contaminant concentrations).	*Do any site effluents exceed internally set effluents levels?* Routinely compare non-radiological EVMP results against internal effluent levels.
c) To confirm the adequacy of controls on effluents from the source.	Although the CRL site has process monitoring managed by the various facilities, the EVMP parallels a defense-in-depth approach by providing a redundant and independent means of identifying unplanned effluents.	A change in waterborne effluent contaminant concentrations to the environment over time could be indicative of a change in the level of control on effluents. Hence to meet this objective, need routine knowledge of non-radiological effluent monitoring results (concentrations) and an understanding of what 'normal' effluents are for a given waterborne effluent stream.	*Are there any abnormally high releases in any of the significant effluent streams?* Routinely trend monitoring results for the various effluent streams and determine whether or not results are as anticipated. Any upward trend, if not coincident with planned work, may suggest a need for increased control and should be investigated.
d) To provide an indication of unusual or unforeseen conditions that might require corrective action or additional monitoring.	Routine monitoring of site effluents and emissions allows for the identification of unusual conditions and the implementation of corrective action and/or additional monitoring, if required. An example of an unusual or unforeseen condition would be an upset at the Waste Treatment Centre Liquid Waste Evaporator (WTC_LWE).	Need knowledge of non-radiological effluent and emission monitoring results and an understanding of what is 'normal' for a given effluent or emission stream. Example results include: • Contaminant concentrations at waterborne final discharge points (or points representative of final discharge) • Waterborne flow rates at final discharge points (or discharge volumes)	*For abnormally high releases in any significant airborne emission or waterborne effluent stream, is corrective action or additional monitoring needed?* Investigate source of abnormal monitoring results and raise remedial or corrective actions or put in additional monitoring, as required.

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EVMP Monitoring Objective [4]	Details on Objective (Explanation)	Information Required to Meet Objective	How Collected Data will be used to Achieve Objective
		For example, in order to obtain an indication of an issue arising with the Power House Discharge (PPD), one needs knowledge of typical contaminant concentrations in the PPD effluent and flow.	
e) To provide data to assess the level of risk on human health and safety, and the potential biological effects in the environment of the nuclear/ hazardous substances of concern released from the facility.	The CRL Non-Radiological EVMP serves to support the periodic update of the site's Environmental Risk Assessment which includes a Human Health Risk Assessment (HHRA) (human exposure assessment) and an Ecological Risk Assessment (EcoRA) (non-human biota exposure assessment).	For each airborne emission and waterborne effluent stream, need to: • Collect non-radiological contaminant concentrations and effluent flows; or • Perform estimations based on operational information such as fuel use; and • Know the dilution factors for each CRL effluent stream; and, • Ecological benchmark values applicable to CRL.	*Are CRL's non-radiological effluents or emissions of concern to the environment?* Compare effluent and emission results to ecological benchmark values making sure to take into consideration dilution factors for each effluent stream.
f) To confirm predictions in environmental assessments.	CRL Site ERA [18].	Only general information is required to meet this objective, i.e., knowledge of contaminant concentrations at final discharge points is sufficient in order to confirm predictions. If recommendations are made by the ERA to gather more monitoring results for a given effluent/emission or parameter, this should be done prior to the update of the next ERA.	Collect and maintain results of any compliance monitoring performed for inclusion in the next revision of the site's ERA.
Secondary Monitoring Objectives:			
a) To provide data for trend analysis.	Non-radiological effluent and emission data collected through the CRL EVMP are trended routinely.	For each airborne emission and waterborne effluent stream, need: • knowledge of what 'normal' effluents and emissions are for a	*Are there any trends being observed in releases in any of the site's effluents or emission streams?* Routinely trend monitoring results for the various effluent and emission streams and determine

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EVMP Monitoring Objective [4]	Details on Objective (Explanation)	Information Required to Meet Objective	How Collected Data will be used to Achieve Objective
		given emission and effluent stream; • to collect non-radiological contaminant concentrations and effluent flows; or • to perform estimations based on operational information such as fuel use.	whether or not results are as anticipated. Any concerning trend, if not coincident with planned work, may suggest a need for increased control and should be investigated.
b) To provide assurance to employees and the public on the effectiveness of emission and effluent control.	Non-radiological effluents and emissions data collected through the CRL EVMP are posted annually on CNL's external website. As well, non-radiological releases which are considered of public interest, including some routine effluents and emissions as well as environmental emergency reportable events are reported as required.	Need knowledge of: • Site's routine non-Radiological airborne emission and waterborne effluents; and • Any reportable events associated with non-radiological effluents or emissions.	Employees only: Collect and maintain a site-wide database of monitoring data accessible to all employees (EDMS – Environmental Data Management System) Employees and Public: Collect, maintain and report results of the non-radiological monitoring program on the external website as: • The Annual Compliance Monitoring Report; and • Required by the Public Information Program [20] (NO_x, SO_x and Halocarbon releases). Non-radiological releases which are considered environmental emergency reportable events as per the Public Information Program [20] are reported as required on the external website.
c) To provide data which, when combined with the results of environmental monitoring and modelling can be used to test or refine the models of the environment used in	Although not routinely done, depending on the needs of ERA risk assessors, the data collected through the CRL EVMP could be used to refine or test standard models.	Only general information is required to meet this objective, i.e., knowledge of contaminant concentrations at final discharge points is useful.	Collect and maintain results of any effluent and emission monitoring performed for possible consideration in models used in the ERA.

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EVMP Monitoring Objective [4]	Details on Objective (Explanation)	Information Required to Meet Objective	How Collected Data will be used to Achieve Objective
the ERA or dose/exposure assessments.			
d) To provide baseline data and capability for monitoring and assessment in emergency conditions.	The data collected through the routine liquid monitoring program data can be used as a baseline as well as routine samples taken during an event can serve to assess the extent of the event. Note: Airborne monitoring is performed through estimation and therefore is not useful for this objective.	For each waterborne effluent stream, need to collect non-radiological contaminant concentrations and effluent flows.	*In an emergency situation, can any of the routine sampling we complete serve as a baseline and evidence of the extent of the event?* If the routine monitoring can serve as both baseline and evidence of an emergency condition, compare the pre-event results to the post-event result to aid in the determination of the extent of the event.
e) Other business purposes (e.g. demonstrating due diligence, meeting a stakeholder commitment, etc.)	Some upstream waterborne effluent locations being monitored despite the downstream effluent also being monitored is considered due diligence (e.g. WTC_LWE). Monitoring is also considered due diligence in the case of storm outfalls.	For the dominant upstream effluent stream (WTC_LWE), collect data for almost all contaminants that could be expected regardless of significance. For storm effluents, collect routine monitoring results.	Collect and maintain results of effluent monitoring performed reporting on trends.

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4.1.1 Effluent and Emission Stream Monitoring Justification

The set of monitoring criteria which specifies which non-radiological effluent and emission streams require monitoring under the Non-radiological EVMP are listed in Table 3. The criteria are designed to help identify more precisely the information required to meet the program's defined objectives.

The full set of criteria (radiological and non-radiological) are listed in *Management and Monitoring of Effluents and Emissions* [5] and the link between the criteria and the program objectives is detailed in *CRL's Integrated Environmental Monitoring Framework* [4].

Tables in Sections 4.1.1.1 to Section 4.1.1.3 list all of CRL's airborne emission and waterborne effluent streams respectively, including any fugitive emissions and effluents. The Tables identify whether each effluent or emission stream meets one or more of the monitoring criteria and if so, which one(s). Justification is provided, in the context of the criteria, for the selection of effluent and emission streams to monitor.

Table 3: Effluent and Emission Stream Monitoring Criteria for the Non-radiological EVMP

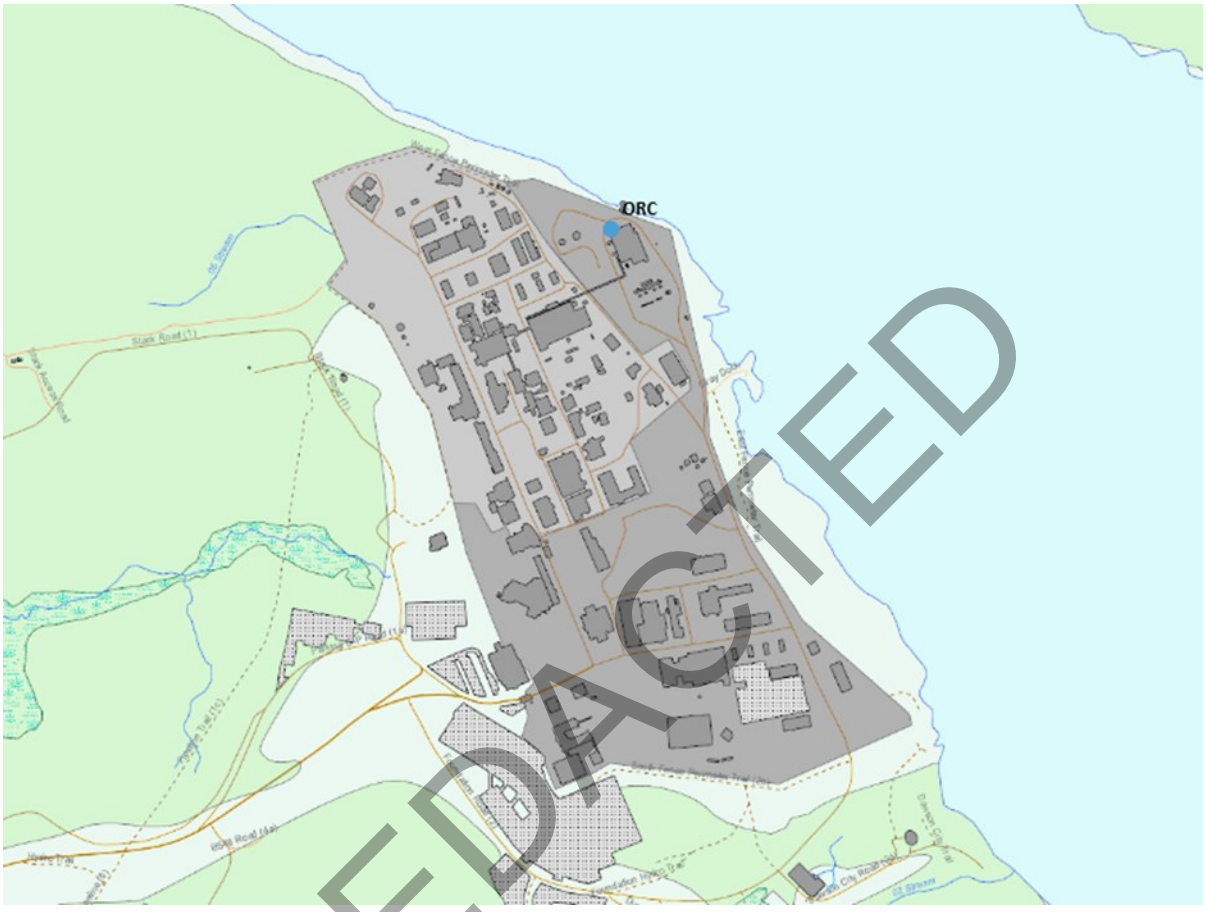
(a) (shall) If monitoring of the effluent or emission stream is required by an Authority Having Jurisdiction (AHJ) then that effluent or emission stream shall be monitored.
(d) (should) If the effluent or emission stream has potential to contribute to biological effects (as determined in an ERA or equivalent risk assessment), based on its constituent radioactive or non-radioactive contaminants, then that effluent or emission stream should be monitored.
(e) (should) If the effluent or emission stream contributes significantly to the dose/exposure for a receptor that has been identified as needing a dose/exposure assessment in an ERA or equivalent risk assessment, then that effluent or emission stream should be monitored.
(f) (should) If monitoring of the effluent stream is triggered under the Municipal/Industrial Strategy for Abatement (MISA) Program, then that effluent stream should be monitored.
(g) (should) In addition to the effluent and emission streams mentioned above, locations with similar environmental conditions but without potential for facility-related effects (i.e., representative of natural background) should be included in the EVMP as reference.
(q) (should) If monitoring is required for other business reasons (e.g., stakeholder concerns, due diligence, etc.).

Note: The lettering convention in this table is that given to the criteria in *Management and Monitoring of Effluent and Emissions* [5] and only includes those criteria which are related to non-radiological monitoring.

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4.1.1.1 Background/Reference Locations

Figure 1 and Table 4 provide details on the single background monitoring location for the Non-radiological EVMP.



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Figure 1: Background Monitoring Locations

Table 4: CRL Background Monitoring Justification

Location [2]	Source Description	Stream Monitoring Criteria Triggered [1]	Monitoring Required?	Justification
Ottawa River Intake (ORC)	This Intake Well draws water in from the Ottawa River for use on site's once-through-cooling water, fire water, service water etc. and represents background levels of the Ottawa River prior to any influences from CNL operations.	g	Monitoring Required	g: Monitoring provides background contaminant levels to aid in identifying what contaminants in CRL effluents are in fact from CRL operations.

Notes:

[1.] Criteria from Table 3 in Section 4.1.1.

[2.] Monitoring location is identified in Figure 2.

4.1.1.2 Waterborne Effluents

Figure 2, Table 5 and Table 6 provide details on the waterborne effluent monitoring locations for the Non-radiological EVMP.

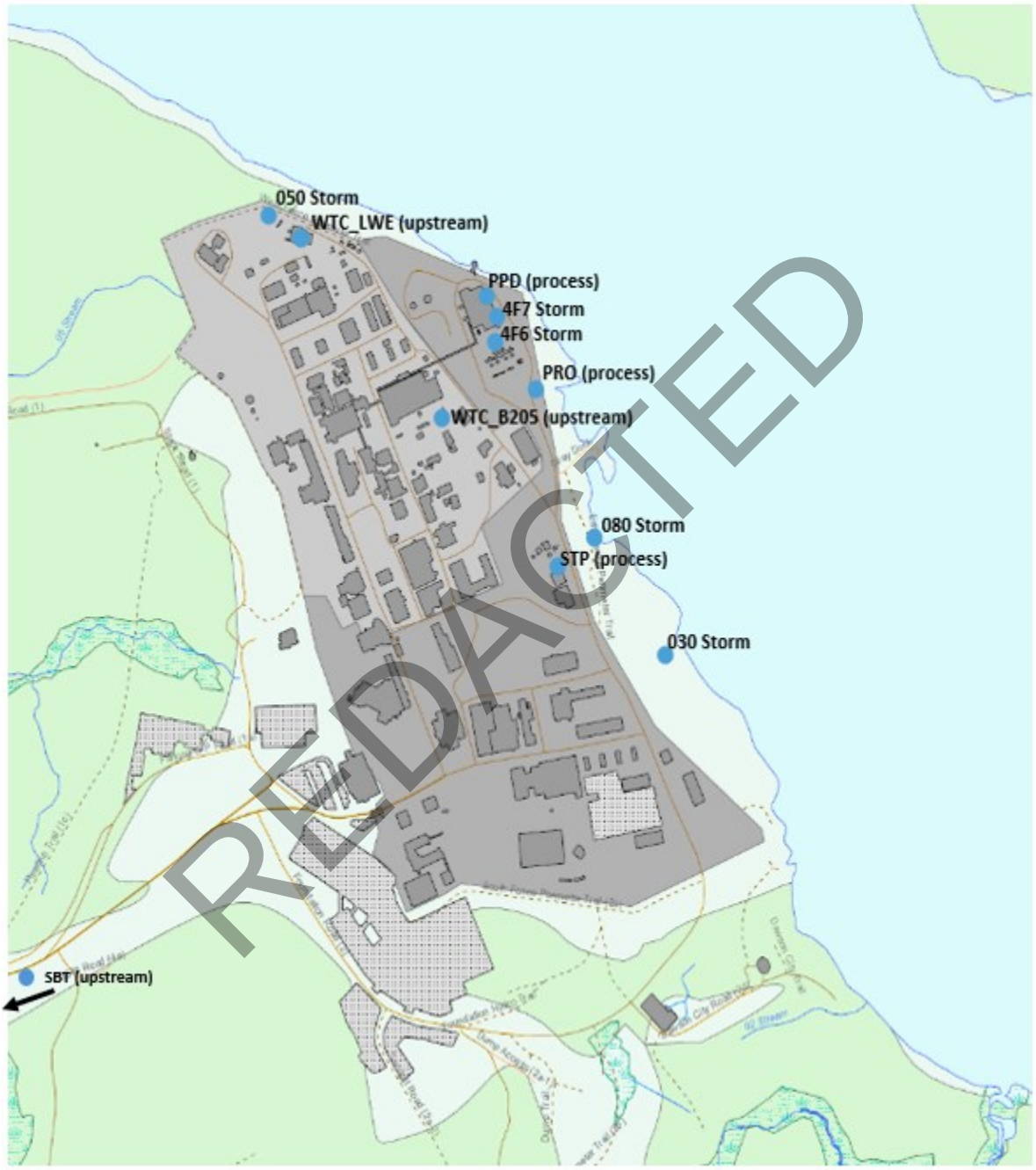


Figure 2: Waterborne Effluents Requiring Monitoring

4.1.1.2.1 Upstream Process Effluent Streams

Table 5: Upstream Process Effluent Monitoring Justification

Waterborne Effluent Stream [2], *Stream Type*, Treatment	Source Description	Stream Monitoring Criteria Triggered [1]	Monitoring Required?	Justification
Waste Treatment Centre Liquid Waste Evaporator (WTC_LWE) *Point batch* Treatment Facility	Upstream Effluent → Process Outfall Collection System → Ottawa River Treatment Centre processes/treats radioactive wastewater originating from a number of facilities/ laboratories in the active area via the Active Drain System, the Decontamination Centre and the Reactor Drain before discharging this distillate to the Process Outfall Collection System.	a, f, q	Monitoring Required	a: CRL license limits in place [3], therefore monitoring to demonstrate compliance. f: MISA process identified this release as a key process effluent which should be monitored prior to being diluted by PRO's flow in order to determine loading to the environment. It has a relatively small volume and can be masked by the flow of the Process Outfall. q: Monitored for due diligence as this stream is the main contributor of contaminants into the Process Outfall.
Waste Treatment Centre [redacted] *Point batch* No treatment	Upstream Effluent → Process Outfall Collection System → Ottawa River Non-active equipment cooling water from the Molybdeum-99 Facility (MPF) collected in tanks (46 E, F and G) prior to being batch discharged to the Process Outfall Collection System and then to the Ottawa River without additional treatment.	f	Monitoring Required	f: MISA process identified the effluent as a key process effluent which should be monitored prior to being significantly diluted by PRO's flow in order to determine loading to the environment.

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Waterborne Effluent Stream [2], *Stream Type*, Treatment	**Source Description**	**Stream Monitoring Criteria Triggered [1]**	**Monitoring Required?**	**Justification**
Spring B Treatment Facility (SBT) *Point continuous* Precipitation, filtration, ion exchange zeolite columns	Upstream Effluent → West Swap → Perch Creek → Ottawa River A groundwater Sr-90 contaminant plume originates from the unlined sand trenches in the northwest corner of WMA[redacted] The plume discharges as a series of seeps that coalesce into the Spring B Stream. The [redacted]Spring B Groundwater Treatment Facility collects water (surface water and groundwater) and its primary function is to treat it to remove Sr-90.	q	Monitoring Required	q: Monitoring for due diligence to increase our understanding of effluent quality, post-treatment.
Various Upstream Building Discharges *Point batch and continuous* No treatment	Upstream Effluent → Site Collection Systems → Ottawa River Individual building discharges into the site's Sanitary, Storm and Process Water Collection Systems	N/A	No Monitoring Required	Administrative Controls are in place [23] to restrict problematic discharges into these systems and each system (Process, Sanitary and Storm) is monitored at its final discharge point prior to entering the environment (Ottawa River) verifying that the administrative controls are effective.

Notes:

1. Criteria from Table 3 in Section 4.1.1.

2. Monitoring locations are identified in Figure 2.

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4.1.1.2.2 Final Effluent Streams

Table 6: CRL Final Effluent Monitoring Justification

Waterborne Effluent Stream [1], *Stream Type,* Treatment	Source Description	Stream Monitoring Criteria Triggered [2]	Monitoring Required?	Justification
Process Effluents				
Sanitary Sewage Treatment Facility (STP) *Point Batch* [3] Treatment Facility	Final Effluent → Ottawa River Facility accepts the Bulk Material Landfill liquid leachate, on-site sanitary holding tanks, sanitary drains in all labs across site accepting small quantities of chemicals, domestic raw sewage from sanitary collection system, backwash from water treatment systems on site and inactive areas and boiler blowdown from the Power House.	a, d, f, q	Monitoring Required	a: The *Wastewater Systems Effluent Regulations* [17] require monitoring of final effluents of the sewage treatment plant. d: Stream was identified as having one or more COPCs (screened in) in 2024 ERA [1]. f: MISA recommends monitoring final effluents of sewage treatment plants after all treatment and inputs but prior to entering the Ottawa River. q: Monitoring is required to potentially report under the Global Reporting Initiative – Water and Effluent [24].
Power House Discharge (PPD) *Point continuous* Oil/water separator	Final Effluent → Ottawa River Once through cooling water for equipment (e.g. pumps and air compressors) located in the Power House; and, roof run-off and building drainage.	d, f, q	Monitoring Required	d: Stream was identified as having one or more COPCs (screened in) in 2024 ERA [1]. f: MISA recommends monitoring final effluents entering the Ottawa River after all treatment (in this case an oil/water separator) and inputs but prior to entering the Ottawa River. q: Monitoring is required to potentially report under the Global Reporting Initiative – Water and Effluent [24].

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Waterborne Effluent Stream [1], *Stream Type,* Treatment	Source Description	Stream Monitoring Criteria Triggered [2]	Monitoring Required?	Justification
Process Outfall (PRO) *Point continuous* No treatment	Final Effluent → Ottawa River Water from [redacted] floor & roof drains and sumps; WTC_LWE treated distillate effluent; [redacted] effluent; and, effluent process water from other facilities on the CRL site.	a, d, f, q	Monitoring Required	a: CRL license limit in place **[3]**, therefore monitoring to demonstrate compliance. d: Stream was identified as having one or more COPCs (screened in) in 2024 ERA [1]. f: Under MISA, once-through-cooling water is required to be monitored at the final outfall after the addition of process and other effluent streams. q: Monitoring is required to potentially report under the Global Reporting Initiative – Water and Effluent [24].
Stormwater Outfalls to Ottawa River				
[redacted] Storm Outfall [redacted] *Point continuous* Settling Pond	[redacted] Storm Outfall → Ottawa River Road and roof run-off, cooling water and groundwater from the Controlled Area, Supervised Area as well as some parking lots.	d, f, q	Monitoring Required	d: Stream was identified as having one or more COPCs (screened in) in 2024 ERA [1]. f: MISA recommends monitoring final effluents entering the Ottawa River after all inputs. q: Monitoring is required to potentially report under the Global Reporting Initiative –Water and Effluent [24]. q: Monitoring for due diligence as this is the largest stormwater collection systems serving much of the built-up area as well as to verify that the settling pond is functioning as expected.
[redacted] Storm Outfall [redacted] *Point continuous* No treatment	[redacted] Storm Outfall → Ottawa River Minimal road and roof run-off from the vicinity of [redacted] as well as tile drains around [redacted]	N/A	No Monitoring Required	With the diversion of almost all of the [redacted] storm collection system to the [redacted] storm collection system, the measurable flows at [redacted] Storm Outfall have significantly reduced and/or non-existent with no flow during the semi-annual monitoring campaigns in the 2019, 2020 and 2021 CYs. As a result, this monitoring location was removed from the EVMP in 2022.

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Waterborne Effluent Stream [1], *Stream Type,* Treatment	Source Description	Stream Monitoring Criteria Triggered [2]	Monitoring Required?	Justification
[redacted] Storm Outfall [redacted] *Point continuous* No treatment	[redacted] Storm Outfall → Ottawa River Road and roof run-off, groundwater from Northeast portion of the Controlled Area.	d, f, q	Monitoring Required	d: Stream was identified as having one or more COPCs (screened in) in 2024 ERA [1]. f: MISA recommends monitoring final effluents entering the Ottawa River after all inputs. q: Monitoring for due diligence as this system is located just outside of the waste treatment center. Note: was historically a larger collection system (prior to storm redirection project in 2018) but has remained in the program since.
[redacted] Storm Outfall [redacted] *Point continuous* Settling Pond	[redacted] Storm Outfall → Ottawa River Road and roof run-off, cooling water, groundwater from northern built-up portion of the Controlled Area [redacted]	d, f, q	Monitoring Required	d: Stream was identified as a having one or more COPCs (screened in) in 2024 ERA [1]. f: MISA recommends monitoring final effluents entering the Ottawa River after all inputs. q: Monitoring for due diligence as this collection system serves a portion of the built-up area as well as to verify that the settling pond is functioning as planned.
[redacted] Storm Outfall [redacted] *Point continuous* No treatment	Manhole [redacted] Storm Outfall → Ottawa River Road and roof run-off, groundwater from the northeast portion of the Built-up portion of the Supervised Area.	d,f, q	Monitoring Required	d: Stream was identified as having one or more COPCs (screened in) in 2024 ERA [1]. f: MISA recommends monitoring final effluents entering the Ottawa River after all inputs. q: Monitoring for due diligence as this collection system serves a portion of the built-up area as well around the Power House and transformer yards.

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Waterborne Effluent Stream [1], *Stream Type,* Treatment	**Source Description**	**Stream Monitoring Criteria Triggered [2]**	**Monitoring Required?**	**Justification**
[redacted] Storm Outfall [redacted] *Point continuous* No treatment	Manhole [redacted] Storm Outfall → Ottawa River Road run-off, groundwater mainly from around the Power House and the [redacted] fuel oil storage tanks (water originating from outside of the Tanks' secondary containment area).	d, f, q	Monitoring Required	d: Stream was identified as having one or more COPCs (screened in) in 2024 ERA [1]. f: MISA recommends monitoring final effluents entering the Ottawa River after all inputs. q: Monitoring for due diligence as this collection system serves a portion of the built-up area outside of the Power House where there was historical storage of coal.
[redacted] *Point Batch* No Treatment	[redacted] Storm Outfall → Ottawa River [redacted] Stormwater discharges only.	N/A	No Monitoring Required	No routine flows or known controlled building discharges but instead only during storm events (intermittent). Sampling attempted monthly during 2008 Special Investigation and found there was no flow.
[redacted] *Point Batch* No Treatment	[redacted] Storm Outfall → Ottawa River Stormwater discharges only.	N/A	No Monitoring Required	No routine flows or known controlled building discharges but instead only during storm events (intermittent). Sampling attempted monthly during 2008 Special Investigation and found there was no flow.
[redacted] *Point Batch* No Treatment	[redacted] Storm Outfall → Ottawa River Stormwater discharges only.	N/A	No Monitoring Required	No routine flows or known controlled building discharges but instead only during storm events (intermittent). Sampling attempted monthly during 2008 Special Investigation and found there was no flow.
[redacted] *Point Batch* No Treatment	[redacted] Storm Outfall → Ottawa River [redacted] Stormwater discharges only.	N/A	No Monitoring Required	No routine flows or known controlled building discharges but instead only during storm events (intermittent). Sampling attempted monthly during 2008 Special Investigation and found there was only one month with flow and no contaminants of concern.

REDACTED

Waterborne Effluent Stream [1], *Stream Type,* Treatment	Source Description	Stream Monitoring Criteria Triggered [2]	Monitoring Required?	Justification
[redacted] *Point Batch* No Treatment	[redacted] Storm Outfall → Ottawa River [redacted] Stormwater discharges only.	N/A	No Monitoring Required	No routine flows or known controlled building discharges but instead only during storm events (intermittent). Sampling attempted monthly during 2008 Special Investigation and found there was no flow.
[redacted] *Point Batch* No Treatment	[redacted] Storm Outfall → Ottawa River Upgradient of the Electrical Yard Landfill. Stormwater discharges only.	N/A	No Monitoring Required	No routine flows or known controlled building discharges but instead only during storm events (intermittent). Sampling attempted monthly during 2008 Special Investigation and found there was no flow.
Stormwater Outfalls To Ground				
[redacted] *Point Batch* No Treatment	[redacted] Storm Sewer → Ground in Supervised Area Located upgradient of [redacted] No controlled building discharges. Stormwater discharges only.	N/A	No Monitoring Required	No known source of contaminants and only in use during storm events, therefore there are no discharges of concern that enter this storm sewer. Its discharges seep back into the groundwater within the CRL property and groundwater monitoring is in place along the River's edge.
[redacted] *Point Batch* No Treatment	[redacted] Storm Sewer → Ground in Controlled Area No controlled building discharges. Stormwater discharges only.	N/A	No Monitoring Required	No known source of contaminants and only in use during storm events, therefore there are no discharges of concern that enter this storm sewer. Its discharges seep back into the groundwater within the CRL property and groundwater monitoring is in place along the River's edge.
[redacted] *Point Batch* No Treatment	[redacted] Storm Sewer → Ground in Supervised Area Connected to [redacted] but no normal discharges.	N/A	No Monitoring Required	There are no discharges of concern that enter this storm sewer and discharges from the storm sewer seep back into the groundwater within the CRL property. Groundwater monitoring is in place along the River's edge.

REDACTED

Waterborne Effluent Stream [1], *Stream Type,* Treatment	Source Description	Stream Monitoring Criteria Triggered [2]	Monitoring Required?	Justification
[redacted] *Point Batch* No Treatment	[redacted] Storm Sewer → Ground in Controlled Area Connected to [redacted] but no normal discharges.	N/A	No Monitoring Required	There are no discharges of concern that enter this storm sewer and discharges from the storm sewer seep back into the groundwater within the CRL property. Groundwater monitoring is in place along the River's edge.
[redacted] *Point Batch* No Treatment	[redacted] Storm Sewer → Ground in Supervised Area No controlled building discharges. Stormwater discharges only.	N/A	No Monitoring Required	No known source of contaminants and only in use during storm events, therefore there are no discharges of concern that enter this storm sewer. Its discharges seep back into the groundwater within the CRL property and groundwater monitoring is in place along the River's edge.
Condensate Discharges to Ground				
Condensate Soaker Pits *Point Batch* No Treatment	Condensate → Ground in Controlled Area and Supervised Area Steamate NA9680	N/A	No Monitoring Required	Concentrations of contaminants meet applicable guidelines; the discharges from the condensate seep back into the groundwater within the CRL property. Groundwater monitoring is in place along the River's edge.
Septic Field Discharge Underground				
Various *Diffuse Intermittent* Septic Tank	No known hazardous discharges to tanks.	N/A	No Monitoring Required	Functioning as per design. Administrative controls in place to prevent hazardous releases.

REDACTED

Waterborne Effluent Stream [1], *Stream Type,* Treatment	Source Description	Stream Monitoring Criteria Triggered [2]	Monitoring Required?	Justification

Notes:

1. Location of those monitoring locations deemed to require monitoring are included in Figure 2; Locations of the effluent streams which are deemed to not require monitoring are identified in the *Chalk River Laboratories Storm Sewer Liquid Release Flow* Diagram 0.

2. Criteria from Table 3 in Section 4.1.1.

3. The STP technically discharges in batches (every few hours) but is considered a "continuous discharge" according to the definition in the *Wastewater Systems Effluent Regulations* [17]

References:

[1] *2024 Environmental Risk Assessment of Chalk River Laboratories,* ENVP-509220-REPT-006396, Rev 0, 2025 Jan, 69264691

REDACTED

4.1.1.3 Airborne Emissions

In general, routine non-radiological airborne emissions can be reviewed in a series of manners: through Environmental Aspect Assessments, Environmental Reviews, the Integrated Work Control Process etc. [**26**]. During the Environmental Aspect Assessment reviews, emissions are scored for environmental significance based on potential environmental impact and probability. An increased level of management is required for emissions with higher scores.

Table 7 through Table 12 outline the routine airborne emissions on the CRL site, identifying whether they require monitoring under the EVMP and the justification for this decision.

Any source on site which is not facility-specific, such as the use of site emergency generators or propane used for building heating, etc., are summarized under “General Site Emissions” (Table 13) instead of under each applicable facility.

REDACTED

4.1.1.3.1 Class I & II Nuclear Facilities

Class I and Class II Nuclear Facilities are listed in the *CRL Licence Conditions Handbook* [3]. Table 7 lists the airborne emission streams associated with these facilities and justifies whether or not monitoring under the EVMP is required.

Table 7: Airborne Emission Streams Monitoring Justification – Class I & II Nuclear Facilities

Airborne Emission Stream, *Stream Type*, EMS Group	Source Description	Stream Monitoring Criteria Triggered [1]	Monitoring Required?	Justification
Class I Nuclear Facilities:				
Nuclear Fuel Fabrication Facility (NFFF) [redacted] Group 8 [27]	See Radioisotope Lab: Fuel Assembly Science and Technologies Laboratory (CRL[redacted]	N/A	N/A	N/A
Recycle Fuel Fabrication Laboratories (RFFL) *Fugitive Intermittent* Group 5 [28]	Final Emission → Atmosphere: [redacted] South Section [redacted] Lab is currently used to produce experimental quantities of mixed-oxide (MOX) fuel for reactor physics tests or demonstration irradiations, actinide chemistry, nuclear forensics, testing of new non-destructive technologies, and new molten salt synthesis preparation glovebox line. Potential fugitive emissions from use of small amounts of chemicals in processing and cleaning. Potential releases of Halons from fire extinguishing systems.	a	Monitoring Required	a: Monitoring is required to demonstrate compliance with the *Federal Halocarbon Regulation* (FHR) [16]. See Section 4.3.3.19 for details on monitoring halocarbons. Emissions of other chemicals are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.

REDACTED

Airborne Emission Stream, *Stream Type*, EMS Group	Source Description	Stream Monitoring Criteria Triggered [1]	Monitoring Required?	Justification
ZED-2 Reactor N/A Group 10 [29]	[redacted] (North-west end) ZED-2 is a heavy-water moderated, low power, research reactor used for reactor physics measurements on different types of reactor fuels and coolants, under a variety of core configurations. No source of routine non-radiological air emissions identified.	N/A	No Monitoring Required	No airborne emissions of hazardous substances identified or anticipated.
Universal Cells *Point Batch* Group 4 [30]	Final Emission → Atmosphere: The Universal Cells consists of three shielded cells [redacted] which are used for inspection and remote manipulation of radioactive materials. Operations include post-irradiation examination (PIE) of materials and fuels in support of research, waste management, decommissioning activities, and packaging of solid wastes and fuel for waste storage. [redacted] Three hot cells and associated equipment and systems, and the ventilation system connection to [redacted] Filtration in place. Small quantities of alcohol and acetone used.	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.
Fuels and Materials Cells *Point Batch* Group 4 [30]	Final Emission → Atmosphere: The Fuels and Material Cells facility consists of twelve shielded cells, which are used for inspection and remote manipulation of radioactive materials. [redacted] Small quantities of acetone and alcohol are used.	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.

REDACTED

Airborne Emission Stream, *Stream Type*, EMS Group	Source Description	Stream Monitoring Criteria Triggered [1]	Monitoring Required?	Justification
Molybdenum-99 Production Facility *Point Batch* Group 3 [31]	Final Effluent → Atmosphere: [redacted] Mo-99 and Xe-133 Cells, [redacted] Delayed System Columns, [redacted] Ventilation System & [redacted] Ventilation Stack, [redacted] FISST, [redacted] Release of NO_x, (nitric acid use in MPF for system rinsing) and small amount of volatile chemicals through the roof stack. Scrubbers, stacks to filter/minimize release. Possible release of very small amounts of mercury through roof stack, [redacted] stack from solution remaining in the FISST tank. Note: mercury is no longer being processed in the facility.	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.
Tritium Laboratory *Point Batch* Group 9 [32]	Final Emission → Atmosphere: [redacted] Small quantities of solvents are used for cleaning purposes. Use of Argon Gas in Inert Atmosphere Glove Box (IAGB), resulting in continual release of Argon (inert gas) to air. Use of gasses during routine lab activities (helium, oxygen, air, nitrogen, neon, carbon dioxide, deuterium, P-10, methane/argon mix) and cryogenic gas such as liquid nitrogen.	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.

REDACTED

Airborne Emission Stream, *Stream Type*, EMS Group	Source Description	Stream Monitoring Criteria Triggered [1]	Monitoring Required?	Justification
Combined Electrolysis and Catalytic Exchange Upgrading and Detritiation Test Facility Group 9 [32]	[redacted] Since the cease of operations in 2001, the CECEUD was placed in a safe shutdown state. No source of routine non-radiological airborne emissions identified.	N/A	No Monitoring Required	No airborne emissions of hazardous substances identified or anticipated.
Waste Treatment Centre and Associated Facilities *Point Batch* Group 7 [33]	Final Emission → Atmosphere: Contaminated water from various drain systems and tanks across the site are pumped through an underground piping network (and in some cases by overland transfer) to [redacted] WTC for treatment prior to discharge to the Process Outfall. [redacted] Liquid Waste Treatment in [redacted] - Small amounts of CO_2 from carbonate destruction, liquid waste immobilization and water/gas reactions. - VOCs and Hg in stacks from bitumenizer and evaporator. - Nitric acid and caustic vapours from chemical addition for pH adjustment.	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.
	Final Emission → Atmosphere: Active Drain System: Nitric acid vapours from chemical addition for pH adjustment/neutralization at [redacted]	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.
	Stored Liquid Waste Tanks: [redacted] Waste Tank Facility (WTF) [redacted]	N/A	No Monitoring Required	No airborne emissions of hazardous substances identified or anticipated.

REDACTED

Airborne Emission Stream, *Stream Type*, EMS Group	Source Description	Stream Monitoring Criteria Triggered [1]	Monitoring Required?	Justification
	No source of routine non-radiological airborne emissions identified.			
	Management of Groundwater Treatment Facilities – Spring B Interception System [redacted] & Chemical Pit Treatment Facility [redacted] No source of routine non-radiological airborne emissions identified.	N/A	No Monitoring Required	No airborne emissions of hazardous substances identified or anticipated.
Waste Management Areas (Operating Facilities) *Fugitive Intermittent* Group 6 [34]	Final Emission → Atmosphere: WMA [redacted]– operating structures: Engineered Facilities (tile holes and cylindrical bunkers); Waste Reception Centre; PCB Storage Facilities; Waste Handling Building; [redacted] administration building Mercury emissions from tileholes. Airborne emissions from vehicle exhaust during operations.	a	Monitoring Required	a: Mercury release from tileholes may be reportable with site emissions under the NPRI reporting program [14]. a: Releases from vehicle exhaust contribute to site GHG CO_2e emissions [15]. See Section 4.3.3.8 for details on monitoring On-site Vehicle Transportation.
	Final Emission → Atmosphere: FPS: Fuel Packaging and Storage Airborne emissions from vehicle exhaust during operations.	a	Monitoring Required	a: Releases from vehicle exhaust contribute to site GHG CO_2e emission [15]. See Section 4.3.3.8 for details on monitoring On-site Vehicle Transportation.
	WMA [redacted] (above grade): Continuous Landfill Site; Unlined Sand Trenches No source of routine non-radiological airborne emissions identified.	N/A	No Monitoring Required	No airborne emissions of hazardous substances identified or anticipated.
	Final Effluent → Atmosphere: WMA [redacted] Above-Ground Potentially Contaminated Salvaged Equipment Storage; Low-Level Radioactive Waste Management Office Storage Buildings and seven luggers; Waste oils, organic liquids and contaminated fluids stored in marine containers.	a	Monitoring Required	a: Releases from vehicle exhaust contribute to site GHG CO_2e emissions [15]. See Section 4.3.3.8 for details on monitoring On-site Vehicle Transportation.

REDACTED

Airborne Emission Stream, *Stream Type*, EMS Group	Source Description	Stream Monitoring Criteria Triggered [1]	Monitoring Required?	Justification
	Airborne emissions from vehicle exhaust during operations.			
	WMA [redacted] Site of Above-Ground Concrete Canisters Used to Store Spent Fuel No source of routine non-radiological airborne emissions identified.	N/A	No Monitoring Required	No airborne emissions of hazardous substances identified or anticipated.
	Final Effluent → Atmosphere: WMA [redacted] Modular Above-Ground Storage of containerized low-level radioactive waste; Shielded Modular Above-Ground Storage (SMAGS) and (MAGS) of containerized low-level radioactive waste; Luggers. Airborne emissions from vehicle exhaust during operations.	a	Monitoring Required	a: Releases from vehicle exhaust contribute to site GHG CO_2e emissions [15]. See Section 4.3.3.8 for details on monitoring On-site Vehicle Transportation.
	Final Effluent → Atmosphere: WMA [redacted] Bulk Material Landfill of CRL dewatered Sewage Sludge Releases (methane or other) from the decomposition of material within the landfill. Airborne emissions from vehicle exhaust during operations.	a	Monitoring Required	a: Releases from vehicle exhaust contribute to site GHG CO_2e emissions [15]. a: Releases from the landfill contribute to the site GHG CO_2e emissions [15]. See Section 4.3.3.8 for details on monitoring On-site Vehicle Transportation and Section 4.3.3.18 for landfill emissions.
Waste Management Areas (Non-Operating Facilities) *Fugitive Intermittent*	WMA [redacted] Unlined Sand Trenches; 1952 NRX Liquid Dispersals; 1954 Experimental Liquid Dispersals; 1955 Experimental Liquid Dispersals; Special Storage No source of routine non-radiological airborne emissions identified.	N/A	No Monitoring Required	No airborne emissions of hazardous substances identified or anticipated.
	WMA [redacted]– non-operating structures: Asphalt Lined Trenches; Unlined Sand Trenches; Rectangular Concrete Bunkers; Concrete Monoliths; Special Concrete Bunkers; Special Burials; Steel Holes	N/A	No Monitoring Required	No airborne emissions of hazardous substances identified or anticipated.

REDACTED

Airborne Emission Stream, *Stream Type*, EMS Group	Source Description	Stream Monitoring Criteria Triggered [1]	Monitoring Required?	Justification
Group 6 [34]	No source of routine non-radiological airborne emissions identified.			
	WMA [redacted] (below grade): (Including WMA [redacted] Extension): Continuous Landfill Site; Unlined Sand Trenches No source of routine non-radiological airborne emissions identified.	N/A	No Monitoring Required	No airborne emissions of hazardous substances identified or anticipated.
	WMA [redacted] Suspect contaminated soils and building Materials No source of routine non-radiological airborne emissions identified.	N/A	No Monitoring Required	No airborne emissions of hazardous substances identified or anticipated.
	WMA [redacted] Port Hope and Ottawa Soil Emplacement No source of routine non-radiological airborne emissions identified.	N/A	No Monitoring Required	No airborne emissions of hazardous substances identified or anticipated.
	Liquid Dispersal Areas: Laundry Pit; Reactor Waste Dispersal Pit [redacted] (the Pot Hole); Reactor Waste Dispersal Pit [redacted] Chemical Waste Dispersal Pit No source of routine non-radiological airborne emissions identified.	N/A	No Monitoring Required	No airborne emissions of hazardous substances identified or anticipated.
	Others: Bulk Storage Compound, Thorium Nitrate Dispersal (20 cubic meter waste from 233U Extraction Plant); Ammonium Nitrate Destruction Plant (1953); Acids, Chemicals and Solvent Pits, and Special Burials No source of routine non-radiological airborne emissions identified.	N/A	No Monitoring Required	No airborne emissions of hazardous substances identified or anticipated.
Class II Nuclear Facilities:				
Health Physics Neutron	[redacted] with control console located in [redacted]	N/A	No	No airborne emissions of hazardous substances

REDACTED

Airborne Emission Stream, *Stream Type*, EMS Group	Source Description	Stream Monitoring Criteria Triggered [1]	Monitoring Required?	Justification
Generator (HPNG) Group 12 [35]	[redacted] No source of routine non-radiological airborne emissions identified.		Monitoring Required	identified or anticipated.
Gamma Beam 150C Irradiation Facility (GBF) Group 12 [35]	Final Emission → Atmosphere: [redacted] with the control console in [redacted] Release of small quantities of lab chemicals (e.g. ethanol, disinfectants).	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.
Gamma Beam Irradiator Model (GC60) *Point Batch* Group 12 [35]	[redacted] with the control console in [redacted] No source of routine non-radiological airborne emissions identified.	N/A	No Monitoring Required	No airborne emissions of hazardous substances identified or anticipated.
Van de Graaff Electron Accelerator *Point Batch* Group 12 [35]	Final Emission → Atmosphere: This accelerator in [redacted] uses both SF_6 and CO_2 gas (greenhouse gases). When maintenance or repairs of the accelerator are required to open it up, the gas is released to the atmosphere.	a, q	Monitoring Required	a: Monitoring is required to demonstrate compliance with the *Greenhouse Gas Reporting Program* [15]. q: Monitoring is required to report under the Global Reporting Initiative – Emissions [36].

Notes:

1. Criteria from Table 3 in Section 4.1.1.

REDACTED

4.1.1.3.2 Radioisotope Labs

Radioactive Labs are listed in the *Site Licences, Certificates, Permits, Building/Facility Contacts & License* [**37**] Table 8 lists of the airborne emission streams associated with these facilities and justifies whether or not monitoring under the EVMP is required.

Table 8: Airborne Emission Streams Monitoring Justification – Radioisotope Laboratories

Airborne Emission Stream, *Stream Type*, EMS Group	Source Description	Stream Monitoring Criteria Triggered [1]	Monitoring Required?	Justification
Class A Radioisotope Laboratories:				
Tritium Laboratory *Point Batch* Group 9 [32]	Final Emission → Atmosphere: [redacted] Work in labs are almost exclusively for tritium in various chemical forms. Very small quantities of solvents (acetone, alcohol etc.) are used by lab operations for cleaning materials.	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.
Class B Radioisotope Laboratories:				
Environmental Organics Analysis Laboratory *Point Batch* Group 12 [35]	Final Emission → Atmosphere: [redacted] Small quantities of volatile solvents (acetone, alcohol, varsol etc.).	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.
Fuel Fabrication Science & Technology Section Laboratory *Point Batch* Group 12 [35]	Final Emission → Atmosphere: [redacted] Small quantities of volatile solvents (acetone, alcohol, varsol etc.).	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.

REDACTED

Airborne Emission Stream, *Stream Type*, EMS Group	Source Description	Stream Monitoring Criteria Triggered [1]	Monitoring Required?	Justification
Chalk River Advanced Fuel Technology (CRAFT) – Ceramics Laboratories Point *Batch* Group 12 [35]	Final Emission → Atmosphere: [redacted] Small quantities of volatile solvents (acetone, alcohol, varsol etc.).	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.
Chromatography Laboratory *Point Batch* Group 12 [35]	Final Emission → Atmosphere: [redacted] Small quantities of volatile solvents (acetone, alcohol, varsol etc.).	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.
Containment Chemistry & Gammacell Laboratories *Point Batch* Group 12 [35]	Final Emission → Atmosphere: [redacted] Small quantities of volatile solvents (acetone, alcohol, varsol etc.).	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.
Coulometric Titration Laboratory *Point Batch* Group 12 [35]	Final Emission → Atmosphere: [redacted] Small quantities of volatile solvents (acetone, alcohol, varsol etc.).	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.
Focused Ion Beam Facility *Point Batch* Group 12 [35]	Final Emission → Atmosphere: [redacted] Infrequent use of small, dilute quantities of volatile solvents (acetone, methanol and Isopropanol etc.).	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.

REDACTED

Airborne Emission Stream, *Stream Type*, EMS Group	Source Description	Stream Monitoring Criteria Triggered [1]	Monitoring Required?	Justification
Hydrogen and Deuterium (H&D) Analysis Laboratories *Point Batch* Group 12 [35]	Final Emission → Atmosphere: [redacted] Small quantities of volatile solvents (acetone, alcohol, phenol etc.) and inert gases (Hydrogen and Argon).	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.
ICP-MS Laboratory *Point Batch* Group 19 [38]	Final Emission → Atmosphere: [redacted] Small quantities of volatile solvents (acetone, alcohol, varsol etc.).	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.
Imaging-XPS Laboratory *Point Batch* Group 12 [35]	Final Emission → Atmosphere: [redacted] Small quantities of volatile solvents (acetone, alcohol, varsol etc.).	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.
Material Sciences Radioactive Specimen Preparation Laboratories *Point Batch* Group 12 [35]	Final Emission → Atmosphere: [redacted] [redacted] is strictly lab storage (no work is performed) Infrequent use of small, dilute quantities of volatile solvents (acetone, methanol and Isopropanol etc.) and acids (Nitric, sulphuric, hydrofluoric, acetic, perchloric etc.).	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.

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Airborne Emission Stream, *Stream Type*, EMS Group	Source Description	Stream Monitoring Criteria Triggered [1]	Monitoring Required?	Justification
Molten Fuel Moderator Interaction Laboratory (MFMI) *Point Batch* Group 12 [35]	Final Emission → Atmosphere: [redacted] The MFMI laboratory is designed to prepare corium thermite for simulated reactor accident experiments. Potential release of small quantities of CO_2, solvents (IPA, acetone), miscellaneous organic and inorganic chemicals used within the lab. Infrequent release of very small quantities of heavy metals, (chromium powder) used in tests.	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.
Neutron Activation Analysis and Radiochemistry Laboratory *Point Batch* Group 12 [35]	Final Emission → Atmosphere: [redacted] Small quantities of volatile solvents (acetone, alcohol, varsol etc.).	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.
[redacted] ACB Satellite Laboratories *Point Batch* Group 1 [39]	Final Emission → Atmosphere: [redacted] The ACB Satellite Lab is the main analytical laboratory for the routine requirements of the NRU reactor. It is considered one laboratory but consists of two rooms [redacted] There are a large variety of samples entering the lab on a daily basis. Dilute acids, normal lab practices.	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.

REDACTED

Airborne Emission Stream, *Stream Type*, EMS Group	Source Description	Stream Monitoring Criteria Triggered [1]	Monitoring Required?	Justification
Radiochemical Analysis Laboratory *Point Batch* Group 19 [38]	Final Emission → Atmosphere: [redacted] Small quantities of volatile solvents (acetone, alcohol, varsol etc.).	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.
Radiochemical Analysis Laboratory *Point Batch* Group 19 [38]	Final Emission → Atmosphere: [redacted] Small quantities of volatile solvents (acetone, alcohol, varsol etc.).	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.
Radiochemistry Applications Laboratory (Target Alpha Therapy) Group 12 [35]	[redacted] No source of routine non-radiological airborne emissions identified [40]	N/A	No Monitoring Required	No airborne emissions of hazardous substances identified or anticipated.
Research Reactor Fuel Development Laboratories *Point Batch* Group 12 [35]	Final Emission → Atmosphere: [redacted] Small quantities of volatile solvents (acetone, alcohol, varsol etc.)	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.
SIMS, SEM and Radioactive Specimen Preparation Laboratories *Point Batch* Group 12 [35]	Final Emission → Atmosphere: [redacted] Small quantities of volatile solvents (acetone, alcohol, varsol etc.)	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.

REDACTED

Airborne Emission Stream, *Stream Type*, EMS Group	Source Description	Stream Monitoring Criteria Triggered [1]	Monitoring Required?	Justification
TIMS Sample Preparation Laboratory *Point Batch* Group 12 [35]	Final Emission → Atmosphere: [redacted] Small quantities of volatile solvents (acetone, alcohol, varsol etc.)	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.
Waste Processing Technology Development Laboratory *Point Batch* Group 19 [38]	Final Emission → Atmosphere: [redacted] Small quantities of volatile solvents (acetone, alcohol, varsol etc.).	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.
Class C Radioisotope Laboratories:				
Bioassay Laboratories *Point Batch* Group 12 [35]	Final Emission → Atmosphere: [redacted] Release of CO_2 through lab use manifolds. Release of known carcinogens from [redacted] small quantities of lab chemicals, (alcohol, bleach, xylenes, etc)	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.
Biological Research Facility Laboratory *Point Batch* Group 12 [35]	Final Emission → Atmosphere: [redacted] Note: [redacted] temporarily reclassified as Class C. Release of CO_2 through lab use manifolds.	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.
Decontamination Test Loops	Final Emission → Atmosphere: [redacted]	N/A	No Monitoring	Emissions are expected routinely however, severity and quantities of chemicals being

REDACTED

Airborne Emission Stream, *Stream Type*, EMS Group	Source Description	Stream Monitoring Criteria Triggered [1]	Monitoring Required?	Justification
Point Batch Group 12 [35]	Small quantities of volatile solvents (alcohol, acetone, phenol etc.) and inert gases (Hydrogen, Argon).		Required	emitted are considered negligible for environmental impact.
Environmental Analytes Laboratory *Point Batch*	Final Emission → Atmosphere: [redacted] Routine lab chemicals, (including volatile solvents such as acetone and alcohols) are released in very small quantities.	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.
Environmental Radiochemistry Laboratory *Point Batch* Group 20 [41]	Final Emission → Atmosphere: [redacted] Routine lab chemicals, (including volatile solvents such as acetone and alcohols) released in small quantities.	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.
Fission Gas Laboratory *Point Batch* Group 12 [35]	Final Emission → Atmosphere: [redacted] Small quantities of volatile solvents (acetone, alcohol, varsol etc.)	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.
Fission Product Release Group Laboratory *Point Batch* Group 12 [35]	Final Emission → Atmosphere: [redacted] Potential release of small quantities of CO_2, solvents (IPA, acetone), miscellaneous organic and inorganic chemicals used within the lab. Infrequent release of very small quantities of heavy metals, (chromium powder) used in tests.	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.

REDACTED

Airborne Emission Stream, *Stream Type*, EMS Group	Source Description	Stream Monitoring Criteria Triggered [1]	Monitoring Required?	Justification
Fuel Assembly Science and Technologies Laboratory (CRL, [redacted] FAST Lab) *Point Batch* Group 12 [35]	Final Emission → Atmosphere: [redacted] During operations in [redacted] the loop will release small amounts of argon to the environment [42].	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact
Metallographic Services Laboratory *Point Batch* Group 12 [35]	Final Emission → Atmosphere: [redacted] Small quantities of volatile solvents (acetone, alcohol, varsol etc.)	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.
Radiochemistry Applications Laboratory *Point Batch* Group 12 [35]	Final Emission → Atmosphere [redacted] Release of CO_2 through lab use manifolds. Release of known carcinogens from [redacted] small quantities of lab chemicals, (alcohol, bleach, xylenes, etc)	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.
Radiochemistry Research Laboratory *Point Batch* Group 12 [35]	Final Emission → Atmosphere [redacted] Release of CO_2 through lab use manifolds. Release of known carcinogens from [redacted] small quantities of lab chemicals, (alcohol, bleach, xylenes, etc)	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.
Radiochemistry Research Laboratory	Final Emission → Atmosphere:	N/A	No Monitoring	Emissions are expected routinely however, severity and quantities of chemicals being

REDACTED

Airborne Emission Stream, *Stream Type*, EMS Group	Source Description	Stream Monitoring Criteria Triggered [1]	Monitoring Required?	Justification
Point Batch Group 12 [35]	[redacted] Small quantities of volatile solvents (acetone, alcohol, varsol etc.)		Required	emitted are considered negligible for environmental impact.
Small Scale Mechanical Testing Laboratory *Point Batch* Group 12 [35]	Final Emission → Atmosphere: [redacted] Small quantities of volatile solvents (acetone, alcohol, varsol etc.)	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.
Medium Activity Material Testing Laboratory (MAMTF) Group 12 [35]	[redacted] The MAMTF testing facility performs mechanical testing on specimens for which the radiation dose rates are too high for unshielded labs. Testing is performed remotely in shielded rooms using cameras, manipulators and a monitor which are mounted on a sliding track to allow for access to any of the test rigs. No source of routine non-radiological airborne emissions identified.	N/A	No Monitoring Required	No airborne emissions of hazardous substances identified or anticipated.
Surface Science Laboratory *Point Batch* Group 12 [35]	Final Emission → Atmosphere: [redacted] Small quantities of volatile solvents (acetone, alcohol, varsol etc.)	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.
Tritium Monitor/Technique Development Laboratory	Final Emission → Atmosphere:	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.

REDACTED

Airborne Emission Stream, *Stream Type*, EMS Group	Source Description	Stream Monitoring Criteria Triggered [1]	Monitoring Required?	Justification
Point Batch Group 12 [35]	[redacted]-used primarily for the testing of tritium monitors and routine tritium instrument calibrations. Release of CO_2 through lab use manifolds. Release of known carcinogens from [redacted] small quantities of lab chemicals, (alcohol, bleach, xylenes, etc)			
Radiochemical Analysis Laboratory *Point Batch* Group 19 [38]	Final Emission → Atmosphere: [redacted] Small quantities of volatile solvents (acetone, alcohol, varsol etc.)	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.

Notes:

1. Criteria from Table 3 in Section 4.1.1

REDACTED

4.1.1.3.3 CRL Nuclear Facilities in Shutdown State

CRL Nuclear Facilities in Extended Shutdown State are listed in the *Site Licences, Certificates, Permits, Building/Facility Contacts & License* [**37**]. Table 9 lists of the airborne emission streams associated with these facilities and justifies whether or not monitoring under the EVMP is required.

Table 9: Airborne Emission Streams Monitoring Justification – CRL Nuclear Facilities in Shutdown State

Airborne Emission Stream, *Stream Type,* EMS Group	Source Description	Stream Monitoring Criteria Triggered [1]	Monitoring Required?	Justification
Nuclear Facilities in Extended Shutdown:				
MAPLE 1 and 2 Reactors Group 11 [43]	[redacted] No source of routine non-radiological airborne emissions identified.	N/A	No Monitoring Required	No airborne emissions of hazardous substances identified or anticipated.
New Processing Facility Group 11 [43]	[redacted] No source of routine non-radiological airborne emissions identified.	N/A	No Monitoring Required	No airborne emissions of hazardous substances identified or anticipated.
Permanent Shutdown Facilities:				
National Research Universal (NRU) Reactor (permanently shutdown facility) *Point Batch* Group 1 [39]	Final Emission → Atmosphere: [redacted] Rod Bays and experimental facilities Dilute acid, various chemicals and dry ice emissions from normal lab operations. Note: All lab processes are exhausted by fumehoods and subsequently through building ventilation (filters). Chemicals are dissolved in water.	a	Monitoring Required	a: Releases from dry ice use contribute to site GHG CO_2e emissions [15] See Section 4.3.3.17 for details on monitoring of Site wide Dry Ice Use (GHG). The rest of the emissions are expected routinely however, severity and quantities of chemicals being emitted (with filtration in place) are considered negligible for environmental impact.

REDACTED

Airborne Emission Stream, *Stream Type,* EMS Group	Source Description	Stream Monitoring Criteria Triggered [1]	Monitoring Required?	Justification
Nuclear Facilities in Extended Shutdown:				
	[redacted] NRU Instrument Shop now a Waste Characterization Laboratory → This building used to house what was called the NRU Instrument Shop which was used for instrument assembly, testing, etc. With the permanent shut down of the reactor, this building is no longer used for this purpose and now houses a part of a waste characterization laboratory. No source of routine non-radiological airborne emissions identified.	N/A	No Monitoring Required	No airborne emissions of hazardous substances identified or anticipated.
	[redacted] Sump House - Provides a sump to accommodate drainage from [redacted] No source of routine non-radiological airborne emissions identified.	N/A	No Monitoring Required	No airborne emissions of hazardous substances identified or anticipated.

Notes:

[1] Criteria from Table 3 in Section 4.1.1.

REDACTED

4.1.1.3.4 CRL Nuclear Facilities Undergoing Decommissioning Activities

CRL Nuclear Facilities Undergoing Decommissioning Activities are listed in the *Site Licences, Certificates, Permits, Building/Facility Contacts & License Representatives* [**37**]. These facilities are assessed on a case-by-case basis and any environmental airborne monitoring requirements are implemented as necessary.

4.1.1.3.5 CRL Facilities/Buildings that Handle or have Handled Nuclear Materials and/or Nuclear Substances

CRL Facilities/Buildings that Handle or have Handled Nuclear Materials and/or Nuclear Substances Nuclear Facilities in Extended Shutdown State are listed in the *Site Licences, Certificates, Permits, Building/Facility Contacts & License Representatives* [**37**]. Table 10 lists of the airborne emission streams associated with these facilities and justifies whether or not monitoring under the EVMP is required.

REDACTED

Table 10: Airborne Emission Streams Monitoring Justification – CRL Facilities/Buildings that Handle or have Handled Nuclear Materials and/or Nuclear Substances

Airborne Emission Stream, *Stream Type*, EMS Group	Source Description	Stream Monitoring Criteria Triggered [1]	Monitoring Required?	Justification
Decontamination Centre Buildings Group 13 [44]	[redacted] – cleaning of radioactively contaminated equipment and materials for re-use. No source of routine non-radiological airborne emissions identified.	N/A	No Monitoring Required	No airborne emissions of hazardous substances identified or anticipated.
Nuclear Materials Storage Facility Group 14 [45]	[redacted] No source of routine non-radiological airborne emissions identified.	N/A	No Monitoring Required	No airborne emissions of hazardous substances identified or anticipated.
Nuclear Materials Storage Facility Group 14 [45]	[redacted] No source of routine non-radiological airborne emissions identified.	N/A	No Monitoring Required	No airborne emissions of hazardous substances identified or anticipated.
Nuclear Safety Experiments *Point Batch* Group 12 [35]	Final Effluent → Atmosphere: [redacted] Small quantities of volatile solvents (acetone, alcohol, varsol etc.)	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.
Metallurgy Area C *Point Batch*	Final Effluent → Atmosphere: [redacted] Small quantities of acids and bases and solvents are used by lab operations for cleaning materials [46].	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.

REDACTED

Airborne Emission Stream, *Stream Type*, EMS Group	Source Description	Stream Monitoring Criteria Triggered [1]	Monitoring Required?	Justification
Site Maintenance *Fugitive Batch* Group 44 [47]	Final Effluent → Atmosphere: [redacted] Zone Maintenance Area Paint fumes, solvents, oils, lubricants and welding fumes.	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.
Shipping/Receiving Facility Group 38 [48]	[redacted] Main receiving building at Outer gate No source of routine non-radiological airborne emissions identified.	N/A	No Monitoring Required	No airborne emissions of hazardous substances identified or anticipated.
Low Background Counting Facility	[redacted] No source of routine non-radiological airborne emissions identified.	N/A	No Monitoring Required	No airborne emissions of hazardous substances identified or anticipated.
Instrumentation and Control Laboratories *Point Batch* Group 42 [49]	Final Effluent → Atmosphere: [redacted] Small quantities of volatile Solvents (alcohols, acetone, Phenols etc.) and inert gases (Hydrogen and argon).	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.
Flasks/Radioactive-Contamination Equipment Group 4 [30]	[redacted] No source of routine non-radiological airborne emissions identified.	N/A	No Monitoring Required	No airborne emissions of hazardous substances identified or anticipated.
Hydrogen Engineering Laboratory *Point Batch* Group 12 [35]	Final Effluent → Atmosphere: [redacted] Potential release of small quantities of CO_2, solvents (IPA, acetone), miscellaneous organic and inorganic chemicals used within the lab.	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.

REDACTED

Airborne Emission Stream, *Stream Type*, EMS Group	Source Description	Stream Monitoring Criteria Triggered [1]	Monitoring Required?	Justification
Waste Analysis Facility Group 31 [50]	[redacted] – Management of solid, non-radioactive, non-hazardous waste. No source of routine non-radiological airborne emissions identified.	N/A	No Monitoring Required	No airborne emissions of hazardous substances identified or anticipated.
Effluent Monitoring/Filter Testing Group 13 [44]	[redacted] - An area in this building is used for the preparation of radioiodine ultimately used for charcoal filter testing across the site. Radioactive iodine shipments are received and unpacked. Radioiodine solutions are prepared for filter testing. No source of routine non-radiological airborne emissions identified.	N/A	No Monitoring Required	No airborne emissions of hazardous substances identified or anticipated.
Chemistry and Materials *Point Batch* Group 12 [35]	Final Effluent → Atmosphere: [redacted] Small quantities of volatile solvents (acetone, alcohol, varsol etc.)	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.
Chemistry and Materials *Point Batch* Group 12 [35]	Final Effluent → Atmosphere: [redacted] Small quantities of volatile solvents (acetone, alcohol, varsol etc.)	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.
Metallurgy *Point Batch* Group 12 [35]	Final Effluent → Atmosphere: [redacted] Small quantities of volatile solvents (acetone, alcohol, varsol etc.)	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.

REDACTED

Airborne Emission Stream, *Stream Type*, EMS Group	Source Description	Stream Monitoring Criteria Triggered [1]	Monitoring Required?	Justification
Decontamination Group 13 [44]	[redacted] – cleaning of contaminated equipment. No source of routine non-radiological airborne emissions identified.	N/A	No Monitoring Required	No airborne emissions of hazardous substances identified or anticipated.
Spring B Facility *Fugitive Intermittent* Group 6 [34]	Final Effluent → Atmosphere: [redacted] Use of equipment for remediation projects and vehicles for transport to sites emits greenhouse gases.	a	Monitoring Required	a: Releases from vehicle exhaust contribute to site GHG CO_2e emissions [15]. See Section 4.3.3.8 for details on monitoring On-site Vehicle Transportation.
Chemical Pit Facility *Fugitive Intermittent* Group 6 [34]	Final Effluent → Atmosphere: [redacted] Use of equipment for remediation projects and vehicles for transport to sites emits greenhouse gases.	a	Monitoring Required	a: Releases from vehicle exhaust contribute to site GHG CO_2e emissions [15]. See Section 4.3.3.8 for details on monitoring On-site Vehicle Transportation.
Spring B Pump and Treat Facility *Fugitive Intermittent* Group 6 [34]	Final Effluent → Atmosphere: [redacted] Use of vehicles for transport to sites emits greenhouse gases.	a	Monitoring Required	a: Releases from vehicle exhaust contribute to site GHG CO_2e emissions [15]. See Section 4.3.3.8 for details on monitoring On-site Vehicle Transportation.
[redacted] NRU/NRC Storage Equipment/Surplus Materials	[redacted] – storage building. No source of routine non-radiological airborne emissions identified.	N/A	No Monitoring Required	No airborne emissions of hazardous substances identified or anticipated.

Notes:

1. Criteria from Table 3 in Section 4.1.1.
2. Buildings with floor area less than $50m^2$ are not included.

REDACTED

4.1.1.3.6 CRL Support Facilities

4.1.1.3.6.1 Support Facilities

CRL Support Facilities are listed in the *Site Licences, Certificates, Permits, Building/Facility Contacts & License Representatives* [**37**]. Table 11 lists of the airborne emission streams associated with these facilities and justifies whether or not monitoring under the EVMP is required.

Table 11: Airborne Emission Streams Monitoring Justification – CRL Support Facilities

Airborne Emission Stream, *Stream Type*, EMS Group	Source Description	Monitoring Criteria Triggered	Monitoring Required?	Justification
Central Alarm Station Group 42 [49]	[redacted] No source of routine non-radiological emissions identified.	N/A	No Monitoring Required	No airborne emissions of hazardous substances identified or anticipated.
Power House Building *Point Continuous* Group 29 [51]	Final Emission → Atmosphere: [redacted] Airborne emissions from the burning of fuel for boilers (Natural Gas, [redacted] Fuel oil and [redacted] fuel oil for cold starts) and Diesel generators. Power House boilers produce heat and steam for use across the site.	a, q	Monitoring Required	a: Monitoring is required to demonstrate compliance with the following legislation: • The *National Pollutant Release Inventory* [14] for Part 4 Criteria Air Contaminants (CACs); and, • *Greenhouse Gas Reporting Program* [15]. q: Monitoring is required to report under the *Global Reporting Initiative* [36]. See Section 0 for Natural Gas. See Section 4.3.3.3 for [redacted] Fuel oil. See Section 4.3.3.7 for [redacted] Fuel oil use. See Section 4.3.3.6 for Site Diesel Generators.
Emergency Power Generator	Final Emission → Atmosphere: [redacted] The burning of diesel fuel in the	a, q	Monitoring Required	a: Releases from diesel generators contribute to site GHG CO_2e emissions [15] and NPRI

REDACTED

Airborne Emission Stream, *Stream Type*, EMS Group	Source Description	Monitoring Criteria Triggered	Monitoring Required?	Justification
Point Batch Group 1 [39]	[redacted] diesel generators release non-radiological airborne emissions. These diesel generators do not run constantly but instead are only run when needed for operations or during their routine testing.			emissions [14] q: Monitoring is required to report under the *Global Reporting Initiative* [36] See Section 4.3.3.6 for Site Diesel Generators.
Administrative, Security Department, and Fire Department Services [redacted] *Point Intermittent* Group 42 [49]	Final Emission → Atmosphere: [redacted] Running of patrol vehicles and fire trucks increases vehicle emissions to atmosphere.	a, q	Monitoring Required	a: Releases from vehicle exhaust contribute to site GHG CO_2e emissions [15]. q: Monitoring is required to report under the *Global Reporting Initiative* [36] See Section 4.3.3.8 for details on monitoring On-site Vehicle Transportation.

REDACTED

4.1.1.3.6.2 Additional Support Facilities

Additional CRL Support Facilities not listed in the *Site Licences, Certificates, Permits, Building/Facility Contacts & License* [**37** but that have non-radiological air emissions are outlined in Table 12.

Table 12: Airborne Emission Streams Monitoring Justification – Additional Support Facilities

Airborne Emission Stream, *Stream Type*, EMS Group	Source Description	Monitoring Criteria Triggered	Monitoring Required?	Justification
Sanitary Sewage Treatment Facility Group 30 [52]	[redacted] – new facility as of 2018 No source of routine airborne emissions identified.	N/A	No Monitoring Required	No airborne emissions of hazardous substances identified or anticipated.
Machine/ Welding/Sheet Metal Shop *Point Batch* *Batch Fugitive* Group 44 [47]	Final Emission → Atmosphere: [redacted] - Fabrication/general machining and welding activities CO_2 and Argon emissions from welding fabrication, metal dust/particulate to air from grinding (zirconium alloys, steel, aluminum) and welding processes. Ventilation at work stations and some fugitive emissions.	N/A	No Monitoring Required	Emissions are expected routinely however, severity and quantities of chemicals being emitted are considered negligible for environmental impact.
Waste Segregation Facility Group 31 [50]	[redacted] No source of routine airborne emissions identified.	N/A	No Monitoring Required	No airborne emissions of hazardous substances identified or anticipated.

REDACTED

Airborne Emission Stream, *Stream Type*, EMS Group	Source Description	Monitoring Criteria Triggered	Monitoring Required?	Justification
Radioactive Hazardous Waste Storage Area (mixed Waste) Group 31 [50]	Marine containers in WMA [redacted] MWDS [redacted] in WMA [redacted] No source of routine airborne emissions identified.	N/A	No Monitoring Required	No airborne emissions of hazardous substances identified or anticipated.

REDACTED

4.1.1.3.7 General Site Emissions

Table 13: Airborne Emission Streams Monitoring Justification – General Site Emissions

Airborne Effluent Stream, *Stream Type*, Filtration	Source Description	Stream Monitoring Criteria Triggered	Monitoring Required?	Justification
NPRI and GHG:				
[redacted] Fuel Oil Used by Power House Boilers *Point Continuous* No Filtration	Final Emission → Atmosphere: The Power House boilers which produce heat and steam for use across the site mainly use natural gas however they still use a small amount of [redacted] Fuel oil as a backup fuel.	a, q	Monitoring Required	a: Monitoring is required to demonstrate compliance with the following legislation: • The *National Pollutant Release Inventory* [14] for Part 1 and Part 4 (Criteria Air Contaminants (CACs)); and, • *Greenhouse Gas Reporting Program* [15]. q: Monitoring is required to report under the *Global Reporting Initiative* [36]
Site Propane Use *Point Continuous* No Filtration	Final Emission → Atmosphere: Propane is used for heating buildings across the site as well as other process type operations. Heating is for those remote buildings not supplied by the central natural gas network.	a, q	Monitoring Required	a: Monitoring is required to demonstrate compliance with the following legislation: • The *National Pollutant Release Inventory* [14] for Part 4 Criteria Air Contaminants (CACs); and, • *Greenhouse Gas Reporting Program* [15]. q: Monitoring is required to report under the *Global Reporting Initiative* [36]
Site Natural Gas Use *Point Continuous* No Filtration	Final Emission → Atmosphere: Natural Gas is the main source of heating and steam production on the CRL site and is supplied to various buildings including the Power House.	a, q	Monitoring Required	a: Monitoring is required to demonstrate compliance with the following legislation: • The *National Pollutant Release Inventory* [14] for Part 1 and Part 4 (Criteria Air Contaminants (CACs)); and, • *Greenhouse Gas Reporting Program* [14]. q: Monitoring is required to report under the *Global Reporting Initiative* [36]

REDACTED

Airborne Effluent Stream, *Stream Type*, Filtration	Source Description	Stream Monitoring Criteria Triggered	Monitoring Required?	Justification
Site Diesel Generators *Point Continuous* No Filtration	Final Emission → Atmosphere: The burning of diesel fuel in various diesel generators (stationary and portable) across the site release non-radiological airborne emissions. These diesel generators do not run constantly but instead are only run when needed for operations or during their routine testing.	a, q	Monitoring Required	a: Monitoring is required to demonstrate compliance with the following legislation: • The *National Pollutant Release Inventory* [14] for Part 1 (Hg); Part 4 Criteria Air Contaminants (CACs); and, • *Greenhouse Gas Reporting Program* [15]. q: Monitoring is required to report under the *Global Reporting Initiative* [36].
[redacted] Fuel Oil use to Cold Start Boilers in [redacted] *Point Continuous* No Filtration	Final Emission → Atmosphere: [redacted] fuel oil is used as cold start light up fuel for the Power House's oil-fired boilers. The burning of this fuel releases non-radiological airborne emissions.	a, q	Monitoring Required	a: Monitoring is required to demonstrate compliance with the following legislation: • The *National Pollutant Release Inventory* [14] for Part 4 Criteria Air Contaminants (CACs); and, • *Greenhouse Gas Reporting Program* [15]. q: Monitoring is required to report under the *Global Reporting Initiative* [36].
On-site Vehicle Transportation *Fugitive Intermittent* No Filtration	Final Emission → Atmosphere: Emissions resulting from day-to-day operations of vehicles (heavy and light vehicles and equipment) on the CRL site.	a, q	Monitoring Required	a: Monitoring is required to demonstrate compliance with the following legislation: • The *National Pollutant Release Inventory* [14] for Part 4 Particulates; and, • *Greenhouse Gas Reporting Program* [15]. q: Monitoring is required to report under the *Global Reporting Initiative* [36].

REDACTED

Airborne Effluent Stream, *Stream Type*, Filtration	Source Description	Stream Monitoring Criteria Triggered	Monitoring Required?	Justification
Fire Fighting Training Complex Burning *Fugitive Intermittent* No Filtration	Final Emission → Atmosphere: This complex completes training exercises which include the burning of wood pallets and straw bales. This burning results in airborne emissions of both NPRI Criteria Air Contaminants as well as Greenhouse Gases.	a, q	Monitoring Required	a: Monitoring is required to demonstrate compliance with the following legislation: • The *National Pollutant Release Inventory* [14] for Part 4 Criteria Air Contaminants (CACs); and, • *Greenhouse Gas Reporting Program* [15]. q: Monitoring is required to report under the *Global Reporting Initiative* [36].
Stationary Equipment *Point Batch* No Filtration	Final Emission → Atmosphere: Concrete/Rock/Asphalt Crusher, Shredder, Scalping Screen, Backup for Fire water pumps and Heaters burning diesel fuel to support site operations. This burning results in airborne emissions of both NPRI Criteria Air Contaminants as well as Greenhouse Gases.	a, q	Monitoring Required	a: Monitoring is required to demonstrate compliance with the following legislation: • The *National Pollutant Release Inventory* [14] for Part 4 Criteria Air Contaminants (CACs); and, • *Greenhouse Gas Reporting Program* [15]. q: Monitoring is required to report under the *Global Reporting Initiative* [36].
NPRI Only:				
Petroleum Storage Tanks *Fugitive Intermittent* No Filtration	Final Emission → Atmosphere: Storage Tanks containing products which can emit VOCs, passively release VOCs anytime the product is stored in them. These emissions vary depending on the type of product, amount of product and the specifics of the tank itself (size, design, colour etc.)	a, q	Monitoring Required	a: Monitoring is required to demonstrate compliance with the *National Pollutant Release Inventory* [14] for Part 4 Criteria Air Contaminants (CACs). q: Monitoring is required to potentially report under the *Global Reporting Initiative* [36].

REDACTED

Airborne Effluent Stream, *Stream Type*, Filtration	Source Description	Stream Monitoring Criteria Triggered	Monitoring Required?	Justification
Construction/ Demolition Activities *Fugitive Intermittent* No Filtration	Final Emission → Atmosphere: Construction and demolition activities taking place on the CRL site routinely result in airborne release of particulates.	a, q	Monitoring Required	a: Monitoring is required to demonstrate compliance with the *National Pollutant Release Inventory* [14] for Part 4 Criteria Air Contaminants (CACs). q: Monitoring is required to potentially report under the *Global Reporting Initiative* [36].
Groundwater Plumes *Fugitive Intermittent* No Filtration	Final Emission → Atmosphere: VOCs are routinely measured through the groundwater monitoring program in relation to historical waste emplacement activities. These VOCs would be released to atmosphere with the surfacing of this groundwater.	a, q	Monitoring Required	a: Monitoring is required to demonstrate compliance with the *National Pollutant Release Inventory* [14]. q: Monitoring is required to potentially report under the *Global Reporting Initiative* [36].
Concrete/Rock/ Asphalt Crushing *Point Batch* No Filtration	Final Emission → Atmosphere: CRL owns a large crusher which is used on a campaign basis to disposition waste concrete rock and asphalt generated on the site. Particulates are released to the air from this activity.	a, q	Monitoring Required	a: Monitoring is required to demonstrate compliance with the *National Pollutant Release Inventory* [14] for Part 4 Criteria Air Contaminants (CACs). q: Monitoring is required to potentially report under the *Global Reporting Initiative* [36].
GHG Only:				
MR-3 Experimental Loop *Fugitive Intermittent* No Filtration	Final Emission → Atmosphere: The loop uses R-134a throughout which is a greenhouse gas and halocarbon. Releases to the environment can be accidental or through micro-leaks.	a, q	Monitoring Required	a: Monitoring is required to demonstrate compliance with the following legislation: The *Greenhouse Gas Reporting Program* [15]. q: Monitoring is required to report under the *Global Reporting Initiative* [36].
High Voltage Tank	Final Emission → Atmosphere:	a, q	Monitoring	a: Monitoring is required to demonstrate compliance with the

REDACTED

Airborne Effluent Stream, *Stream Type*, Filtration	Source Description	Stream Monitoring Criteria Triggered	Monitoring Required?	Justification
Fugitive Intermittent No Filtration	The tank is a purchased sealed unit continuing SF_6 (a potent greenhouse gas). Any release would be accidental.		Required	*Greenhouse Gas Reporting Program* [15]. q: Monitoring is required to report under the *Global Reporting Initiative* [36].
Dry Ice Use *Point Batch* No Filtration	Final Emission → Atmosphere: The use of dry ice (solid form of CO_2) results in the release of CO_2 to the atmosphere which is a greenhouse gas.	a, q	Monitoring Required	a: Monitoring is required to demonstrate compliance with the *Greenhouse Gas Reporting Program* [15]. q: Monitoring is required to report under the *Global Reporting Initiative* [36].
Landfill Emissions *Fugitive Intermittent* No Filtration	Final Emission → Atmosphere: The decomposition of waste in landfills results in the release of greenhouse gases. CRL currently has two landfills on site.	a, q	Monitoring Required	a: Monitoring is required to demonstrate compliance with the *Greenhouse Gas Reporting Program* [15]. q: Monitoring is required to report under the *Global Reporting Initiative* [36].
Halocarbon Releases *Fugitive Intermittent* No Filtration	Final Emission → Atmosphere: Site refrigeration systems, air-conditioning systems and fire-extinguishing systems which release halocarbons to the environment.	a	Monitoring Required	a: Monitoring is required to demonstrate compliance with the *Federal Halocarbon Regulations* [16].

REDACTED

4.2 Performance and Acceptance Criteria

In order to ensure that the data collected as part of the EVMP is adequate for its intended purpose, the data is subject to performance and acceptance criteria. Note that the program's non-radiological airborne monitoring is all completed through estimation rather than measurement, therefore there are no performance or acceptance criteria identified for the airborne portion of the monitoring program.

4.2.1 Performance Criteria

4.2.1.1 Measurement Sensitivity Levels for Non-radiological Analyses of Waterborne Effluents

It is important to ensure that each non-radiological analysis performed in the laboratory can yield a result that enables the EVMP to meet its objectives (see Section 4.1). In essence, this obligates the program to ensure that the contaminant concentration results obtained from the monitoring program can be compared to the most stringent of any applicable regulatory discharge concentration limits.

Table 14 compares the programs current LMDLs for each parameter to the applicable monitoring limit(s) for that parameter. The program's LMDLs are all well below the effluent limits therefore ensuring that the monitoring results can be used to demonstrate compliance with these limits.

Table 14: Laboratory Method Detection Limits (LMDL) and Their Comparison to CRL Monitoring Limits

ATG	Parameter	Unit	Laboratory	LMDL **	Wastewater Regulation* [17]	CNL Guideline [53]	Site Licence Limit [3]
1a	Biological Oxygen Demand	mg/L	BV Labs	0.5	--	20	--
1b	Carbonaceous BOD	mg/L	BV Labs	0.80	25	--	--
3	pH	N/A	EMB	--	--	6-9	6-9
--	Unionized ammonia	mg/L	BV Labs	--	1.25	--	--
6	Phosphorus, Unfiltered Total	µg/L	ACB BV Labs	25 20	--	1000	1000
8	Total Suspended Solids	mg/L	ACB	3.0	25	25	25
9	Chromium, Unfiltered Total	µg/L	ACB BV Labs	0.4	--	500	500
9	Copper, Unfiltered Total	µg/L	ACB BV Labs	0.8	--	500	500
9	Lead, Unfiltered Total	µg/L	ACB BV Labs	0.1 0.06	--	100	100
9	Nickel, Unfiltered Total	µg/L	ACB BV Labs	3 0.4	--	500	500
9	Zinc, Unfiltered Total	µg/L	ACB BV Labs	2 1	--	500	500
9a	Iron, Unfiltered Total	µg/L	ACB BV Labs	4 5	--	1000	--

REDACTED

ATG	Parameter	Unit	Laboratory	LMDL **	Wastewater Regulation* [17]	CNL Guideline [53]	Site Licence Limit [3]
12	Mercury, Unfiltered Total	µg/L	ACB	0.006	--	1.0	1.0
14	Phenolics, Unfiltered React	µg/L phenol	ACB	1.9	--	20	--
25	Solvent Extractables	mg/L	ACB	1.0	--	15	15
35	E-coli	Counts/100ml	BV Labs	0	--	200	--

*Regulations only apply to the Sanitary Sewage Treatment Facility.
** Current as of issuance of Plan. Note: LMDLs are subject to change
ATG – Analytical Test Group; LMDL – Laboratory Method Detection Limit

4.2.2 Acceptance Criteria

4.2.2.1 Quality Verification Measurements

Acceptance criteria in place for Quality Control (QC) of field sample measurements at CRL, including travelling blanks, travelling spiked blanks and duplicates are in place in accordance with MISA recommendations.

In general, the following statistical process is followed when determining these criteria:

Field QC Samples	Quality Control Test	Test Acceptance Criteria
Travelling Blank	Contamination	Results ≤ 3 times LMDL
Travelling Spiked Blank	Accuracy	Recovery (Determined Value/Expected *100) between 50 – 150%
Duplicate*	Precision	Relative Percent Difference ≤ 50%

Note:

* If the result is ≤ 3 x's LMDL, the QV assessment is voided on the basis of low-level results.

4.2.2.2 Sample Unavailability

Sample unavailability for the Non-Radioactive EVMP could be the result of a number of circumstances; for example sampling according to the monitoring schedule was missed, the collected sample was contaminated or lost, an automatic sampler failure, etc. Acceptance Criteria for such events are shared company-wide and therefore are outlined in *Management and Monitoring of Effluents and Emissions* [5] along with steps which need be taken to compensate for the missed data.

4.3 Detailed Design by Effluent or Emission Stream

Based on the CRL Effluent Verification Monitoring Program objectives described in Section 4.1 and the assessment of each CRL effluent and emission stream against stream monitoring criteria described in Section 4.1.1 the tables included in this section outline the detailed design of those streams designated as requiring compliance monitoring.

For each effluent or emission stream designated as requiring monitoring, the parameter

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monitoring criteria listed in Table 15 are used to help determine and justify which parameters require compliance monitoring and which do not. Exactly how these criteria are linked to the program objectives is detailed in *CRL's Integrated Environmental Monitoring Framework* [4]. Parameters include contaminants and physical stressors. The detailed design tables also identify and justify the required monitoring frequencies.

In addition to the detailed design tables found in this section, the reader should always reference the current *Effluent Verification Monitoring Program Sampling Schedule* [10] for the most current monitoring that is in place under the EVMP.

Appendix B provides similar detailed design tables for effluent streams were at one time but are no longer part of the EVMP.

Table 15: Parameter Monitoring Criteria for the Effluent Verification Monitoring Program

Identifier	***Need to Monitoring Criteria - Parameter***
h	(shall) If effluent or emission monitoring of a contaminant or physical stressor is explicitly specified by an Authority Having Jurisdiction (AHJ) then that contaminant or physical stressor shall be monitored.
i	(shall) If the results of an ERA or equivalent risk assessment indicate potential concern with the release of a contaminant, or with a physical stressor, then that contaminant or physical stressor shall be monitored.
j	(shall) If effluent or emission monitoring of a contaminant supports a radiation dose assessment or assessment of potential exposure, then that contaminant shall be monitored.
k	(shall) If there is an operational need to identify an unplanned or uncontrolled effluent or emission (reasonably foreseeable upset event) of a contaminant into the environment, then that contaminant shall be monitored.
m	(should) In the case of a waterborne effluent stream, and when no ERA (or equivalent risk assessment) exists that can provide more specific guidance on the parameter(s) to be monitored, if annual average contaminant concentrations at a point of discharge from one of the company's site properties or to a permanent surface water body on site may exceed *Guidelines for Canadian Drinking Water Quality* (or equivalent) for a radioactive contaminant, then that contaminant should be monitored.
n	(should) If a contaminant is likely to approach or has the potential to exceed regulatory release limits or internal release limits, then that contaminant should be monitored.

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Identifier	***Need to Monitoring Criteria - Parameter***
o	(should) If a non-radioactive contaminant is a reportable substance under the *National Pollutant Release Inventory* (NPRI) and is released in an effluent or emission stream at greater than 10% of the mass or concentration threshold for that contaminant, then it should be monitored.
p	(should) If effluent monitoring of a non-radioactive contaminant is triggered under the MISA Protocol, then that contaminant should be monitored.
q	If monitoring is required for other business reasons (e.g., stakeholder concerns, due diligence, etc.).

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4.3.1 Background/ Reference Locations

4.3.1.1 Ottawa River Intake

Table 16: Detailed Design – Ottawa River Intake

Ottawa River Clearwell (ORC) - Description and Monitoring History **Description:** This monitoring location is located within the Power House. It is a large reservoir of river water which is used for the site's process water, fire water and service water. There are actually two intake wells located in the Power House; historically the ORC monitoring location was at the "NRX intake well" however in 2014, this monitoring location was switched to the "NRU intake well". The reasoning behind this switch was that the intake pipe for the NRX intake well was higher in the River's water column (at 12m depth) than the NRU intake well intake pipe (at 24m depth), thereby causing variation of the temperature of the two wells during times of the year when the river was stratified. Since the cooling water constituting the PRO effluent was being drawn from the NRU well, this change of monitoring location was deemed appropriate in order to accurately determine the amount of heat that the site operations were emitting at the time. Note: Other monitoring parameters are not expected to vary between the two intake wells. **Source Term:** Ottawa River water **Potential Non-radiological Contaminants:** Those present in background levels in the Ottawa River **Discharge Characteristics:** N/A **Monitoring Strategy:** This monitoring location represents background river contaminant levels. Analysis of intake water was not part of the requirements of the MISA Program (1990) as the Ministry did not intend to consider net loadings in setting effluent limits; therefore there was no MISA classification for this location. The Ministry's viewpoint is that Best Available Technology (BAT) will subject all contaminants to the same treatment regardless of source and that there will be no practical means of separately quantifying the impact of intake water contaminants on the final performance. However, the company began monitoring at this location as it was felt that background information was useful in interpreting the results of the Process Outfall (PRO). Monitoring frequencies of this location therefore reflect those of the PRO Outfall monitoring location.

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Ottawa River Intake (ORC) *						
ATG	**Parameter Name**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
3	pH	q	Monitored: (was in 1990; 2002-present) q: 1990: Added to align with Process Outfall monitoring and get a better understanding of the River characteristics [1]. 1991: Removed as deemed not to be required under the MISA program [1]. q: 2002: Added again to align with Process Outfall monitoring and get a better understanding of the River characteristics; a gross indicator of water quality [2].	M	Monthly Grab ***	1. Frequency: 1990: Monthly to align with monthly Process Outfall monitoring while effluent characterization was taking place [1]. 2002: Quarterly to align with quarterly Process Outfall monitoring designed to capture seasonal variation [2]. 2013: Changed to monthly to align with Process Outfall monitoring which had changed in order to align with a site licence requirement [3]. Sample Type: Grab appropriate because river quality is relatively constant over time. 2. N/A
4a	Ammonium, Total Filter React	N/A	Not Monitored: (was in 1990) q: 1990: Added to align with Process Outfall monitoring and get a better understanding of the River characteristics [1]. 1991: Removed as deemed not to be required under the MISA program [1].	N/A	N/A	1. Frequency: 1990: Monthly to align with monthly Process Outfall monitoring while effluent characterization was taking place [1]. 1991: Removed [1]. 2. N/A
4b	Nitrates, Total Filter Reactive	N/A	Not Monitored: (was in 1990; 2010-2016) q: 1990: Added to align with Process Outfall monitoring [1]. 1991: Removed as deemed not to be required under the MISA program [1]. q: 2010: Added to align with Process Outfall monitoring and get a better understanding of the River characteristics [4]. 2016: Removed as natural variation is well established and, was being removed from PRO, WTC_LWE, WTC_[redacted] monitoring as well and is no longer needed for background levels [9].	N/A	N/A	1. Frequency: 1990: Monthly to align with monthly Process Outfall monitoring while effluent characterization was taking place [1]. 1991: Removed [1]. 2010: Quarterly to align with quarterly Process Outfall monitoring in place capturing seasonal variation [4]. 2016: Removed [9]. 2. N/A

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Ottawa River Intake (ORC) *						
ATG	**Parameter Name**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
5a	Dissolved Organic Carbon (DOC)	N/A	Not Monitored: (was in 1990; 2002-2016) q: 1990: Added to align with Process Outfall monitoring [1]. 1991: Removed as deemed not to be required under the MISA program [1]. q: 2002: Added to align with Process Outfall monitoring and get a better understanding of the River characteristics [2]. 2016: Removed as natural variation is well established [9].	N/A	N/A	1. Frequency: 1990: Monthly to align with monthly Process Outfall monitoring while effluent characterization was taking place [1]. 1991: Removed as deemed not to be required under the MISA program [1]. 2002: Quarterly to align with quarterly Process Outfall monitoring in place capturing seasonal variation [2]. 2016: Removed [9]. 2. N/A
5b	Carbon, Total Organic (TOC)	N/A	Not Monitored: (was in 1990; 2002-2016) q: 1990: Added to align with Process Outfall monitoring [1]. 1991: Removed as deemed not to be required under the MISA program [1]. q: 2002: Added to align with Process Outfall monitoring and get a better understanding of the River characteristics [2]. 2016: Removed as natural variation is well established [9].	N/A	N/A	1. Frequency: 1990: Monthly to align with monthly Process Outfall monitoring while effluent characterization was taking place [1]. 1991: Removed as deemed not to be required under the MISA program [1]. 2002: Quarterly to align with quarterly Process Outfall monitoring in place capturing seasonal variation [2]. 2016: Removed [9]. 2. N/A
6	Phosphorus, Unfiltered Total	N/A	Not Monitored: (was in 1990; 2002-2016) q: 1990: Added to align with Process Outfall monitoring [1]. 1991: Removed as deemed not to be required under the MISA program [1]. q: 2002: Added to align with Process Outfall monitoring and get a better understanding of the River characteristics [2]. 2016: Removed as results are consistently non-detect [9].	N/A	N/A	1. Frequency: 1990: Monthly to align with monthly Process Outfall monitoring while effluent characterization was taking place [1]. 1991: Removed as deemed not to be required under the MISA program [1]. 2002: Quarterly to align with quarterly Process Outfall monitoring in place capturing seasonal variation [2]. 2016: Removed [9]. 2. N/A

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Ottawa River Intake (ORC) *						
ATG	**Parameter Name**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
7	Conductivity, @ 25˚C	q	Monitored: (1990; 2002-present) q: 1990: Added to align with Process Outfall monitoring [1]. 1991: Removed as deemed not to be required under the MISA program [1]. q: 2002: Added to align with Process Outfall monitoring and get a better understanding of the River characteristics [2].	M	Monthly Grab ***	1. Frequency: 1990: Monthly to align with monthly Process Outfall monitoring while effluent characterization was taking place [1]. 1991: Removed [1]. 2002: Quarterly to align with quarterly Process Outfall monitoring in place capturing seasonal variation [2]. 2013: Increased to monthly to align with monthly Process Outfall monitoring used as a gross indicator of water quality [3]. Sample Type: Grab appropriate because river quality is relatively constant over time. 2. N/A
8	Total Suspended Solids (TSS)	q	Monitored: (1990-1991; 2002-present) q: 1990: Added to align with Process Outfall monitoring [1]. 1991: Removed as deemed not to be required under the MISA program [1]. q: 2002: Added to align with Process Outfall monitoring and get a better understanding of the River characteristics [2].	M	Semi-annual Grab ***	1. Frequency: 1990: Monthly to align with monthly Process Outfall monitoring while effluent characterization was taking place [1]. 1991: Removed [1]. 2002: Quarterly to align with quarterly Process Outfall monitoring in place capturing seasonal variation [2]. 2016: Reduced to Semi-annual as values are at or close to detection level [9]. Sample Type: Grab appropriate because river quality is relatively constant over time. 2. N/A

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Ottawa River Intake (ORC) *						
ATG	**Parameter Name**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
9	Aluminium, Unfiltered Total & Boron, Unfiltered Total & Chromium, Unfiltered Total & Copper, Unfiltered Total & Lead, Unfiltered Total & Nickel, Unfiltered Total & Vanadium, Unfiltered Total & Zinc, Unfiltered Total	q	Monitored: (1990; 2002-present) q: 1990: Added to align with Process Outfall monitoring [1]. 1991: Removed as deemed not to be required under the MISA program [1]. q: 2002: Added to align with Process Outfall monitoring and get a better understanding of the River characteristics [2].	M	Monthly Grab ***	1. Frequency: 1990: Monthly to align with monthly Process Outfall monitoring while effluent characterization was taking place [1]. 1991: Removed [1]. 2002: Quarterly to align with quarterly Process Outfall monitoring in place capturing seasonal variation [2]. 2016: Reduced to Semi-annual as levels of background in River are well established [9]. 2024: Increased to monthly for increased resolution on incoming water from the Ottawa River which may help compare possible oddities in effluent concentrations for locations where the main water source is drawn from the Ottawa River [11]. Sample Type: Grab appropriate because river quality is relatively constant over time. 2. N/A
9	Cadmium, Unfiltered Total & Lithium, Unfiltered Total & Strontium, Unfiltered Total	q	Monitored: (2002-present) q: 2002: Added to align with Process Outfall monitoring and get a better understanding of the River characteristics [2].	M	Monthly Grab ***	1. Frequency: 2002: Quarterly to align with quarterly Process Outfall monitoring in place capturing seasonal variation [2]. 2016: Reduced to semi-annual as levels of background in River are well established [9]. 2024: Increased to monthly for increased resolution on incoming water from the Ottawa River which may help compare possible oddities in effluent concentrations for locations where the main water source is drawn from the Ottawa River [11]. Sample Type: Grab appropriate because river quality is relatively constant over time. 2. N/A

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Ottawa River Intake (ORC) *						
ATG	**Parameter Name**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
9	Silver, Unfiltered Total	N/A	Not Monitored: (was from 2002 – 2014) q: 2002: Added to align with Process Outfall monitoring and get a better understanding of the River characteristics [2]. 2014: Removed as never detected either at Process Outfall or ORC and not a suspected contaminant on site [8].	N/A	N/A	1. Frequency: 2002: Quarterly to align with quarterly Process Outfall monitoring in place capturing seasonal variation [2]. 2014: Removed [8]. 2. N/A
9a	Iron, Unfiltered Total	q	Monitored: (1990; 2002-present) q: 1990: Added to align with Process Outfall monitoring [1]. 1991: Removed as deemed not to be required under the MISA program [1]. q: 2002: Added to align with Process Outfall monitoring and get a better understanding of the River/background characteristics [2].	M	Monthly Grab ***	1. Frequency: 1990: Monthly to align with monthly Process Outfall monitoring while effluent characterization was taking place [1]. 1991: Removed [1]. 2002: Quarterly to align with quarterly Process Outfall monitoring in place capturing seasonal variation [2]. 2016: Reduced to Semi-annual as levels of background in River are well established [9]. 2024: Increased to monthly for increased resolution on incoming water from the Ottawa River which may help compare possible oddities in effluent concentrations for locations where the main water source is drawn from the Ottawa River [11]. Sample Type: Grab appropriate because river quality is relatively constant over time. 2. N/A
9a	Uranium, Unfiltered Total	q	Monitored: (2010 – present) q: 2010: Added to align with Process Outfall monitoring in order to identify any background levels which may be present [4].	M	Monthly Grab ***	1. Frequency: 2010: Quarterly to align with quarterly Process Outfall monitoring in place capturing seasonal variation [4]. 2016: Reduced to Semi-annual as levels of background in River are well established [9]. 2024: Increased to monthly for increased resolution on incoming water from the Ottawa River which may help compare possible oddities in effluent concentrations for locations where the main water source is drawn from the Ottawa River [11]. Sample Type: Grab appropriate because river quality is relatively constant over time. 2. N/A

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Ottawa River Intake (ORC) *						
ATG	**Parameter Name**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
12	Mercury, Unfiltered Total	q	Monitored: (1993-Present) q: 1993: Added in efforts to determine if the source of mercury in the Sanitary Sewage Treatment Facility (STP) and Waste Treatment Centre (WTC) may have come from the Ottawa River [5]. A source of mercury continues to be the WTC_LWE therefore understanding background levels in the river water is important.	M	Semi-annual Grab ***	1. Frequency: 1993: Quarterly monitoring to capture major seasonal variations [6]. 2004: Increased to monthly sampling in order to better determine background mercury levels in the Ottawa River and increase the accuracy in loading calculation of mercury specifically due to the interest in this parameter in the WTC_LWE effluent [7]. 2016: Reduced to Semi-annual as levels of background in River are well established [10]. Sample Type: Grab appropriate because river quality is relatively constant over time. 2. N/A
14	Phenolics, Unfiltered React	N/A	Not Monitored: (was in 1990; 2002-2016) q: 1990: Added to align with Process Outfall monitoring [1]. 1991: Removed as deemed not to be required under the MISA program [1]. q: 2002: Added to align with Process Outfall monitoring and get a better understanding of the River characteristics [2]. 2016: Removed as historical data demonstrate that river's natural conditions are consistently below the detection limit [9].	N/A	N/A	1. Frequency: 1990: Monthly to align with monthly Process Outfall monitoring while effluent characterization was taking place [1]. 1991: Removed [2]. 2002: Quarterly to align with quarterly Process Outfall monitoring in place capturing seasonal variation [3]. 2016: Removed [10]. 2. N/A
25	Solvent Extractables	N/A	Not Monitored: (was in 1990; 1993-2016) q: 1990: Added to align with Process Outfall monitoring [1]. 1991: Removed as deemed not to be required under the MISA program [1]. q: 1993: Resumed as determined to be key parameter for this monitoring point (temp, Hg and oil/grease only) [5]. 2016: Removed as historical data demonstrate that river's natural conditions are consistently below the detection limit [9].	N/A	N/A	1. Frequency: 1993: Added in 1993 in efforts to better determine River background levels of this parameter which is being monitored in other effluent streams. Although the levels of this parameter could be variable, quarterly monitoring was chosen as a screening frequency as there was no known concern [5], [7]. 2016: Removed [9]. 2. N/A

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Ottawa River Intake (ORC) *						
ATG	**Parameter Name**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
--	Temperature Influent Mean	N/A	Not Monitored: (was from 1990-2018) q: 1990 - Added to align with Process Outfall monitoring in order to determine what heat was being added to the Ottawa River because of site operations (ΔT from intake to Process Outfall) [1]. 2018: Removed analysis of temperature of all liquid effluents with the shutdown of the National Research Universal (NRU) as the cooling of the reactor was the dominant source of released heat [10].	N/A	N/A	1. Frequency: 1990: Daily as ΔT is variable based on site operations and changes in River temperature [1]. 2018: Removed [10]. 2. N/A

Notes:
MISA - Municipal/Industrial Strategy for Abatement.
* Current as of issuing date of document. Always refer to the latest version of EVMP Monitoring Schedule
** See Table 7: Parameter Monitoring Criteria for the Effluent Compliance Monitoring Program
*** Manual Single Grab (in a bucket) from NRU Intake well. Monthly and semi-annual samples are on a set day during the period.

References:

[1] *MISA Liquid Effluent Monitoring at CRL: Summary of Monitoring Results for the Period 1990 June to 1991 May*, RC-809, 1992 March.
[2] *Non-Radiological Liquid Effluent Monitoring at CRL: Summary of the Monitoring Results for the Period 1991 May to 1992 December*, RC-1086, 1993 September.
[3] *Non-Radiological Emissions Monitoring at CRL: The Results for 2002,* AECL-MISC-421-02, 2003 March.
[4] *Non-Radiological Monitoring Schedule for CRL*, CRL-509200-062-000-0001, Rev5, 2013 January. 23651749
[5] *Non-Radiological Monitoring Schedule for CRL,* CRL-509200-062-000-0001, Rev1, 2009 December. 23657146
[6] *MISA Gap Monitoring for 1993, Second Half*, EP-C93-050, 1993 June 16.
[7] *Non-Radiological Emission Monitoring at CRL: The Results for 2004*, AECL-MISC-421-04, 2005 March. 22385847
[8] *Non-Radiological Liquid Effluent Monitoring at CRL: Results for the Period 1993 January to December*, NSN-ESRSD-117, 1995 January. 22506084
[9] *Non-Radiological Monitoring Schedule for CRL*, CRL-509200-062-000-0001, Rev6, 2013 December. 23651723
[10] *Effluent Sampling Schedule for CRL – Liquid (Non-Radiological),* CRL-509200-062-000-0004, Rev5, 2016 January. 22728251
[11] *Effluent Verification Monitoring Program Sampling Schedule for CRL & NPD – Non-Radiological Liquid Effluent*, CRL-509200-062-000-0004, Rev12, 2018 December. 42016713
[12] *Effluent Verification Monitoring Program Sampling Schedule for CRL, NPD & DP*, CRL-509200-062-000-0004, Rev 26, 2024 Sept 5. 67072696

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4.3.2 Waterborne Effluents

4.3.2.1 Upstream Process Effluent Streams

4.3.2.1.1 Waste Treatment Centre Liquid Waste Evaporator (WTC_LWE)

Table 17: Detailed Design - WTC_LWE

Description: Treatment Centre processes/treats radioactive wastewater originating from a number of facilities/ laboratories in the active area via the Active Drain System, the Decontamination Centre and the Reactor Drain before discharging this condensate/distillate to the Process Outfall Collection System. It is therefore considered an upstream monitoring location.
Source Term: The effluent from this waste stream is dependent on the waste which is being produced in the facilities across the site and can therefore vary.
Potential Non-radiological Contaminants: Varies depending on waste being accepted for treatment.
Discharge Characteristics: Effluent is released to the Process Outfall Collection System in batches. Number of batch discharges depend on the operation of the facility but in recent years have ranged from ten to twenty-three annually. Batches tend to be approximately 33-37 m^3 each. The WTC normally completes a series of batch discharges in a row, known as a "run" which are released typically over a number of days.
Monitoring Strategy: This monitoring point was part of the original MISA program and routine monitoring began in 1991 and has been monitored consistently since then with minor changes to the parameters and frequency of monitoring. Effluent monitoring takes place after all treatment has taken place but prior to the effluent being discharged to the Process Outfall Collection System. Grab samples are taken from each batch tank prior to discharge and compiled to form a composite sample. Tanks are on continuous circulation throughout process allowing a grab to be a representative sample type for each tank.

Waste Treatment Centre Liquid Waste Evaporator (WTC_LWE) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type ***** **2. Estimation over Measurement**
1	Chemical Oxygen Demand No Treatment	p	Monitored: (1991 – present) p: 1991: Monitored as CRL's process effluents were identified as having a significant fraction of the total loading of COD in the Electrical Power Generating Sector [1].	M	Per Run Composite	1. Frequency: 1991: Quarterly once identified as a Priority 1 Pollutant for this stream [1] and would capture seasonal variability in the service water. 2022: Changed to monthly in effort to streamline/simplify monitoring of this stream. Note: reductions in processing requirements means that number of samples will not increase greatly as a result of this change [2], [3]. 2023: Changed from monthly to "Per run" as monthly sampling/analysis frequency could have potentially missed one or more runs if there were more that one run in a month [15].

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Waste Treatment Centre Liquid Waste Evaporator (WTC_LWE) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type ***** **2. Estimation over Measurement**
						Sample Type: Grabs of well circulated tanks are used to form a composite to form representative sample from each of the tanks released. 2. N/A
3	pH Caustic Addition	p	Monitored: (1990 – present) p: 1990: Core parameter required under MISA specifically for this location and all process effluent streams as a gross indicator of effluent quality [4].	M	Batch Grab	1. Frequency: 1990: MISA recommends daily or per batch for all process effluent due to possible variability and pH's ability to act as a gross indicator in case there are issues with a single batch within a run [4]. Sample Type: Grab is appropriate because batch is well mixed prior to release. 2. N/A
4a	Ammonium, Total Filter React N/A	N/A	Not Monitored: (was from 1993 – 1997) p: 1993: Added as CRL was identified as having a significant fraction of the total loading of this parameter in the Electrical Power Generating Sector [5]. 1997: Removed as no significant level found in effluent and no known source [6].	N/A	N/A	1. Frequency: 1993: Added monthly at each of the process and combined effluents for characterization [5]. 1997: Removed [6]. 2. N/A
4b	Nitrates, Total Filter Reactive N/A	N/A	Not Monitored: (was from 1990 – 2014) 1990: Core parameter required under MISA specifically for this location as nitric acid was being used to adjust the pH before treatment [4]. 2014: Removed as nitric acid is no longer used to adjust pH, removing the source and thereby removing the need to monitor this parameter [7].	N/A	N/A	1. Frequency: 1990: Monthly to characterize and then as a routine scan based on changing operations [4]. 2014: Removed [7]. 2. N/A
5a	Dissolved Organic Carbon (DOC) No Treatment	p	Monitored: (1990 – present) p: 1990: Core parameter required under MISA specifically for this location as this is a treatment facility which may accept wastewater from facilities on site which have some contamination (from the use of hydraulic oils, greases, lubricating oils etc.) [4].	M	Per Run Composite	1. Frequency: 1990: Weekly in order to initially characterize the effluent (recommended by MISA) and then as a routine check for contamination as a result of spills or leaks; weekly sampling captures each "run" [1]. 2016: Reduced to monthly as variability is low [8].

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Waste Treatment Centre Liquid Waste Evaporator (WTC_LWE) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type ***** **2. Estimation over Measurement**
						2023: Changed from monthly to "Per run" as monthly sampling/analysis frequency could have potentially missed one or more runs if there were more that one run in a month [15]. Sample Type: Grabs of well circulated tanks are used to form a monthly composite to ensure representative sample from each of the tanks released. 2. N/A
5b	Total Organic Carbon (TOC) No Treatment	p	Monitored: (1990 – present) p: 1990: Core parameter required under MISA specifically for this location as this is a treatment facility which may accept wastewater from facilities on site which have some contamination (from the use of hydraulic oils, greases, lubricating oils etc.) [4].	M	Per Run Composite	1. Frequency: 1990: Weekly in order to initially characterize the effluent and then as a routine check for contamination as a result of spills or leaks; weekly sampling captures each "run" [1]. Note: Identified as a Priority 1 Pollutant for the stream under MISA. 2016: Reduced to monthly as variability is low [8]. 2023: Changed from monthly to "Per run" as monthly sampling/analysis frequency could have potentially missed one or more runs if there were more that one run in a month [15]. Sample Type: Grabs of well circulated tanks are used to form a monthly composite to ensure representative sample from each of the tanks released. 2. N/A
6	Phosphorus, Unfiltered Total Treatment	h, p	Monitored: (1990 – present) p: 1990: Core parameter required under MISA specifically for this location [4]. h: 2006 - Site Licence Limit came into effect. Monitoring required to determine compliance [9].	M	Per Run Composite	1. Frequency: 1990: Weekly for Process Effluents as identified as a Priority 1 Pollutant for the stream, therefore close monitoring was determined to be appropriate [1]. 2014: Reduced to monthly as it has been non-detectable for over 5 years. Monthly is required however for the Site Licence Limit [7]. 2023: Changed from monthly to "Per run" as monthly sampling/analysis frequency could have potentially missed one or more runs if there were more that one run in a month [15]. Sample Type: Grabs of well circulated tanks are used to form a monthly composite to ensure representative sample from each of the tanks released. 2. N/A

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Waste Treatment Centre Liquid Waste Evaporator (WTC_LWE) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type ***** **2. Estimation over Measurement**
7	Conductivity, @ [redacted] No Treatment	p	Monitored: (1990 – present) p: 1990: Core parameter required under MISA specifically for this location as a gross indicator of effluent quality [4].	M	Batch Grab	1. Frequency: 1990: MISA recommends daily or per batch for all process effluent due to possible variability and conductivity's ability to act as a gross indicator in case there are issues with a single batch within a run [1]. Sample Type: Grab is appropriate because batch is well mixed prior to release. 2. N/A
8	Residue, Part Loss Igntn Volatile Suspended Solids (VSS) N/A	N/A	Not Monitored: (was from 1993 – 2014) 1993: Monitored as CRL's process effluents were identified as having a significant fraction of the total loading of VSS in the Electrical Power Generating Sector [5]. 2014: Removed as consistently insignificant contribution to site total (<0.5%) and ≤ LMDL. (Note: More appropriate for treatment facilities with biological treatment (i.e. Sewage Treatment Plants).	N/A	N/A	1. Frequency: 1993: Quarterly as not expected to have a relatively large contribution to overall site loading [1]. 2014: Removed [7]. 2. N/A
8	Total Suspended Solids (TSS) Treatment	h, p	Monitored: (1990; 1993 - present) 1990: Monitored for effluent characterization purposes [4]. 1991: Removed. P: 1993: Identified as a core parameter required under MISA specifically for this location as a gross indicator of effluent quality and measure of effectiveness of the treatment system equipment [4]. h: 2006 - Site Licence Limit came into effect. Monitoring required to determine compliance [9].	M	Per Run Composite	1. Frequency: 1990: Weekly in order to initially characterize the effluent (recommended by MISA) [1]. 1991: Removed [1]. 1993: Weekly as a routine check for contamination as a result of spills or leaks; weekly sampling captures each "run". 2006 Note: Must be at least monthly for the Site Licence Limit [9]. 2022: Changed to monthly in effort to streamline/simplify monitoring of this stream. Note: reductions in processing requirements means that number of samples will not change greatly as a result of this change [2], [3]. 2023: Changed from monthly to “Per run” as monthly sampling/analysis frequency could have potentially missed one or more runs if there were more that one run in a month [15]. Sample Type: Grabs of well circulated tanks are used to form a monthly composite to ensure representative sample from each of the tanks released.

REDACTED

Waste Treatment Centre Liquid Waste Evaporator (WTC_LWE) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type ***** **2. Estimation over Measurement**
						2. N/A
9	Aluminium, Unfiltered Total No Treatment	p	Monitored: (1990 – present) p: 1990: Core parameter required under MISA specifically for this location (i.e. process effluent from treatment facility accepting varying waste). Known to have a high background at CRL [10].	M	Per Run Composite	1. Frequency: 1990: Weekly scan due to varying waste being accepted by the treatment facility. More frequent due to higher profile of this parameter (core parameter and high background) [1]. 2022: Changed to monthly in effort to streamline/simplify monitoring of this stream. Note: reductions in processing requirements means that number of samples will not change greatly as a result of this change [2], [3]. 2023: Changed from monthly to "Per run" as monthly sampling/analysis frequency could have potentially missed one or more runs if there were more that one run in a month [15]. Sample Type: Grabs of well circulated tanks are used to form a monthly composite to ensure representative sample from each of the tanks released. 2. N/A
9	Boron, Unfiltered Total No Treatment	p	Monitored: (1990 – present) p: 1990: Parameter required under MISA specifically for this location (i.e. process effluent from treatment facility accepting varying waste) [10].	M	Per Run Composite	1. Frequency: 1990: Monthly scan due to varying waste being accepted by the treatment facility and not a core parameter [1]. 2018: Increased to weekly in order to align with other parts of ATG which were being monitored weekly [11]. 2022: Changed to monthly in effort to streamline/simplify monitoring of this stream. Note: reductions in processing requirements means that number of samples will not change greatly as a result of this change [2], [3]. 2023: Changed from monthly to "Per run" as monthly sampling/analysis frequency could have potentially missed one or more runs if there were more that one run in a month [15]. Sample Type: Grabs of well circulated tanks are used to form a monthly composite to ensure representative sample from each of the tanks released. 2. N/A

REDACTED

Waste Treatment Centre Liquid Waste Evaporator (WTC_LWE) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type ***** **2. Estimation over Measurement**
9	Cadmium, Unfiltered Total No Treatment	p	Monitored: (1990 – present) p: 1990: Parameter required under MISA specifically for this location (i.e. process effluent from treatment facility accepting varying waste) [10].	M	Per Run Composite	1. Frequency: 1990: Monthly scan due to varying waste being accepted by the treatment facility and not a core parameter [1]. 2018: Increased to weekly in order to align with other parts of ATG which were being monitored weekly [11]. 2022: Changed to monthly in effort to streamline/simplify monitoring of this stream. Note: reductions in processing requirements means that number of samples will not change greatly as a result of this change [2], [3]. 2023: Changed from monthly to "Per run" as monthly sampling/analysis frequency could have potentially missed one or more runs if there were more that one run in a month [15]. Sample Type: Grabs of well circulated tanks are used to form a monthly composite to ensure representative sample from each of the tanks released. 2. N/A
9	Chromium, Unfiltered Total Treatment	h, p	Monitored: (1990 – present) p: 1990: Parameter required under MISA specifically for this location (i.e. process effluent from treatment facility accepting varying waste) [10]. h: 2006 - Site Licence Limit came into effect. Monitoring required to determine compliance [9].	M	Per Run Composite	1. Frequency: 1990: Monthly scan due to varying waste being accepted by the treatment facility and not a core parameter [1]. 2006 Note: Must be at least monthly for the Site Licence Limit [9]. 2018: Increased to weekly in order to align with other parts of ATG which were being monitored weekly [11]. 2022: Changed to monthly in effort to streamline/simplify monitoring of this stream. Note: reductions in processing requirements means that number of samples will not change greatly as a result of this change [2], [3]. 2023: Changed from monthly to "Per run" as monthly sampling/analysis frequency could have potentially missed one or more runs if there were more that one run in a month [15]. Sample Type: Grabs of well circulated tanks are used to form a monthly composite to ensure representative sample from each of the tanks released. 2. N/A

REDACTED

Waste Treatment Centre Liquid Waste Evaporator (WTC_LWE) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type ***** **2. Estimation over Measurement**
9	Copper, Unfiltered Total Treatment	h, p	Monitored: (1990 – present) p: 1990: Core parameter required under MISA specifically for this location (process effluent from treatment facility accepting varying waste) [10]. h: 2006 - Site Licence Limit came into effect. Monitoring required to determine compliance [9].	M	Per Run Composite	1. Frequency: 1990: Weekly scan due to varying waste being accepted by the treatment facility. More frequent due to higher profile of this parameter (core parameter) [1]. 2006 Note: Must be at least monthly for the Site Licence Limit [9]. 2022: Changed to monthly in effort to streamline/simplify monitoring of this stream. Note: reductions in processing requirements means that number of samples will not change greatly as a result of this change [2], [3]. 2023: Changed from monthly to "Per run" as monthly sampling/analysis frequency could have potentially missed one or more runs if there were more that one run in a month [15]. Sample Type: Grabs of well circulated tanks are used to form a monthly composite to ensure representative sample from each of the tanks released. 2. N/A
9	Lead, Unfiltered Total Treatment	h, p	Monitored: (1990 – present) p: 1990: Parameter required under MISA specifically for this location (i.e. process effluent from treatment facility accepting varying waste) [10]. h: 2006 - Site Licence Limit came into effect. Monitoring required to determine compliance [9].	M	Per Run Composite	1. Frequency: 1990: Monthly scan due to varying waste being accepted by the treatment facility and not a core parameter [1]. 2006 Note: Must be at least monthly for the Site Licence Limit [9]. 2018: Increased to weekly in order to align with other parts of ATG which were being monitored weekly [11]. 2022: Changed to monthly in effort to streamline/simplify monitoring of this stream. Note: reductions in processing requirements means that number of samples will not change greatly as a result of this change [2], [3]. 2023: Changed from monthly to "Per run" as monthly sampling/analysis frequency could have potentially missed one or more runs if there were more that one run in a month [15]. Sample Type: Grabs of well circulated tanks are used to form a monthly composite to ensure representative sample from each of the tanks released. 2. N/A

REDACTED

Waste Treatment Centre Liquid Waste Evaporator (WTC_LWE) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type ***** **2. Estimation over Measurement**
9	Lithium, Unfiltered Total No Treatment	p	Monitored: (1990 – present) p: 1990: Parameter required under MISA specifically for this location (i.e. process effluent from treatment facility accepting varying waste) [10].	M	Per Run Composite	1. Frequency: 1990: Monthly scan due to varying waste being accepted by the treatment facility and not a core parameter [1]. 2018: Increased to weekly in order to align with other parts of ATG which were being monitored weekly [11]. 2022: Changed to monthly in effort to streamline/simplify monitoring of this stream. Note: reductions in processing requirements means that number of samples will not change greatly as a result of this change [2], [3]. 2023: Changed from monthly to "Per run" as monthly sampling/analysis frequency could have potentially missed one or more runs if there were more that one run in a month [15]. Sample Type: Grabs of well circulated tanks are used to form a monthly composite to ensure representative sample from each of the tanks released. 2. N/A
9	Nickel, Unfiltered Total Treatment	h, p	Monitored: (1990 – present) p: 1990: Parameter required under MISA specifically for this location (i.e. process effluent from treatment facility accepting varying waste) [10]. h: 2006 - Site Licence Limit came into effect. Monitoring required to determine compliance [9].	M	Per Run Composite	1. Frequency: 1990: Monthly scan due to varying waste being accepted by the treatment facility and not a core parameter [1]. 2006 Note: Must be at least monthly for the Site Licence Limit [9]. 2018: Increased to weekly in order to align with other parts of ATG which were being monitored weekly [11]. 2022: Changed to monthly in effort to streamline/simplify monitoring of this stream. Note: reductions in processing requirements means that number of samples will not change greatly as a result of this change [2], [3]. 2023: Changed from monthly to "Per run" as monthly sampling/analysis frequency could have potentially missed one or more runs if there were more that one run in a month [15]. Sample Type: Grabs of well circulated tanks are used to form a monthly composite to ensure representative sample from each of the tanks released. 2. N/A

REDACTED

Waste Treatment Centre Liquid Waste Evaporator (WTC_LWE) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type ***** **2. Estimation over Measurement**
9	Silver, Unfiltered Total N/A	N/A	Not Monitored: (was from 1990 – 1993) 1990: Parameter required under MISA specifically for this location (i.e. process effluent from treatment facility accepting varying waste) [10]. 1993: Monitoring dropped as levels were found to be consistently below LMDL [5].	N/A	N/A	1. Frequency: 1990: Monthly scan due to varying waste being accepted by the treatment facility and not a core parameter [1]. 1993: Removed [5]. 2. N/A
9	Strontium, Unfiltered Total No Treatment	p	Monitored: (1990 – present) p: 1990: Parameter required under MISA specifically for this location (i.e. process effluent from treatment facility accepting varying waste) [10].	M	Per Run Composite	1. Frequency: 1990: Monthly scan due to varying waste being accepted by the treatment facility and not a core parameter [1]. 2018: Increased to weekly in order to align with other parts of ATG which were being monitored weekly [11]. 2022: Changed to monthly in effort to streamline/simplify monitoring of this stream. Note: reductions in processing requirements means that number of samples will not change greatly as a result of this change [2], [3]. 2023: Changed from monthly to "Per run" as monthly sampling/analysis frequency could have potentially missed one or more runs if there were more that one run in a month [15]. Sample Type: Grabs of well circulated tanks are used to form a monthly composite to ensure representative sample from each of the tanks released. 2. N/A
9	Vanadium, Unfiltered Total No Treatment	p	Monitored: (1990 – present) p: 1990: Parameter required under MISA specifically for this location (i.e. process effluent from treatment facility accepting varying waste) [10].	M	Per Run Composite	1. Frequency: 1990: Monthly scan due to varying waste being accepted by the treatment facility and not a core parameter [1]. 2018: Increased to weekly in order to align with other parts of ATG which were being monitored weekly [11]. 2022: Changed to monthly in effort to streamline/simplify monitoring of this stream. Note: reductions in processing requirements means that number of samples will not increase greatly as a result of this change [2], [3]. 2023: Changed from monthly to "Per run" as monthly sampling/analysis frequency could have potentially missed one or more runs if there were more that one run in a month [15].

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Waste Treatment Centre Liquid Waste Evaporator (WTC_LWE) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type ***** **2. Estimation over Measurement**
						Sample Type: Grabs of well circulated tanks are used to form a monthly composite to ensure representative sample from each of the tanks released. 2. N/A
9	Zinc, Unfiltered Total Treatment	h, p	Monitored: (1990 – present) p: 1990: Core parameter required under MISA specifically for this location [10]. h: 2006 - Site Licence Limit came into effect. Monitoring required to determine compliance [9].	M	Per Run Composite	1. Frequency: 1990: Weekly scan due to varying waste being accepted by the treatment facility. More frequent due to higher profile of this parameter (core parameter) [1]. 2006 Note: Must be at least monthly for the Site Licence Limit [9]. 2022: Changed to monthly in effort to streamline/simplify monitoring of this stream. Note: reductions in processing requirements means that number of samples will not increase greatly as a result of this change [2], [3]. 2023: Changed from monthly to "Per run" as monthly sampling/analysis frequency could have potentially missed one or more runs if there were more that one run in a month [15]. Sample Type: Grabs of well circulated tanks are used to form a monthly composite to ensure representative sample from each of the tanks released. 2. N/A
9a	Iron, Unfiltered Total No Treatment	p	Monitored: (1990 – present) p: 1990: Core parameter required under MISA specifically for this location. Known to have a high background at CRL [10].	M	Per Run Composite	1. Frequency: 1990: Weekly scan due to varying waste being accepted by the treatment facility. More frequent due to higher profile of this parameter (core parameter and high background) [1]. 2022: Changed to monthly in effort to streamline/simplify monitoring of this stream. Note: reductions in processing requirements means that number of samples will not increase greatly as a result of this change [2] [3]. 2023: Changed from monthly to "Per run" as monthly sampling/analysis frequency could have potentially missed one or more runs if there were more that one run in a month [15]. Sample Type: Grabs of well circulated tanks are used to form a monthly composite to ensure representative sample from each of the tanks released. 2. N/A

REDACTED

Waste Treatment Centre Liquid Waste Evaporator (WTC_LWE) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type ***** **2. Estimation over Measurement**
9a	Uranium, Unfiltered Total No Treatment	q	Monitored: (2007 – present) q: 2007: Added based on SRC comment as EnvP was monitoring this in the radioactive program but not the non-radioactive program [12].	M	Per Run Composite	1. Frequency: 2007: Weekly scan in line with iron (also ATG 9a) [13]. 2014: Reduced to monthly to align with cadmium as analysis for uranium and cadmium are done in combination (not with iron). Mostly non-detects to date and not a known contaminant of concern for this effluent or this sector [7]. 2018: Increased to weekly in order to align with other parts of ATG which were being monitored weekly [11]. 2022: Changed to monthly in effort to streamline/simplify monitoring of this stream. Note: reductions in processing requirements means that number of samples will not increase greatly as a result of this change [2], [3]. 2023: Changed from monthly to "Per run" as monthly sampling/analysis frequency could have potentially missed one or more runs if there were more that one run in a month [15]. Sample Type: Grabs of well circulated tanks are used to form a monthly composite to ensure representative sample from each of the tanks released. 2. N/A
10	Antimony, Unfiltered Total N/A	N/A	Not Monitored: (was from 1991 – 1993) 1991: Scan as part of characterization for treatment facilities [1]. 1993: Removed as not detected in any concentration of concern and no known source [5].	N/A	N/A	1. Frequency: 1991: Quarterly for characterization of the effluent [1]. 1993: Removed [5]. 2. N/A
10	Arsenic, unfiltered Total N/A	N/A	Not Monitored: (was from 1991 – 1993) 1991: Scan as part of characterization for treatment facilities [1]. 1993: Removed as not detected in any concentration of concern and no known source [5].	N/A	N/A	1. Frequency: 1991: Quarterly for characterization of the effluent [1]. 1993: Removed [5]. 2. N/A

REDACTED

Waste Treatment Centre Liquid Waste Evaporator (WTC_LWE) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type ***** **2. Estimation over Measurement**
12	Mercury, Unfiltered Total Treatment	h, p	Monitored: (1990 – present) p: 1990: Required under MISA specifically for this location (known historical contaminant in waste treated by the Waste Treatment Centre) [4]. h: 2006 - Site Licence Limit came into effect. Monitoring required to determine compliance [9].	M	Batch Grab	1. Frequency: 1990: Monthly scan due to varying waste effluent [4]. 2005: Increased to every batch based on Special Investigation monitoring which took place in 2005 and 2006 in response to issues with mercury levels in the effluent. The investigation revealed that batch sampling was more representative of actual mercury concentrations therefore per batch monitoring was added to the routine monitoring program [12]. Note: The CNL Guideline is also a "daily" limit meaning each batch result should be compared; whereas, the site licence limit is a monthly average limit. Sample Type: Grab is appropriate because batch is well mixed prior to release. 2. N/A
14	Phenolics, Unfiltered React No Treatment	p	Monitored: (1990 - present) p: 1990: Core parameter required under MISA specifically for this location as it is a process effluent with a known source from the detergents being used at the site's decontamination centre [4]. The WTC_LWE has the highest levels of phenolics of all of the CRL process effluent streams.	M	Per Run Composite	1. Frequency: 1990: Monthly for characterization of the effluent. 1991: Weekly as noted levels were observed and due to varying waste streams being treated, weekly sampling captures each "run" [1]. 2022: Changed to monthly in effort to streamline/simplify monitoring of this stream. Note: reductions in processing requirements means that number of samples will not increase greatly as a result of this change [2], [3]. 2023: Changed from monthly to “Per run” as monthly sampling/analysis frequency could have potentially missed one or more runs if there were more that one run in a month [15]. Sample Type: Grabs of well circulated tanks are used to form a monthly composite to ensure representative sample from each of the tanks released. 2. N/A
16	Volatiles, Halogenated N/A	N/A	Not Monitored: (was from 1991 - 2016) 1991: Monitoring initiated for this stream as the treatment centre is designed to collect liquid waste containing various chemicals from across the CRL site [1].	N/A	N/A	1. Frequency: 1991: Quarterly for characterization of the effluent [1]. 1992: Routine scan based on potential for sources due to varying inputs [5]. 2016: Removed [11]. 2. N/A

REDACTED

Waste Treatment Centre Liquid Waste Evaporator (WTC_LWE) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type ***** **2. Estimation over Measurement**
			2016: Removed monitoring of entire ATG as results were consistently non-detectable (except for only a few parameters) [11].			
16	Chloroform N/A	N/A	Not Monitored: (was from 1991 - 2022) p: 1991: Monitoring initiated for this stream as the treatment centre is designed to collect liquid waste containing various chemicals from across the CRL site [1]. q: 2016: Retained [11] (despite removal of monitoring for the rest of ATG 16) as there are routinely detectable results for this parameter. 2022: Removed as the results were consistently non-detectable since NRU was shut down (2019 through 2021) [3].	N/A	N/A	1. Frequency: 1991: Quarterly for characterization of the effluent [1]. 2022: Removed [3]. 2. N/A
16	Methylene Chloride N/A	N/A	Not Monitored: (was from 1991 - 2022) p: 1991: Monitoring initiated for this stream as the treatment centre is designed to collect liquid waste containing various chemicals from across the CRL site [1]. q: 2016: Retained [11] (despite removal of monitoring for the rest of ATG 16) as there are routinely detectable results for this parameter. 2022: Removed as the results were consistently non-detectable since NRU was shut down (2019 through 2021) [3].	N/A	N/A	1. Frequency: 1991: Quarterly for characterization of the effluent [1]. 2022: Removed [3]. 2. N/A
17	Volatiles, Non-Halogenated N/A	N/A	Not Monitored: (was from 1991 - 2016) p: 1991: Monitoring initiated for this stream as the treatment centre is designed to collect liquid waste containing various chemicals from across the CRL site [1]. 2016: Removed ATG as a whole as results were consistently non-detectable (except for Toluene) [11].	N/A	N/A	1. Frequency: 1991: Quarterly for characterization of the effluent [1]. 1992: Routine scan based on potential for sources due to varying inputs [5]. 2016: Removed [11]. 2. N/A

REDACTED

Waste Treatment Centre Liquid Waste Evaporator (WTC_LWE) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type ***** **2. Estimation over Measurement**
17	Toluene N/A	N/A	Not Monitored: (was from 1991 - 2022) p: 1991: Monitoring initiated for this stream as the treatment centre is designed to collect liquid waste containing various chemicals from across the CRL site [1]. q: 2016: Retained (despite removal of monitoring for the rest of ATG 17) as there are routinely detectable results for this parameter [11]. 2022: Removed as the results were consistently non-detectable since NRU was shut down (2019 through 2021) [3].	N/A	N/A	1. Frequency: 1991: Quarterly for characterization of the effluent [1]. 2022: Removed [3]. Sample Type: 2. N/A
19	Extractables, Neutral N/A	N/A	Not Monitored: (1991 - 2016) p: 1991: Monitoring initiated for this stream as the treatment centre is designed to collect liquid waste containing various chemicals from across the CRL site [1]. 2016: Removed [11] as results were consistently non-detectable (except for Indole, butylbenzyl phthalate and 2-ethylhexyl phthalate) and monitoring was a should as per MISA.	N/A	N/A	1. Frequency: 1991: Quarterly for characterization of the effluent [1]. 1992: Routine scan based on potential for sources due to varying inputs [5]. 2016: Removed [11]. 2. N/A
19	butylbenzyl phthalate N/A	N/A	Not Monitored: (was from 1991 - 2022) p: 1991: Monitoring initiated for this stream for all of ATG 19 (including butylbenzyl phthalate) as the treatment centre is designed to collect liquid waste containing various chemicals from across the CRL site [1]. q: 2016: Retained (despite removal of monitoring for the rest of ATG 19) as there are routinely detectable results for this parameter [11]. 2022: Removed as the results were consistently non-detectable since NRU was shut down (2019 through 2021) [3].	N/A	N/A	1. Frequency: 1991: Quarterly for characterization of the effluent [1]. 2022: Removed [3]. 2. N/A

REDACTED

Waste Treatment Centre Liquid Waste Evaporator (WTC_LWE) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type ***** **2. Estimation over Measurement**
19	Bis-2-ethylhexyl phthalate N/A	N/A	Not Monitored: (was from 1991 - 2022) p: 1991: Monitoring initiated for this stream for all of ATG 19 (including 2-ethylhexyl phthalate) as the treatment centre is designed to collect liquid waste containing various chemicals from across the CRL site [1]. q: 2016: Retained (despite removal of monitoring for the rest of ATG 19) as there are routinely detectable results for this parameter [11]. 2022: Removed as the results were consistently non-detectable since NRU was shut down (2019 through 2021) [3].	N/A	N/A	1. Frequency: 1991: Quarterly for characterization of the effluent [1]. 2022: Removed [3]. 2. N/A
19	Indole N/A	N/A	Not Monitored: (was from 1991 - 2022) p: 1991: Monitoring initiated for this stream for all of ATG 19 (including indole) as the treatment centre is designed to collect liquid waste containing various chemicals from across the CRL site [1]. q: 2016: Retained (despite removal of monitoring for the rest of ATG 19) as there are routinely detectable results for this parameter [11]. 2022: Removed as the results were consistently non-detectable since NRU was shut down (2019 through 2021) [3].	N/A	N/A	1. Frequency: 1991: Quarterly for characterization of the effluent [1]. 2022: Removed [3]. 2. N/A
20	Extractables, Acid N/A	N/A	Not Monitored: (was from 1991 - 2016) p: 1991: Monitoring initiated for this stream as the treatment centre is designed to collect liquid waste containing various chemicals from across the CRL site [1]. 2016: Removed as results were consistently non-detects (except for phenols and cresol which have been detectable but are also covered under this monitoring program by ATG 14 – Phenolics) [11].	N/A	N/A	1. Frequency: 1991: Quarterly for characterization of the effluent [1]. 2016: Removed [11]. 2. N/A

REDACTED

Waste Treatment Centre Liquid Waste Evaporator (WTC_LWE) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type ***** **2. Estimation over Measurement**
23	Extractables, Chlorinated N/A	N/A	Not Monitored: (was from 1991 - 2016) p: 1991: Monitoring initiated for this stream as the treatment centre is designed to collect liquid waste containing various chemicals from across the CRL site [1]. 2016: Removed as results were consistently non-detects [11].	N/A	N/A	1. Frequency: 1991: Quarterly for characterization of the effluent [1]. 1992: Quarterly routine scan based on potential for sources due to varying inputs [5]. 2016: Removed [11]. 2. N/A
24	Chlorinates Dioxins and Furans N/A	N/A	Not Monitored: (was from 1991 - 1999) p: 1991: Monitoring initiated for this stream as the treatment centre is designed to collect liquid waste containing various chemicals from across the CRL site [1]. 1999: Removed from all monitoring points on site as no significant levels were being detected and no known sources of contaminants [14].	N/A	N/A	1. Frequency: 1991: Quarterly [1]. 1999: Removed [14]. 2. N/A
25	Solvent Extractables Treatment	h, p	Monitored: (1990 - present) p: 1990: Core parameter required under MISA specifically for this location as this is a treatment facility which may accept wastewater from facilities on site which have some contamination [4]. h: 2006 - Site Licence Limit came into effect. Monitoring required to determine compliance [9].	M	Per Run Composite	1. Frequency: 1991: Weekly in order to initially characterize the effluent and then as a routine check for contamination as a result of spills or leaks [1]. Note: Concentrations are variable and weekly sampling captures each "run", therefore despite only requiring monthly monitoring to compare to Site Licence Limit, weekly continues to be justified. 2022: Changed to monthly in effort to streamline/simplify monitoring of this stream. Note: reductions in processing requirements means that number of samples will not increase greatly as a result of this change [2], [3]. 2023: Changed from monthly to "Per run" as monthly sampling/analysis frequency could have potentially missed one or more runs if there were more that one run in a month [15]. Sample Type: Grabs of well circulated tanks are used to form a monthly composite to ensure representative sample from each of the tanks released. 2. N/A

REDACTED

Waste Treatment Centre Liquid Waste Evaporator (WTC_LWE) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type ***** **2. Estimation over Measurement**
27	Polychlorinated Biphenyls (PCB) N/A	N/A	Not Monitored: (was from 1990 - 1997) 1990: Periodic check looking for contamination as a result of spills or leaks [10]. 1997: Removed as there were no results above the LMDL since monitoring commenced and no known source on site suspected of future contamination. Also, being monitored under the GWMP with no contamination noted [7].	N/A	N/A	1. Frequency: 1990: Quarterly check [10]. 1997: Removed [6]. 2. N/A
--	Volume of Batches & Number of Batches N/A	p	Monitored: (1990 - present) p: 1990: Core parameter under MISA used to determine track each release [4].	M	Batch N/A	1. Frequency: 1990: Batch estimates do not require continuous flow monitoring and can therefore be estimated based on batch size and time of discharge [1]. Note: batch size can vary therefore per batch is appropriate. Sample Type: N/A, instead tank level readings used. 2. N/A

Notes:
LMDL - Laboratory Method Detection Level; SRC Safety Review Committee; MISA - Municipal/Industrial Strategy for Abatement; ATG - Analytical Test Group; EnvP – Environmental Protection Program; GWMP – Groundwater Monitoring Program.
* Current as of issuing date of document. Always refer to the latest version of EVMP Monitoring Schedule (CRL-509200-062-000-0004).
** See Table 15 *Parameter Monitoring Criteria for the Effluent Verification Monitoring Program*
References:

[1] *Non-Radiological Liquid Effluent Monitoring at CRL: Summary of the Monitoring Results for the Period 1991 May to 1992 December*, RC-1086, 1993 December. 56574973
[2] *Review of Need for and Frequency of WTC_LWE Monitoring of ATG 16, 17 and 19 & Overall Frequencies*, ENVP-509220-022-000 2022 February. 56574973
[3] *Effluent Verification Monitoring Program Sampling Schedule for CRL & NPD – Non-Radiological Liquid Effluent*, CRL-509200-062-000-0004, Rev 20, 2022 DRAFT.
[4] *The Development Document for the Effluent Monitoring Regulation for the Electric Power Generation Sector*, MISA, 1990.
[5] *Non-Radiological Liquid Effluent Monitoring at CRL: Results for the Period 1993 January to December*, NSN-ESRSD-117, 1995 January. 22506084
[6] *Non-Radiological Liquid Effluent Monitoring at CRL: The Results for 1997*, AECL-MISC-397-97, 1998 September. 22869405
[7] *Non-Radioactive Monitoring Schedule for CRL*, CRL-509200-062-000-0001, Rev 6, 2013 December. 23651723
[8] *Effluent Sampling Schedule for CRL - Liquid (Non-radiological)*, CRL-509200-062-000-0004, Rev 3, 2016 January. 22730333
[9] *Nuclear Research and Testing Establishment Operating Licence and Handbook: Chalk River Laboratories*, NRTEOL-LCH-01, 2011 November.
[10] *MISA Liquid Effluent Monitoring at CRL: Summary of Monitoring Results for the Period 1990 June to 1991 May,* RC-809, 1992 March.
[11] *Effluent Verification Monitoring Program Sampling Schedule for CRL & NPD – Non-Radiological Liquid Effluent*, CRL-509200-062-000-0004, Rev 11, 2018 February. 40635477
[12] *SRC Acceptance of the Annual Program Report - Non-Radiological Effluent Monitoring in 2005 at Chalk River Laboratories*, SRCM-62-059, 2006 August.
[13] *Changes to Non-Radiological Monitoring Program for 2007 and the Conclusion of Special Investigation Monitoring at MP0600 - Stream "01",* EnvP-07-024, 2007 March. 24725279.

REDACTED

Waste Treatment Centre Liquid Waste Evaporator (WTC_LWE) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type ***** **2. Estimation over Measurement**
[14] *Non-Radiological Liquid Effluent Monitoring at CRL: The Results for 1999,* AECL-MISC-397-99, 2000 October. 22876499						
[15] *Effluent Verification Monitoring Program Sampling Schedule for CRL, NPD & DP,* Rev 24, 2023 June, CRL-509200-062-000-0004, 61545704						

REDACTED

4.3.2.1.2 Waste Treatment Centre Building [redacted]

Table 18: Detailed Design - WTC_[redacted]

Description: There are a set tanks in [redacted] which are known to be radioactively contaminated and are therefore discharged to the WTC for treatment and [redacted] which are not expected to be radioactively contaminated and are discharged to the Process Outfall Collection System. This facility is part of the WTC and associated facilities and collects all the process water generated from Molybdenum-99 Production Facility (MPF). [redacted] are therefore part of the Non-radiological effluent monitoring program and are considered an upstream monitoring location.
Source Term: These tanks are used to collect all the process water generated from Molybdenum-99 Production Facility (MPF). The MPF facility continues to be in safe shutdown and as such, has not been in operations since 2016 October.
Potential Non-radiological Contaminants: Metals and Solids
Discharge Characteristics: Effluent is released to the Process Outfall Collection System in batches. Typically, the number of batch releases per year is between three to six. The total volume of effluent released is approximately 150-350 m^3 annually.
Effluent Treatment: None.
Monitoring Strategy: This monitoring point was not part of the original MISA program but instead was added to the monitoring program in 2002 as it was identified as a potential source of contaminants entering the environment, via the Process Outfall Collection System, whose effects would not be able to be determined due to their masking by the significant flow and therefore dilution of the Process Outfall. Since then, it has been monitored consistently with minor changes to the parameters and frequency of monitoring.
The tanks fill at different rates therefore releases may be from one tank one time and a different tank the next time. Tanks are circulated for 5 minutes prior to taking a sample from its discharge valve. Samples are checked for radiological parameter prior to releasing and samples are taken during release for verification non-radiological monitoring.

Waste Treatment Centre Building [redacted] (WTC_[redacted] *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
1	Chemical Oxygen Demand (COD) No Treatment	p	Monitored: (2014 – present) p: 2014: Monitored as CRL's process effluents were identified as having a significant fraction of the total loading of COD in the Electrical Power Generating Sector [1].	M	Batch Grab ***	1. Frequency: 2014: Quarterly to align with site effluent COD monitoring already in place on process effluents [1] and would capture seasonal variability in the service water. 2022: Changed to Batch monitoring in order to simplify the monitoring schedule for this effluent [6]. Sample Type: Grab sample after tank being discharged has been circulated for approximately 5 minutes to ensure release is homogeneous. 2. N/A

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Waste Treatment Centre Building [redacted] (WTC_[redacted] *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
3	pH No Treatment	p	Monitored: (2002 – present) p: 2002: Core parameter required under MISA as a gross indicator of effluent quality for all process effluents [2].	M	Batch Grab ***	1. Frequency: 2002: MISA recommends for all process batch discharges as a scan for other potential problems which may be occurring [4]. Sample Type: Grab sample after tank being discharged has been circulated for approximately 5 minutes to ensure release is homogeneous. 2. N/A
4a	Ammonium, Total Filter React (ionized + un-ionized) No Treatment	N/A	Not Monitored: (1991 – 1997) 1991: CRL was thought to have a significant contribution in The Electrical Power Generating Sector, therefore monitoring was added at all process and combined effluents in 1991. 1997: Removed monitoring from WTC_[redacted] as it was not expected to significantly contribute (no known source) [5].	N/A	N/A	1. Frequency: 1991: Added monthly at each of the process and combined effluents for characterization [3]. 1997: Removed [5]. 2. N/A
4b	Nitrates, Total Filter Reactive No Treatment	N/A	Not Monitored: (2002 – 2014) 2002: Core parameter required under MISA for process effluents [2]. 2014: Removed as there is no known source and results to data have been comparable to levels in River water and far below the CWQG guideline limit [1].	N/A	N/A	1. Frequency: 2002: Monthly as a scan [2]. 2014: Removed [1]. 2. N/A
5a	Dissolved Organic Carbon (DOC) No Treatment	p	Monitored: (2002 – present) p: 2002: Core parameter required under MISA for effluents that have the potential to be contaminated with hydraulic oils, greases, lubricating oils etc. as they consist primarily of cooling water used for various equipment [2].	M	Batch Grab ***	1. Frequency: 2002: Monthly as a characterization for the effluent [2]. Note: A routine monthly scan is appropriate (looking for any issues as a result of leaking equipment). Frequency aligns with monitoring of TSS, TOC & Solvent Extractables. 2022: Changed to Batch monitoring as the number of batches per year has decreased and in order to simplify the monitoring schedule for this effluent [6]. Sample Type: Grab sample after tank being discharged has been circulated for approximately 5 minutes to ensure release is homogeneous. 2. N/A

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Waste Treatment Centre Building [redacted] (WTC_[redacted] *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
5b	Total Organic Carbon (TOC) No Treatment	p	Monitored: (2002 – present) p: 2002: Core parameter required under MISA for effluents that have the potential to be contaminated with hydraulic oils, greases, lubricating oils etc. as they consist primarily of cooling water used for various equipment [2].	M	Batch Grab ***	1. Frequency: 2002: Monthly as a characterization for the effluent [2]. Note: A routine monthly scan is appropriate (looking for any issues as a result of leaking equipment). Frequency aligns with monitoring of TSS, DOC & Solvent Extractables. 2022: Changed to Batch monitoring as the number of batches per year has decreased and in order to simplify the monitoring schedule for this effluent [6]. Sample Type: Grab sample after tank being discharged has been circulated for approximately 5 minutes to ensure release is homogeneous. 2. N/A
6	Phosphorus, Unfiltered Total No Treatment	N/A	Not Monitored: (2002 – 2014) 2002: Core parameter required under MISA as a gross indicator of effluent quality in certain process effluents [2]. 2014: Removed as there is no source of phosphorus entering this waste stream and no significant levels noted to date (almost all results have been <LMDL) [1].	N/A	N/A	1. Frequency: 2002: Monthly as a characterization for the effluent [2]. 2014: Removed [1]. 2. N/A
7	Conductivity, @[redacted] No Treatment	p	Monitored: (2002 – present) p: 2002: Core parameter required under MISA as a gross indicator of effluent quality [2].	M	Batch Grab ***	1. Frequency: 2002: MISA recommends daily for process effluents as this parameter is useful as a gross indicator of effluent quality to be used as a screening tool [4]. Sample Type: Grab sample after tank being discharged has been circulated for approximately 5 minutes to ensure release is homogeneous. 2. N/A

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Waste Treatment Centre Building [redacted] (WTC_[redacted] *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
8	Residue, Part Loss Ignitn Volatile Suspended Solids (VSS) No Treatment	N/A	Not Monitored: (2002 – 2014) 2002: Added to this process effluent as CRL was identified as having a significant fraction of the total loading of this parameter in the Electric Power Generators Sector [2]. 2014: Removed as consistently insignificant contribution to site total (<1.5%) with most results being ≤ LMDL. (Note: More appropriate for treatment facilities with biological treatment (i.e. Sewage Treatment Plants) [7].	N/A	N/A	1. Frequency: 2002: Quarterly as a scan (Same frequency as was being completed at WTC-LWE) [2]. 2014: Removed [1]. 2. N/A
8	Total Suspended Solids (TSS) No Treatment	p	Monitored: (2002 – present) p: 2002: Core parameter required under MISA as a gross indicator of effluent quality [2].	M	Batch Grab ***	1. Frequency: 2002: Monthly as a scan for effluent quality [2]. 2014: Increased to weekly due to the number of exceedances being experienced for this parameter at this monitoring location [1]. 2022: Changed to Batch monitoring as the number of batches per year has decreased and in order to simplify the monitoring schedule for this effluent [6]. Sample Type: Grab sample after tank being discharged has been circulated for approximately 5 minutes to ensure release is homogeneous. 2. N/A
9	Aluminium, Unfiltered Total & Copper, Unfiltered Total & Zinc, Unfiltered Total No Treatment	p	Monitored: (2002 – present) p: 2002: Core parameter required under MISA for CRL process effluents. Also known to have a high background at CRL [2].	M	Batch Grab ***	1. Frequency: 2002: Monthly as a scan with the assumption that the parameter would not vary greatly in this effluent [2]. 2014: Increased to weekly due to the number of exceedances being experienced for metals at this monitoring location [1]. 2016 Note: Remain weekly as results are variable [8]. 2022: Changed to Batch monitoring as the number of batches per year has decreased and in order to simplify the monitoring schedule for this effluent [6]. Sample Type: Grab sample after tank being discharged has been circulated for approximately 5 minutes to ensure release is homogeneous. 2. N/A

REDACTED

Waste Treatment Centre Building [redacted] (WTC_[redacted] *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
9	Boron, Unfiltered Total & Cadmium, Unfiltered Total & Chromium, Unfiltered Total & Lead, Unfiltered Total & Lithium, Unfiltered Total & Nickel, Unfiltered Total & Strontium, Unfiltered Total & Vanadium, Unfiltered Total No Treatment	p	Monitored: (2002 – present) p: 2002: Metals are parameters required under MISA for process effluents, therefore added at this location. Also, when analysis is run for metals which are core parameters, all results for ATG 9 are obtained [2].	M	Batch Grab ***	1. Frequency: 2002: Monthly as a scan with the assumption that the parameter would not vary greatly in this effluent [2]. 2014: Increased to weekly due to the number of exceedances being experienced for metals at this monitoring location [1]. 2016: Reduced back to Monthly [8] after weekly investigation period was complete and parameter determined to be not significantly variable. 2022: Changed to Batch monitoring as the number of batches per year has decreased and in order to simplify the monitoring schedule for this effluent [6]. Sample Type: Grab sample after tank being discharged has been circulated for approximately 5 minutes to ensure release is homogeneous. 2. N/A
9a	Iron, Unfiltered Total No Treatment	p	Monitored: (2002 – present) p: 2002: Core parameter required under MISA for CRL process effluents. Also known to have a high background at CRL [2].	M	Batch Grab ***	1. Frequency: 2002: Monthly as a scan with the assumption that the parameter would not vary greatly in this effluent [2]. 2012: Increased to per batch due to the number of exceedances being experienced for metals at this monitoring location [7]. 2016 Note: Remain per batch as results are variable [8]. Sample Type: Grab sample after tank being discharged has been circulated for approximately 5 minutes to ensure release is homogeneous. 2. N/A
9a	Uranium, Unfiltered Total No Treatment	q	Monitored: (2007 – present) q: 2007: Added based on SRC comment as EnvP was monitoring this in the radioactive program but not the non-radioactive program [9].	M	Batch Grab ***	1. Frequency: 2007: Monthly as a scan with the assumption that the parameter would not vary greatly in this effluent [2]. 2014: Increased to weekly due to the number of exceedances being experienced for metals at this monitoring location [1]. 2016: Reduced back to Monthly [8] after weekly investigation period was complete and parameter determined to be not significantly variable. 2022: Changed to Batch monitoring as the number of batches per year has decreased and in order to simplify the monitoring schedule for this effluent [6].

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Waste Treatment Centre Building [redacted] (WTC_[redacted] *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
						Sample Type: Grab sample after tank being discharged has been circulated for approximately 5 minutes to ensure release is homogeneous. 2. N/A
12	Mercury, Unfiltered Total No Treatment	p	Monitored: (2002 – present) p: 2002: Core parameter required under MISA for CRL's process effluents and known to be used in the facility in which this cooling water is used, although a source for this entering the wastewater is not known [2].	M	Batch Grab ***	1. Frequency: 2002: Monthly as a scan with the assumption that the parameter would not vary greatly in this effluent [2] . 2014: Increased to weekly due to the number of exceedances being experienced for metals at this monitoring location [1]. 2016 Note: Remain weekly as results are variable [8]. 2022: Changed to Batch monitoring as the number of batches per year has decreased and in order to simplify the monitoring schedule for this effluent [6]. Sample Type: Grab sample after tank being discharged has been circulated for approximately 5 minutes to ensure release is homogeneous. 2. N/A
14	Phenolics, Unfiltered React No Treatment	p	Monitored: (2002 – present) p: 2002: Core parameter required under MISA for process effluents [2]. 2014 Note: There is no known source and results have been consistently close to the LMDL since 2008 and this stream contributes <1% of site loading of phenolics. Even in 2007, when there was a spike noted (41 u/L), this effluent still contributed <1% of site loading for that year.	M	Batch Grab ***	1. Frequency: 2002: Monthly as a scan with the assumption that the parameter would not vary greatly in this effluent [2]. 2014: Semi-annual check (instead of removing) as there have been detectable results in the past [1]. 2022: Changed to Batch monitoring in order to simplify the monitoring schedule for this effluent [6]. Sample Type: Grab sample after tank being discharged has been circulated for approximately 5 minutes to ensure release is homogeneous. 2. N/A
25	Solvent Extractables No Treatment	p	Monitored: (2002 – present) p: 2002: Core parameter required under MISA for effluents which have a chance in coming in contact with equipment which use lubricating oils, greases, transformer oils, fuel oil and hydraulic fluids [2].	M	Batch Grab ***	1. Frequency: 2002: Monthly as a characterization for the effluent [2]. Note: the effluent exhibits some variability therefore a routine monthly scan is appropriate (looking for any issues as a result of leaking equipment). Frequency aligns with monitoring of TSS, DOC & TOC. 2016: Reduced to Quarterly as results are consistently just over or below the LMDL [8]. 2022: Changed to Batch monitoring in order to simplify the monitoring schedule for this effluent [6].

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Waste Treatment Centre Building [redacted] (WTC_[redacted] *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
						Sample Type: Grab sample after tank being discharged has been circulated for approximately 5 minutes to ensure release is homogeneous. 2. N/A
--	Volume of Batches & Number of Batches NA	p	Monitored: (2002 – present) p: 2002: Core parameter under MISA used to determine track each release [2].	M	Batch N/A	1. Frequency: 2002: Batches are released manually and are therefore manually tracked by staff. Volume released per batch can vary and is determined by taking tank level readings before and after each discharge. Note: a single batch release may take place over a number of days. Sample Type: N/A, instead tank level readings used. 2. N/A

Notes:
MISA – Municipal/Industrial Strategy for Abatement; ATG - Analytical Test Group; LMDL - Laboratory Method Detection Level
* Current as of issuing date of document. Always refer to the latest version of EVMP Monitoring Schedule (CRL-509200-062-000-0004).
** See Table 15 *Parameter Monitoring Criteria for the Effluent Verification Monitoring Program*
*** Grab from the respective tank being discharged is circulated for 5 minutes prior to taking a manual single grab from single sampling valve.

References:

[1] *Non-Radioactive Monitoring Schedule for CRL*, CRL-509200-062-000-0001, Rev 6, 2013 December. 23651723
[2] *Non-Radiological Emission Monitoring at CRL: The Results for 2002,* AECL-MISC-421-02, 2003 March. 22385827
[3] *Non-Radiological Liquid Effluent Monitoring at CRL: Summary of the Monitoring Results for the Period 1991 May to 1992 December*, RC-1086, 1993 December. 40793178
[4] *The Development Document for the Effluent Monitoring Regulation for the Electric Power Generation Sector,* MISA, 1990.
[5] *Non-Radiological Liquid Effluent Monitoring at CRL: The Results for 1997*, AECL-MISC-397-97, 1998 September. 22869405
[6] *Effluent Verification Monitoring Program Sampling Schedule for CRL & NPD – Non-Radiological Liquid Effluent,* CRL-509200-062-000-0004, Rev20, 2022 DRAFT.
[7] *Non-Radiological Liquid Effluent Monitoring at CRL: Results for the Period 1993 January to December,* NSN-ESRSD-117, 1995 January. 22506084
[8] *Effluent Sampling Schedule for CRL - Liquid (Non-radiological)*, CRL-509200-062-000-0004, Rev 3, 2016 January. 22730333
[9] *SRC Acceptance of the Annual program Report - Non-Radiological Effluent Monitoring in 2005 at Chalk River Laboratories,* SRCM-62-059, 2006 August.

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4.3.2.1.3 Spring B Groundwater Treatment Facility (SBT)

Table 19: Detailed Design – Spring B Groundwater Treatment Facility (SBT)

Description: A groundwater Sr-90 contaminant plume originates from the unlined sand trenches in the northwest corner of WMA B. The plume discharges as a series of seeps that coalesce into the Spring B Stream. The [redacted] Spring B Groundwater Treatment Facility collects water (surface water and groundwater) and its primary function is to treat it to remove Sr-90. The treated groundwater and surface water effluents are discharged downgradient of the facility before migrating towards West Swamp. The new treatment facility was commissioned in 2019 and added to the EVMP in 2023.
Source Term: Groundwater and surface water originating from the unlined sand trenches in the northwest corner of WMA B.
Potential Non-Radiological Contaminants: metals
Discharge Characteristics: The discharge is treated primarily to remove Sr-90 and discharged back to the natural Spring B. The flow rate is variable as it is depends on the facility treatment and intake amounts. The flow is reported as a total litres of treated effluent per month to Environmental Protection. The average flow for 2023 was 4 m^3/day.
Effluent Treatment: Precipitation, filtration, ion exchange zeolite columns. Additionally, the facility maintains a robust operational control monitoring program which samples the waters in the feed tank, neutralization tank, and discharge tank at the facility. A composite sample is collected at each location via an autosampler over a month's time and analyzed to track facility performance.
Monitoring Strategy: Direct measurement from manual grab sample. Note: There are monitoring locations downgradient of the Spring B Groundwater Treatment Facility as part of the Environmental Monitoring Program (at "SBD" and "PCW") and the CRL Groundwater Monitoring Program.

Spring B Groundwater Treatment Facility (SBT) *						
ATG	Parameter Name Treatment	Parameter Criteria **	Justification for Monitoring (or not Monitoring) of Parameter	Measurement or Estimation	Monitoring Frequency & Sample Type	Justification for: 1. Monitoring Frequency & Sample Type 2. Estimation over Measurement
3	pH pH is raised and then neutralized.	j	Monitored: (2023 – present) j: 2023: Aligns with parameters being monitored at the downstream Spring B Discharge (SBD) Environmental Monitoring surface water monitoring Location [1].	M	Semi-annual Grab	1. Frequency: 2023: Semi-annual aligns with the monitoring at SBD under the EMP. Sample Type: Grab sample is appropriate as the source to the facility is groundwater and therefore effluent quality is expected to be constant over time. 2. N/A
4b	Nitrate + Nitrite (N) (Nitrates, Total Filter Reactive) No Treatment	j	Monitored: (2023 – present) j: 2023: Aligns with parameters being monitored at the downstream Spring B Discharge (SBD) Environmental Monitoring surface water monitoring Location [1].	M	Semi-annual Grab	1. Frequency: 2023: Semi-annual aligns with the monitoring at SBD under the EMP. Sample Type: Grab sample is appropriate as the source to the facility is groundwater and therefore effluent quality is expected to be constant over time. 2. N/A
5a	Dissolved Organic Carbon (DOC)	j	Monitored: (2023 – present) j: 2023: Aligns with parameters being	M	Semi-annual Grab	1. Frequency:

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Spring B Groundwater Treatment Facility (SBT) *						
ATG	Parameter Name Treatment	Parameter Criteria **	Justification for Monitoring (or not Monitoring) of Parameter	Measurement or Estimation	Monitoring Frequency & Sample Type	Justification for: 1. Monitoring Frequency & Sample Type 2. Estimation over Measurement
	No Treatment		monitored at the downstream Spring B Discharge (SBD) Environmental Monitoring surface water monitoring Location [1].			2023: Semi-annual aligns with the monitoring at SBD under the EMP. Sample Type: Grab sample is appropriate as the source to the facility is groundwater and therefore effluent quality is expected to be constant over time. 2. N/A
5b	Total Organic Carbon (COD) No Treatment	j	Monitored: (2023 – present) j: 2023: Aligns with parameters being monitored at the downstream Spring B Discharge (SBD) Environmental Monitoring surface water monitoring Location.	M	Semi-annual Grab	1. Frequency: 2023: Semi-annual aligns with the monitoring at SBD under the EMP. Sample Type: Grab sample is appropriate as the source to the facility is groundwater and therefore effluent quality is expected to be constant over time. 2. N/A
6	Phosphorus, Unfiltered Total No Treatment	j	Monitored: (2023 – present) j: 2023: Aligns with parameters being monitored at the downstream Spring B Discharge (SBD) Environmental Monitoring surface water monitoring Location [1].	M	Semi-annual Grab	1. Frequency: 2023: Semi-annual aligns with the monitoring at SBD under the EMP. Sample Type: Grab sample is appropriate as the source to the facility is groundwater and therefore effluent quality is expected to be constant over time. 2. N/A
7	Conductivity, @ [redacted] No Treatment	j	Monitored: (2023 – present) j: 2023: Aligns with parameters being monitored at the downstream Spring B Discharge (SBD) Environmental Monitoring surface water monitoring Location [1].	M	Semi-annual Grab	1. Frequency: 2023: Semi-annual aligns with the monitoring at SBD under the EMP. Sample Type: Grab sample is appropriate as the source to the facility is groundwater and therefore effluent quality is expected to be constant over time. 2. N/A

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Spring B Groundwater Treatment Facility (SBT) *						
ATG	Parameter Name Treatment	Parameter Criteria **	Justification for Monitoring (or not Monitoring) of Parameter	Measurement or Estimation	Monitoring Frequency & Sample Type	Justification for: 1. Monitoring Frequency & Sample Type 2. Estimation over Measurement
9	Aluminium, Unfiltered Total & Boron, Unfiltered Total & Cadmium, Unfiltered Total & Chromium, Unfiltered Total & Copper, Unfiltered Total & Lead, Unfiltered Total & Lithium, Unfiltered Total & Nickel, Unfiltered Total & Strontium, Unfiltered Total & Vanadium, Unfiltered Total & Zinc, Unfiltered Total Filtration and precipitation	j	Monitored: (2023 – present) j: 2023: Aligns with parameters being monitored at the downstream Spring B Discharge (SBD) Environmental Monitoring surface water monitoring Location [1].	M	Semi-annual Grab	1. Frequency: 2023: Semi-annual aligns with the monitoring at SBD under the EMP. Sample Type: Grab sample is appropriate as the source to the facility is groundwater and therefore effluent quality is expected to be constant over time. 2. N/A
10	Selenium, Unfiltered Total Filtration and precipitation	j	Monitored: (2023 – present) j: 2023: Aligns with parameters being monitored at the downstream Spring B Discharge (SBD) Environmental Monitoring surface water monitoring Location [1].	M	Semi-annual Grab	1. Frequency: 2023: Semi-annual aligns with the monitoring at SBD under the EMP. Sample Type: Grab sample is appropriate as the source to the facility is groundwater and therefore effluent quality is expected to be constant over time. 2. N/A
12	Mercury, Unfiltered Total Filtration and precipitation	j	Monitored: (2023 – present) j: 2023: Aligns with parameters being monitored at the downstream Spring B Discharge (SBD) Environmental Monitoring surface water monitoring Location [1].	M	Semi-annual Grab	1. Frequency: 2023: Semi-annual aligns with the monitoring at SBD under the EMP. Sample Type: Grab sample is appropriate as the source to the facility is groundwater and therefore effluent quality is expected to be constant over time. 2. N/A

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Spring B Groundwater Treatment Facility (SBT) *						
ATG	Parameter Name Treatment	Parameter Criteria **	Justification for Monitoring (or not Monitoring) of Parameter	Measurement or Estimation	Monitoring Frequency & Sample Type	Justification for: 1. Monitoring Frequency & Sample Type 2. Estimation over Measurement
14	Phenolics, Unfiltered Total No Treatment	j	Monitored: (2023 – present) j: 2023: Aligns with parameters being monitored at the downstream Spring B Discharge (SBD) Environmental Monitoring surface water monitoring Location [1].	M	Semi-annual Grab	1. Frequency: 2023: Semi-annual aligns with the monitoring at SBD under the EMP. Sample Type: Grab sample is appropriate as the source to the facility is groundwater and therefore effluent quality is expected to be constant over time. 2. N/A
16	Volatiles, Halogenated No Treatment	j	Monitored: (2023 – present) j: 2023: Identified by the Groundwater Monitoring Program to be present in the groundwater capture zone for the Spring B treatment facility [1].	M	Semi-annual Grab	1. Frequency: 2023: Semi-annual aligns with the monitoring at SBD under the EMP and in Groundwater Monitoring Program. Sample Type: Grab sample is appropriate as the source to the facility is groundwater and therefore effluent quality is expected to be constant over time. 2. N/A
17	Volatiles, Non-Halogenated No Treatment	j	Monitored: (2023 – present) j: 2023: Identified by the Groundwater Monitoring Program to be present in the groundwater capture zone for the Spring B treatment facility [1].	M	Semi-annual Grab	1. Frequency: 2023: Semi-annual aligns with the monitoring at SBD under the EMP and in Groundwater Monitoring Program. Sample Type: Grab sample is appropriate as the source to the facility is groundwater and therefore effluent quality is expected to be constant over time. 2. N/A
19	Bis-2-Ethylhexyl Phthalate No Treatment	j	Monitored: (2023 – present) j: 2023: Identified by the Groundwater Monitoring Program to be present in the groundwater capture zone for the Spring B treatment facility [1].	M	Semi-annual Grab	1. Frequency: 2023: Semi-annual aligns with the monitoring at SBD under the EMP and in Groundwater Monitoring Program. Sample Type: Grab sample is appropriate as the source to the facility is groundwater and therefore effluent quality is expected to be constant over time. 2. N/A

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Spring B Groundwater Treatment Facility (SBT) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
30	Chloride & Sulphates No Treatment	j	Monitored: (2023 – present) j: 2023: Identified by the Groundwater Monitoring Program to be present in the groundwater capture zone for the Spring B treatment facility [1].	M	Semi-annual Grab	1. Frequency: 2023: Semi-annual aligns with the monitoring at SBD under the EMP and in Groundwater Monitoring Program. Sample Type: Grab sample is appropriate as the source to the facility is groundwater and therefore effluent quality is expected to be constant over time. 2. N/A
N/A	Tributyl Phosphate No Treatment	N/A	Not Monitored: Although observed to be slightly elevated in groundwater in the vicinity (i.e. monitoring wells [redacted] in WMA [redacted], current laboratories used by the Non-Radioactive EVMP do not test for this parameter. Taking this into consideration, this parameter has not been added to the Non-radioactive EVMP as it is felt that its monitoring under the routine Groundwater Monitoring Program as well as through local plume studies provides sufficient data to determine any environmental effect.	N/A	N/A	N/A
--	Flow Rate (m^3/day) N/A	q	Monitored: (2023 – present) q: Core physical characteristic may be used to determine loading from the source.	M	Daily Continuous	1. Frequency: 2023: Daily volume determined by the facility's automated system. Semi-annual reports align with the monitoring at SBD under the EMP and in Groundwater Monitoring Program. Sample type: Continuous automated measure is a requirement of the facility. 2. N/A

Notes:
ATG - Analytical Test Group
* Current as of issuing date of document. Always refer to the latest version of EVMP Monitoring Schedule (CRL-509200-062-000-0004).
** See Table 7 *Parameter Monitoring Criteria for the Effluent Verification Monitoring Program*
References:

[1] *Effluent Verification Monitoring Program Sampling Schedule for CRL, NPD & DP*, Rev 24, 2023 June 29, CRL-509200-062-000-004, 61545704

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4.3.2.2 Final Effluent Streams

4.3.2.2.1 Process Effluents

4.3.2.2.1.1 Sanitary Sewage Treatment Facility

Table 20: Detailed Design – Sanitary Sewage Treatment Facility (STP)

Description: CRL built a new Sewage Treatment Plant (STP) which was commissioned in the fall of 2018 and is considered secondary treatment. The Plant treats domestic waste before discharging to the Ottawa River.
Source Term: The Sanitary Outfall wastewater collection system extends to almost all of the buildings in the built-up area of CRL and is designed to collect domestic wastewater from sinks, showers and washrooms in buildings (including cleaning products); industrial and process wastewater from sinks, floor drains and sumps in various labs, workshops and facilities; and cooling water. Small quantities of low toxicity, water-soluble chemicals may be discharged into this system from some labs and facilities. This collection system also accepts routine Power House boiler blowdowns (continuous and intermittent), leachate from the Bulk Material Landfill (WMA-J) and greywater from wastewater holding tanks.
Potential Non-radiological Contaminants: Typical Sanitary type waste as well as industrial waste.
Discharge Characteristics: The treated effluent is discharged to the Ottawa River in batch releases every few hours after separation of sludge which is sent to the Bulk Material Landfill [redacted] Effluent is discharged through a 12" pipe extending a distance of about 350 ft into the Ottawa River at a water depth of about 2 m.
Effluent Treatment: Grit removal, Screening, Activated sludge, Sequencing batch reactor, Biological ammonia removal – nitrification only, Chemical precipitation (phosphorus) and UV disinfection.
Monitoring Strategy: The STP effluent is continuously sampled using an automatic composite sampler which takes samples every 15 minutes during discharge. Final effluent is routinely analysed for chemical contaminants as part of CRL Non-Radioactive Monitoring Program after all treatment processes. Routine monitoring has been in place since the commissioning of the new facility in the fall of 2018.

Sanitary Sewage Treatment Facility (STP) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
1	Chemical Oxygen Demand (COD) Activated Sludge/SBR Process	p	Monitored: (1991 – present) p: 1991: Monitored as CRL's process effluents were identified as having a significant fraction of the total loading COD in the Electrical Power Generating Sector [1], [9].	M	Quarterly 24 hr Composite *****	1. Frequency: 1991: Semi-annual monitoring [1]. 1993: Increased to Quarterly once identified as a Priority 1 Pollutant for this stream [2]. Sample Type: 24-hour composite is representative of the day's effluent which can vary based on plant and site operations (influent received by facility). 2. N/A

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Sanitary Sewage Treatment Facility (STP) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
1a	Biological Oxygen Demand (BOD) Activated Sludge/SBR Process	q	Monitored: (2010 – present) q: 2010: Due diligence - Added as BOD is a conventional parameter monitored at STPs across the country [3], [4].	M	Weekly 24 hr Composite ***	1. Frequency: 2010: Weekly as known variability through operational control monitoring in place therefore more frequent than monthly (to compare to monthly CNL Guideline) was felt to be appropriate [4]. 2014 Note: Monitoring of BOD is not required under the *Wastewater Systems Effluent Regulations* [8], instead CBOD monitoring is. Further, only monthly CBOD monitoring is required, therefore the frequency of weekly monitoring of BOD is considered due diligent. Sample Type: 24 hour composite is representative of the day's effluent which can vary based on plant and site operations (influent received by facility). 2. N/A
1b	Carbonaceous Biological Oxygen Demand (CBOD) Activated Sludge/SBR Process	h	Monitored: (2010 – present) h: 2010: Added as is required under the *Wastewater Systems Effluent Regulations* [4], [8] to ensure releases remain under release limit.	M	Monthly 24 hr Composite ***	1. Frequency: 2010: Started monthly [4] as needed to get a baseline to determine risk of *Proposed Regulation* [8] limits on CRL. 2012: Decreased to quarterly as appeared to be upcoming frequency requirement under *Proposed Regulations* [8]. 2013: Monthly requirement released with final *Wastewater Systems Effluent Regulations* [8] (but at least 10 days after any other sample), when published (monthly monitoring, quarterly reporting). Sample Type: Composite conservative as WSER allows for composite or grab for a system whose annual average daily volume is between 100 m_3/day and 2,500 m^3/day (CRL is registered in this range). 2. N/A
3	pH Caustic Addition	p	Monitored: (1991 – present) p: 1991: Core parameter required under MISA specifically for this location (and all process effluents) as a gross indicator of effluent quality [1].	M	Daily 24 hr Composite ***	1. Frequency: 1991: MISA recommends daily for process effluents as a scan for other potential problems which may be occurring and effluent quality can be quite variable [9]. Sample Type: Other local sewage treatment facilities which are provincially regulated are required to maintain a pH between 6.0 and 9.5 at all times and effluent quality can change throughout a 24-hr period therefore having a composite sample taken throughout the day (versus a single grab) is appropriate. 2. N/A

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Sanitary Sewage Treatment Facility (STP) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
3	pH Caustic Addition	h	Monitored: (2010 – present) h: 2010: Required under the *Wastewater Systems Effluent Regulations* [8] for un-ionized ammonia analyses which is done monthly. Unionized Ammonia = Total Ammonia x $1 \div (1 + 10^{(1 + 10^{9.56 - pH})})$	M	Monthly 24 hr Composite *** ***	1. Frequency: 2010: Monthly requirement under *Wastewater Systems Effluent Regulations* to align with unionized ammonia frequency [8]. Sample Type: Sample is required to be the same as that taken for unionized ammonia [8]. 2. N/A
4a	Total Kjedahl Nitrogen (TKN) N/A	N/A	Not Monitored: (was in 1990) p: 1990: Required for monitoring of process and combined effluents as it provides a measure of the total organic nitrogen in the effluent [1]. 1991: Removed. Identified as a Priority 1 Pollutant for sewage treatment plants as it is an indicator of treatment plant performance only where nitrification/denitrification is used (tertiary treatment type) [9], [11]. 2018 Note: New STP is secondary treatment and does not have full Nitrification/ denitrification.	N/A	N/A	1. Frequency: 1990: Thrice weekly because over the 10 mg/L threshold set by MISA [1]. 1991: Removed [11]. 2. N/A
4a	Total Ammonia - N (ionized + un-ionized) Biological Nitrification/ Activated Sludge/SBR Process	i, p, q	Monitored: (1993 – present) p: 1993: Added as CRL was identified as having a significant fraction of the total loading of this parameter in the Electrical Power Generating Sector. Ammonia is expected to be concentrated in water treatment plant effluents [2]. 2014 Note: Boiler blowdown effluent which is now being discharged to this effluent stream (instead of PPD) are expected to be a source of ammonia as well. q: Monitoring for due diligence as Total Ammonia is a common parameter having imposed regulatory limits on sewage treatment plant facilities (e.g. Deep River and Pembroke both have limits which are seasonal). i: Identified as a COPC (screened in) in 2024 ERA – Table 46 [23].	M	Monthly 24 hr Composite *** ***	1. Frequency: 1993: Added monthly at each of the process effluents for characterization (averages are below the 10mg/L MISA threshold which would have required thrice weekly monitoring) [2]. Sample Type: 24-hour composite is representative of the day's effluent which can vary based on plant and site operations (influent received by facility). 2. N/A

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Sanitary Sewage Treatment Facility (STP) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
-	Un-ionized ammonia (expressed as N) Biological Nitrification/ Activated Sludge/SBR Process	h, i	Monitored: (2010 – present) h: 2010: Added to program as is required under the *Wastewater Systems Effluent Regulations* [3], [4], [8]. i: Identified as a COPC (screened in) in 2024 ERA – Table 46 [23].	M	Monthly 24 hr Composite ***	1. Frequency: 2010: Started monthly as needed to get a baseline to determine risk of *Proposed Regulation* [8] limits on CRL. 2012: Decreased to Quarterly as appeared to be upcoming requirement under *Proposed Regulations* [8]. 2013: Monthly requirement released with final *Wastewater Systems Effluent Regulations* [8] when published (monthly monitoring, quarterly reporting). Sample Type: WSER allow for composite or grab for a system whose annual average daily volume is between 100 m3/day and 2,500 m3/day (CRL is registered in this range). 2. N/A
4b	Nitrates, Total Filter Reactive (Nitrate + Nitrite) Biological Nitrification/ Activated Sludge/SBR Process	i, p	Monitored: (1991 – present) p: 1991: Core parameter required under MISA specifically for sewage treatment plants and combined effluents. 1996: Boiler blowdown effluent was redirected to this waste stream as well [1]. 2014 Note: Concentrations, although well below the CWQG limit are notably higher than the background River water demonstrating that nitrification, produced by biological processes, takes place in this stream. i: Identified as a COPC (screened in) in 2024 ERA – Table 46 [23].	M	Monthly 24 hr Composite ***	1. Frequency: 1991: Monthly in order to initially characterize the effluent (recommended by MISA) and then as a routine check for function of treatment plant [1]. Sample Type: 24-hour composite is representative of the day's effluent which can vary based on plant and site operations (influent received by facility). 2. N/A
5a	Dissolved Organic Carbon (DOC) Activated Sludge/SBR Process	p	Monitored: (1991 – present) p: 1991: Core parameter required under MISA specifically for this location as this is a treatment facility which may accept wastewater from facilities on site which have some contamination (from the use of hydraulic oils, greases, lubricating oils etc.) [1].	M	Weekly 24 hr Composite ***	1. Frequency: 1991: Weekly in order to initially characterize the effluent (recommended by MISA) and then as a routine check for contamination as a result of spills or leaks [1]. Sample Type: 24-hour composite is representative of the day's effluent which can vary based on plant and site operations (influent received by facility). 2. N/A
5b	Total Organic Carbon (TOC) Activated Sludge/SBR Process	p	Monitored: (1991 – present) p: 1991: Core parameter required under MISA specifically for this location as this is a treatment facility which may accept wastewater from facilities	M	Weekly 24 hr Composite ***	1. Frequency: 1991: Weekly in order to initially characterize the effluent (recommended by MISA) and then as a routine check for contamination as a result of spills or leaks [1].

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Sanitary Sewage Treatment Facility (STP) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
			on site which have some contamination (from the use of hydraulic oils, greases, lubricating oils etc.) [1].			Sample Type: 24-hour composite is representative of the day's effluent which can vary based on plant and site operations (influent received by facility). 2. N/A
6	Phosphorus, Unfiltered Total Chemical Precipitation/ Activated Sludge/SBR Process	p	Monitored: (1991 – present) p: 1991: Core parameter required under MISA specifically for this location due to the known source of phosphate being used on the site (i.e. cleaners) [1]. 1996: A new source is introduced from the addition of the boiler blowdown to this effluent (disodium phosphate chemical is added to the boilers) [13].	M	Monthly 24 hr Composite *** ***	1. Frequency: 1991: Weekly for Process Effluents as identified as a Priority 1 Pollutant for the steam, therefore close monitoring was determined to be appropriate [1]. 1996 Note: Needs to be frequent enough to capture boiler blowdown contributions as well [13]. 2016: Reduced to monthly as was determined to still capture variation [16]. Sample Type: 24-hour composite is representative of the day's effluent which can vary based on plant and site operations (influent received by facility). 2. N/A
7	Conductivity, [redacted] Activated Sludge/SBR Process	p	Monitored: (1991 – present) p: 1991: Core parameter required under MISA specifically for this location as a gross indicator of effluent quality [1].	M	Daily 24 hr Composite *** ***	1. Frequency: 1991: MISA recommends daily for process effluents as this parameter is useful as a gross indicator of effluent quality to be used as a screening tool [1], [9]. Sample Type: 24-hour composite is representative of the day's effluent which can vary based on plant and site operations (influent received by facility). 2. N/A
8	Residue, Part Loss Igntn, Volatile Suspended Solids (VSS) Chemical Precipitation/ Activated Sludge/SBR Process	p	Monitored: (1993 – present) p: 1993: Monitored as CRL's process effluents were identified as having a significant fraction of the total loading of VSS in the Electrical Power Generating Sector. Significant contribution likely from Sewage Treatment Plant which has biological treatment [2].	M	Monthly 24 hr Composite *** ***	1. Frequency: 1993: Monthly (most frequent of all site effluents) as this effluent is expected to be the largest contributor to the overall site loading and due to operations it is expected that there will be some variability in levels [2]. Sample Type: 24-hour composite is representative of the day's effluent which can vary based on plant and site operations (influent received by facility). 2. N/A
8	Total Suspended Solids (TSS) Chemical Precipitation/ Activated Sludge/SBR Process	h, i, p	Monitored: (1991 – present) p: 1991: Core parameter required under MISA specifically for this location as a gross indicator of effluent quality and measure of effectiveness of the treatment system separation equipment [1], [3].	M	Weekly 24 hr Composite *** ***	1. Frequency: 1991: MISA recommends daily for process effluents as a scan for other potential problems which may be occurring [1]. 2016: Reduced to weekly which was determined to be sufficient. Note: Only required monthly (but at least 10 days after any other sample) by the *Wastewater Systems Effluent Regulations* [8], [14].

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Sanitary Sewage Treatment Facility (STP) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
			h: 2010: Also required under the *Wastewater Systems Effluent Regulations* [8]. i: Identified as a COPC (screened in) in 2024 ERA – Table 46 [23].			Sample Type: WSER allow for composite or grab for a system whose annual average daily volume is between 100 m^3/day and 2,500 m^3/day (CRL is in this range). 24-hour composite is representative of the day's effluent which can vary based on plant and site operations (influent received by facility) [8]. 2. N/A
9	Aluminium, Unfiltered Total No Treatment	i, p	Monitored: (1991 – present) p: 1991: Core parameter required under MISA specifically for this location (i.e. process effluent from treatment facility accepting varying waste). i: Identified as a COPC (screened in) in 2024 ERA – Table 46 [23].	M	Weekly 24 hr Composite ***	1. Frequency: 1991: Weekly scan due to varying waste being accepted by the treatment facility, source of Aluminum Chlorohydrate used in the STP process and the higher profile of this parameter (core parameter and high background) [1]. Note: Clarifos (non-aluminium based coagulant) is now being used as the coagulant at the SSTF. Sample Type: 24-hour composite is representative of the day's effluent which can vary based on plant and site operations (influent received by facility). 2. N/A
9	Boron, Unfiltered Total & Lithium, Unfiltered Total & Nickel, Unfiltered Total & Strontium, Unfiltered Total & Vanadium, Unfiltered Total No treatment	p	Monitored: (1991 – present) p: 1991: Parameter required under MISA specifically for this location (i.e. process effluent from treatment facility accepting varying waste) [1].	M	Weekly 24 hr Composite ***	1. Frequency: 1991: Monthly scan of metals due to varying waste being accepted by the treatment facility [1]. 2018: Changed to weekly as results are being obtained through the need for other metals to be run weekly in ATG 9 [14]. Sample Type: 24-hour composite is representative of the day's effluent which can vary based on plant and site operations (influent received by facility). 2. N/A
9	Cadmium, Unfiltered Total & Chromium, Unfiltered Total & Lead, Unfiltered Total No treatment	i, p	Monitored: (1991 – present) p: 1991: Parameter required under MISA specifically for this location (i.e. process effluent from treatment facility accepting varying waste) [1]. i: Identified as a COPC (screened in) in 2024 ERA – Table 46 [23].	M	Weekly 24 hr Composite ***	1. Frequency: 1991: Monthly scan of metals due to varying waste being accepted by the treatment facility [1]. 2018: Changed to weekly as results are being obtained through the need for other metals to be run weekly in ATG 9 [14]. Sample Type: 24-hour composite is representative of the day's effluent which can vary based on plant and site operations (influent received by facility). 2. N/A
9	Copper, Unfiltered Total & Zinc, Unfiltered Total	i, p	Monitored: (1991 – present) p: 1991: Core parameter required under MISA specifically for this location (process effluent from	M	Weekly	1. Frequency:

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Sanitary Sewage Treatment Facility (STP) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
	No treatment		treatment facility accepting varying waste). Potential source includes site-wide piping [1]. i: Identified as a COPC (screened in) in 2024 ERA – Table 46 [23].		24 hr Composite ***	1991: Weekly scan due to varying waste being accepted by the treatment facility. More frequent due to higher profile of this parameter (core parameter and high background) [1]. Sample Type: 24-hour composite is representative of the day's effluent which can vary based on plant and site operations (influent received by facility). 2. N/A
9a	Iron, Unfiltered Total No treatment	p	Monitored: (1991 – present) p: 1991: Core parameter required under MISA specifically for this location. Known to have a high background at CRL. Potential source includes site-wide piping [1].	M	Weekly 24 hr Composite ***	1. Frequency: 1991: Weekly scan due to varying waste being accepted by the treatment facility and the higher profile of this parameter (core parameter and high background) [1]. Sample Type: 24-hour composite is representative of the day's effluent which can vary based on plant and site operations (influent received by facility). 2. N/A
9a	Uranium, Unfiltered Total No treatment	q	Monitored: (2007 – present) q: 2007: Added based on SRC comment as EnvP was monitoring this in the radioactive program but not the non-radioactive program [5].	M	Weekly 24 hr Composite ***	1. Frequency: 2007: Set to Weekly to line up with the frequency of iron sampling (same ATG group) [5]. 2014: Reduced to Monthly to align with cadmium which is current analysis and because it is not a core parameter for this effluent stream. Also, very low levels have been noted to date [10]. 2016: Reduced to Quarterly as results are all very low [16]. 2018: Increased to weekly to align with cadmium analysis frequency [14]. Sample Type: 24-hour composite is representative of the day's effluent which can vary based on plant and site operations (influent received by facility). 2. N/A
10	Antimony, Unfiltered Total & Arsenic, Unfiltered Total N/A	N/A	Not Monitored: (was from 1990 – 1993) p: 1990: Scan as part of characterization for treatment facilities [11]. 1993: Removed as not detected in any concentration of concern [12].	N/A	N/A	1. Frequency: 1990: Quarterly for characterization [11]. 1991: Semi-annual as a scan [11]. 1993: Removed [12]. 2. N/A
12	Mercury, Unfiltered Total No Treatment	i, p	Monitored: (1991 - present) p: 1991: Core parameter required under MISA specifically for this location which accepts wastewater from across the entire site which is known to use some mercury in its operations [1].	M	Monthly 24 hr Composite ***	1. Frequency: 1991: Monthly as was not identified a Priority 1 Pollutant under MISA for this process stream however, based on the number and nature of influent points, a routine sweep was felt to be appropriate [1]. Sample Type: 24-hour composite is representative of the day's effluent which can vary based on plant and site operations (influent received by facility).

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Sanitary Sewage Treatment Facility (STP) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
			i: Identified as a COPC (screened in) in 2024 ERA – Table 46 [23].			2. N/A
14	Phenolics, Unfiltered React No Treatment	i, p	Monitored: (1991 – present) p: 1991: Priority 1 Pollutant identified under MISA specifically for this location and is a general indicator of treatment success [1]. 1996: Continues to be required with the redirection of the site boiler blowdown to this effluent (Phenolics has the potential to be concentrated through the boiler water demineralization process) [9]. i: Identified as a COPC (screened in) in 2024 ERA – Table 46 [23].	M	Weekly 24 hr Composite *** ***	1. Frequency: 1991: Weekly for process effluents as identified as a Priority 1 Pollutant for the steam, therefore close monitoring was determined to be appropriate. Note: Weekly is frequent enough to capture boiler blowdown contributions [1]. Sample Type: 24-hour composite is representative of the day's effluent which can vary based on plant and site operations (influent received by facility). 2. N/A
16	Volatiles, Halogenated (entire ATG Suite) N/A	N/A	Not Monitored: (was from 1991 – 2016) p: 1991: Full ATG suite monitoring initiated for this stream as the treatment centre is designed to collect liquid waste containing various chemicals from across the CRL site [1]. Reported on those parameters which showed notable results in any given year (e.g. 1,1,1 trichloroethane). 2016: Removed entire ATG suite [16] as most results were consistently non-detectable. Started to report on only those parameters which were historically detectable (chloroform and bromodichloromethane) and monitoring was a "should" as per MISA.	N/A	N/A	1. Frequency: 1991: Quarterly for characterization of the effluent as it was expected that there would be some detectable levels of these parameters based on site operations [1]. 1992: Quarterly as a routine scan based on potential for sources due to varying inputs [2]. 2016: Removed ATG as a whole [16]. 2. N/A
16	Chloroform (separate from whole ATG 16) No Treatment	i, q	Monitored: (2016 – present) q: 2016: Monitoring of chloroform specifically was retained for this stream as the treatment centre is designed to collect liquid waste containing various chemicals from across the CRL site and chloroform was known to be used on site in various cleaners and solvents and chloroform is known to be formed as a result of chlorination of a stream of this nature and has been shown to be detectable in this effluent [16]. i: Identified as a COPC (screened in) in 2024 ERA – Table 46 [23].	M	Monthly Grab	1. Frequency: 2016: Review of data to date found that monthly was sufficient to capture variation in concentrations [16]. Sample Type: Grab sample required for VOCs according to MISA [18] and N288.5:22 [22]. 2. N/A

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Sanitary Sewage Treatment Facility (STP) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
16	Bromodichloromethane (separate from whole ATG 16) No Treatment	q	Monitored: (2016 – present) q: 2016: Monitoring of Bromodichlorormethane specifically was retained for this stream (despite removal of monitoring for the rest of ATG 16) as there were routinely detectable results for this parameter [16].	M	Semi-annual Grab	1. Frequency: 2016: Review of data to date found that semi-annual was sufficient to capture variation in concentrations [16]. Sample Type: Grab sample required for VOCs according to MISA [18]and N288.5:22 [22]. 2. N/A
17	Volatiles, Non-Halogenated (entire ATG suite) N/A	N/A	Not Monitored: (was from 1991 – 2016) 1991: Full ATG suite monitoring initiated for this stream as the treatment centre is designed to collect liquid waste containing various chemicals from across the CRL site [1]. Reported on those parameters which showed notable results in any given year. 2016: Removed entire ATG suite [16] as most results were consistently non-detectable. Started to report on only those parameters which were historically detectable (toluene) and monitoring was a "should" as per MISA.	N/A	N/A	1. Frequency: 1991: Quarterly for characterization of the effluent as it was expected that there would be some detectable levels of these parameters based on site operations [1]. 1992: Semi-annual as a routine scan based on potential for sources due to varying inputs [2]. 2016: Removed ATG as a whole [16]. 2. N/A
17	Toluene (separate from whole ATG 17) No Treatment	q	Monitored: (2016 – present) q: 2016: Monitoring of Toluene specifically was retained for this stream (despite removal of monitoring for the rest of ATG 17) as there are routinely detectable results for this parameter [16].	M	Semi-annual Grab	1. Frequency: 2016: Review of data to date found that semi-annual was sufficient to capture variation in concentrations [16]. Sample Type: Grab sample required for VOCs according to MISA [18]and N288.5:22 [22]. 2. N/A
19	Extractables, Neutral N/A	N/A	Not Monitored: (was from 1991 – 2016) p: 1991: Monitoring initiated for this stream as the treatment centre is designed to collect liquid waste containing various chemicals from across the CRL site [1]. 2016: Removed entire ATG suite as most results were consistently non-detectable. Started to report on only those parameters which were historically detectable (Butylbenzyl Phthalate and Bis-2-	N/A	N/A	1. Frequency: 1991: Semi-annual for characterization of the effluent [1]. 1992: Semi-annual as a routine scan based on potential for sources due to varying inputs [2]. 2016: Removed ATG as a whole [16]. 2. N/A

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Sanitary Sewage Treatment Facility (STP) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
			ethylhexyl Phthalate) and monitoring was a "should" under MISA [16].			
19	Butylbenzyl Phthatlate No Treatment	i, q	Monitored: (2016 – present) 2016: Monitoring of Butylbenzyl Phthatlate specifically was retained for this stream as there were routinely detectable results for this parameter [16]. i: Identified as a COPC (screened in) in 2024 ERA – Table 46 [23].	M	Semi-annual 24 hr Composite ***	1. Frequency: 2016: Review of data to date found that semi-annual was sufficient to capture variation in concentrations [16]. Sample Type: 24-hour composite is representative of the day's effluent which can vary based on plant and site operations (influent received by facility). 2. N/A
19	Bis-2-ethylhexyl Phthalate No Treatment	q	Monitored: (2016 – present) 2016: Monitoring of Bis-2-ethylhexyl Phthalate specifically was retained for this stream as there were routinely detectable results for this parameter [16].	M	Semi-annual 24 hr Composite ***	1. Frequency: 2016: Review of data to date found that semi-annual was sufficient to capture variation in concentrations [16]. Sample Type: 24-hour composite is representative of the day's effluent which can vary based on plant and site operations (influent received by facility). 2. N/A
20	Extractables, Acid N/A	N/A	Not Monitored: (1991 – 2016) p: 1991: Monitoring initiated for this stream as the treatment centre is designed to collect liquid waste containing various chemicals from across the CRL site [1]. 2016: Removed as results were consistently non-detectable and monitoring was a "should" as per MISA [16].	N/A	N/A	1. Frequency: 1991: Semi-annual for characterization of the effluent [1]. 1992: Semi-annual as a routine scan based on potential for sources due to varying inputs [2]. 2016: Removed [16]. 2. N/A
23	Extractables, Chlorinated N/A	N/A	Not Monitored: (was from 1991 – 2016) p: 1991: Monitoring initiated for this stream as the treatment centre is designed to collect liquid waste containing various chemicals from across the CRL site [1]. 2016: Removed as results were consistently non-detectable and monitoring was a "should" as per MISA [16].	N/A	N/A	1. Frequency: 1991: Semi-annual for characterization of the effluent [1]. 1992: Semi-annual as a routine scan based on potential for sources due to varying inputs [2]. 2016: Removed [16]. 2. N/A

REDACTED

Sanitary Sewage Treatment Facility (STP) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
24	Chlorinates Dioxins and Furans N/A	N/A	Not Monitored: (was from 1991 – 1999) p: 1991: Monitoring initiated for this stream as the treatment centre is designed to collect liquid waste containing various chemicals from across the CRL site [1]. 1999: Removed from all monitoring points on site as no significant levels were being detected and no known source of contaminants [14].	N/A	N/A	1. Frequency: 1991: Semi-annual for characterization purposes. Note: Not suspected to be present in concentration of concern [1]. 1999: Removed [14]. 2. N/A
25	Solvent Extractables No Treatment	p	Monitored: (1991 – present) p: 1991: Core parameter required under MISA specifically for this location as it collects waste waters from various facilities across the site where there is a vast use of lubricating oils, greases, transformer oils, fuel oil and hydraulic fluids [1]. 1996: Also required to be monitored in boiler blowdown effluents which are now being discharged to this waste stream [13].	M	Monthly 24 hr Composite ***	1. Frequency: 1991: Weekly in order to screen for spills/leaks from various facilities across the site [1]. 1996 Note: Weekly considered to be frequent enough to capture new boiler blowdown contributions as well [13]. 2016: Reduced to Monthly as will capture same variation [16]. Sample Type: 24-hour composite is representative of the day's effluent which can vary based on plant and site operations (influent received by facility). 2. N/A
27	Polychlorinated Biphenyls (PCB) N/A	N/A	Not Monitored: (was from 1991 – 1997) p: 1991: Monitored due to potential contaminants resulting from a spill or leak [1]. 1997: Removed from monitoring as all results were ≤ LMDL and no known source of contamination on the site. Also, being monitored under the GWMP with no contamination noted [6].	N/A	N/A	1. Frequency: 1991: Semi-annual as a scan for this effluent which is not suspected of being contaminated [1]. 1997: Removed [6]. 2. N/A
30	Chloride No Treatment	i, q	Monitored: (2018 – present) q: 2018: Investigation of Conductivity issues in the effluent identified a source of chloride coming from the Power House water softener system regeneration [14]. i: Identified as a COPC (screened in) in 2024 ERA – Table 46 [23].	M	Monthly 24 hr Composite ***	1. Frequency: 2018: Monthly to align with other anion analysis at the stream. Conductivity monitoring continues to be completed daily [14]. Sample Type: 24-hour composite is representative of the day's effluent which can vary based on plant and site operations (influent received by facility). 2. N/A

REDACTED

Sanitary Sewage Treatment Facility (STP) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
30	Fluoride No Treatment	i	Monitored: (2025 – present) i: Identified as a COPC (screened in) in 2024 ERA – Table 46 [23].	M	Monthly 24 hr Composite ***	1. Frequency: 2025: Monthly to align with other anion analysis at the stream. Sample Type: 24-hour composite is representative of the day's effluent which can vary based on plant and site operations (influent received by facility). 2. N/A
31	Total Residual Oxidants (Total Residual Chlorine) N/A	N/A	Not Monitored: (was from 1991 – 2018) p: 1991: Core parameter under MISA for Process effluents which use chlorine for disinfection or defouling [1], [3]. h: 2010: Required under the *Wastewater Systems Effluent Regulations* [8]. 2018: Removed as the new SSTF uses UV disinfection (not chlorine), therefore monitoring of chlorine residual is not required under the *Wastewater Systems Effluent Regulations* [8] nor MISA.	N/A	N/A	1. Frequency: 1990: Daily as recommended for STPs under MISA [1]. 2003: Reduced to weekly due to reduction in chlorine use at this facility (thereby making it less of a concern) and switched to colorimetric method which is used provincially [7], [8], [9]. Note: *The Wastewater Systems Effluent Regulations* [8] have a monthly monitoring requirement and do not prescribe a required analytical method. 2018: Removed [15]. 2. N/A
35	Fecal Coliforms (*E. coli*) UV disinfection	n, q	Monitored: (2003 – present) n, q: 2003: Added in 2003 as there was an initiative to optimize the amount of chlorine being used for disinfection by reducing; however, CRL still needed to ensure that appropriate disinfection continued to take place. During this reduction, *E. coli* levels need the stay below the CNL Guideline Limit Value [7]. 2018 Note: The New STP does not use chlorine for disinfection but instead UV. The guideline for disinfection remains the same.	M	Weekly Grab	1. Frequency: 2003: Weekly to align with Total Residual Chlorine (TRCl) monitoring frequency [7]. Note: There is a monthly CNL Guideline for *E.coli*, therefore should monitor here at least monthly. 2018 Note: Continuing with weekly to provide verification of effectiveness of UV system. Sample Type: Grab is required under MISA [18]. 2. N/A
--	Flow Rate (m^3/day) N/A	h, j, p, q	Monitored: (1991 - present) p: 1991: Core parameter under MISA for process effluents used to determine loading from the source [1]. j: Flow rate is needed to determine dilution factor for use in risk assessment.	M	Daily Continuous	1. Frequency: 1991: MISA recommends daily for process effluents [9]. 2010: Daily volume determination (m^3/day) required under the *Federal Wastewater Systems Effluent Regulations* [8], for effluents which discharge an average daily volume of <2,500 m^3 (CRL falls in this category). Sample type: Continuous measure of effluent is acceptable measurement type under the *Wastewater Systems Effluent Regulations* [8]. Device is a parshall flume and transponder.

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Sanitary Sewage Treatment Facility (STP) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
			h: 2010: Became legal requirement under the *Wastewater Systems Effluent Regulations* [8]. q: 2020: Monitoring is required to potentially report under the Global Reporting Initiative – Water [20].			2. N/A
--	Temperature Effluent Maximum N/A	N/A	Not Monitored: (was from 2010 – 2018) 2010: Added as is required under the *Wastewater Systems Effluent Regulations* [8]. Also considered a basic measure for a treatment process which EnvP should be monitoring with respect to thermal output [3], [4]. 2018: Removed as determined to not be required by the *Wastewater Systems Effluent Regulations* [8].	N/A	N/A	1. Frequency: 2010: Daily desired by EnvP staff to determine variability and as an indicator of other potential issues with the operation [3]. Note: There is a quarterly monitoring requirement under the WSER [8]. 2018: Removed. 2. N/A
--	Acute Rainbow Trout Toxicity Testing N/A	h	Monitored: (2014 – present) h: 2014: Routine single concentration testing added as the release of non-lethal effluent is required under the *Wastewater Systems Effluent Regulations* [8]. h: 2018: REGDOC 2.9.1: "the licensee shall ensure that the effluent and emission monitoring demonstrate that controlled releases to water frequented by fish are not acutely lethal" [19]. NOTE: Multi-concentration tests are triggered in the event of a single concentration test failure.****	M	Quarterly **** Grab	1. Frequency: 2014: Semi-annual: Not explicitly dictated by the *Wastewater Systems Effluent Regulations* for a facility as small as CRL's. The regulation does however dictate frequency for larger systems (quarterly or monthly) therefore CRL chose a less frequent monitoring basis than that [8]. Note: Failure of a mortality single concentration test will result in additional bi-weekly LC50 tests, until three consecutive passes are achieved. 2016: Increased to Quarterly [16] to align with conditions associated with the current Transitional Authorization at the time [17] to discharge which requires the effluent to be not acutely lethal. 2019: Despite expiry of the CRL Transitional Authorization, maintained quarterly monitoring as reporting under WSER is required quarterly. 2024: Failure of a mortality single concentration test now requires *an additional LC50 test without delay*, followed by the bi-weekly LC50 tests, until three consecutive passes are achieved [21]. Sample Type: Grab sample specified by *Wastewater Systems Effluent Regulations* [21] and under MISA [18]. 2. N/A

REDACTED

Sanitary Sewage Treatment Facility (STP) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
--	Mortality test additional suite: total and dissolved metals, anions (nitrate, nitrite, sulphate, phosphate, chloride, fluoride), total suspended solids, total dissolved solids, dissolved organic carbon, total organic carbon, total ammonia, unionized ammonia, sulphide, alkalinity, hardness, biological oxygen demand, chemical oxygen demand, carbonaceous oxygen demand)	q	Monitored: (2024 – present) q: Monitoring commenced to align with the acutely toxicity tests in efforts to help identify the cause of toxicity, if toxicity were to occur.	M	Quarterly **** Grab	1. Frequency: 2024: Quarterly - taken at the same time as STP mortality tests. Sample Type: Grab sample to align with the sample type of the acute toxicity testing samples being taken. 2. N/A

Notes:
CRL – Chalk River Laboratories; CWQG – Canadian Water Quality Guidelines; CNL – Canadian Nuclear Laboratories; LMDL - Laboratory Method Detection Level; STP - Sewage Treatment Plants; MISA - Municipal/Industrial Strategy of Abatement; ATG – Analytical Test Group; GWMP – Groundwater Monitoring Program; WSER – Wastewater System Effluent Regulations; UV – ultraviolet; EnvP – Environmental Protection Program
Priority 1 Pollutant were identified by the ministry in the early stages of MISA, are stream specific and are those pollutants which were detected.
* Current as of issuing date of document. Always refer to the latest version of EVMP Monitoring Schedule (CRL-509200-062-000-0004).
** See Table 15 *Parameter Monitoring Criteria for the Effluent Verification Monitoring Program*
*** 24 hr Composite sample taken every 15 minutes (set volume). All 24-hour composite samples are 8:30am to 8:30am the following day. For example, weekly is a 24-hour composite from one day of the week; Monthly is a 24-hour composite from one day of the month; quarterly is a 24-hour composite from one day of the quarter.
**** Toxicity Testing - Failure of a mortality single concentration test will result in an additional LC50 test without delay, followed by bi-weekly LC50 tests, until three consecutive passes are achieved.

References:

[1] *Non-Radiological Liquid Effluent Monitoring at CRL: Summary of the Monitoring Results for the Period 1991 May to 1992 December,* RC-1086, 1993 December.
[2] *Non-Radiological Liquid Effluent Monitoring at CRL: Results for the Period 1993 January to December,* NSN-ESRSD-117, 1995 January. 22506084
[3] *Non-Radiological Program Review in 2010,* CRL-509244-QAPR-001, 2010 May. 22425224
[4] *Revision to CY 2010 Non-Radiological Monitoring Schedule*, EnvP-10-068, 2010 March. 23024873
[5] *SRC Acceptance of the Annual program Report - Non-Radiological Effluent Monitoring in 2005 at Chalk River Laboratories,* SRCM-62-059, 2006 August.
[6] *Non-Radiological Liquid Effluent Monitoring at CRL: The Results for 1997,* AECL-MISC-397-97, 1998 September. 22869405
[7] *Non-Radiological Monitoring for First Half of 2003*, EP-C2001-033, 2002 December.
[8] Canada Gazette, *Regulations Amending the Wastewater Systems Effluent Regulations,* SOR/2024-97, 2024 May.
[9] *The Development Document for the Effluent Monitoring Regulation for the Electric Power Generation Sector,* MISA, 1990.

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Sanitary Sewage Treatment Facility (STP) *						
ATG	Parameter Name Treatment	Parameter Criteria **	Justification for Monitoring (or not Monitoring) of Parameter	Measurement or Estimation	Monitoring Frequency & Sample Type	Justification for: 1. Monitoring Frequency & Sample Type 2. Estimation over Measurement

[10] *Non-Radioactive Monitoring Schedule for CRL,* CRL-509200-062-000-0001, Rev 6, 2013 December. 23651723
[11] *MISA Liquid Effluent Monitoring at CRL: Summary of Monitoring Results for the Period 1990 June to 1991 May,* RC-809, 1992 March.
[12] *Non-Radiological Liquid Effluent Monitoring at CRL: Results for the Period 1993 January to December,* NSN-ESRSD-117, 1995 January. 22506084
[13] *Non-radiological Liquid Effluent Monitoring at CRL: The Results for 1996,* AECL-MISC-397-96, 1997 October. 22769857
[14] *Effluent Verification Monitoring Program Sampling Schedule for CRL,* CRL-509200-062-000-0004, Rev6, 2016 May. 22728204
[15] *Effluent Verification Monitoring Program Sampling Schedule for CRL & NPD,* CRL-509200-062-000-0004, Rev 12, 2018 August.
[16] *Effluent Sampling Schedule for CRL – Liquid (Non-Radiological),* CRL-509200-062-000-0004, Rev 3, 2016 January. 22730333
[17] Environment Canada, *Wastewater Systems Effluent Regulations, Transitional Authorization*, 2014 November 27.
[18] Municipal/Industrial Strategy for Abatement (MISA), *Protocol for the Sampling and Analysis of Industrial/Municipal Wastewater,* Version 2.0, 2016 January.
[19] *Environmental Protection: Environmental Principles, Assessments and Protection Measures,* version 1.2 CNSC, REGDOC-2.9.1, 2020 September.
[20] Global Sustainability Standards Board, *Global Reporting Initiative 303: Water and Effluent,* 2018.
[21] Canada Gazette*, Regulations Amending the Wastewater Systems Effluent Regulations*, SOR/2024-97, 2024 May 27.
[22] Canadian Standards Association, *Effluent and Emissions Monitoring Programs at Nuclear Facilities*, CSA N288.5:22, 2022 February.
[23] EnvP-509220-REPT-006396, *2024 Environmental Risk Assessment of Chalk River Laboratories*, Rev 0, 2025 January 69264691

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4.3.2.2.1.2 Powerhouse Discharge

Table 21: Detailed Design – Powerhouse Discharge (PPD)

Description: The PPD monitoring station is located at the effluent of the Power House Discharge. The water discharged through this line is comprised mostly of once-through cooling water for equipment located in the Power House (e.g., air compressors and water pumps).
Source Term: The majority of the volume is cooling water used for the Power House air compressors and other equipment; roof run-off and building drainage also contribute. Historically, the Power House boiler blowdown was discharged via this effluent however in 1996, the boiler blowdown effluent was redirected to the Sanitary Outfall collection system, thereby reducing the potential contaminants in the Power House Drain effluent significantly.
Potential Non-radiological Contaminants: oil/grease
Discharge Characteristics: Continuous discharge. The current annual flow is estimated at 63 m^3/day [16].
Effluent Treatment: An Oil/water separator is in place to remove/reduce COD and oil/grease. The oil/water separator was installed in 1996 in the Power House through which all potentially oil contaminated wastewater was directed. This installation was a protective measure put in place after oil was known to be released through this effluent [1].
Monitoring Strategy: Monitored since the inception of the Non-radioactive monitoring program in 1990, the Power House discharge continues to be monitored under the program however, the water chemistry of the effluent has since significantly changed over this period. Historically, the inclusion of the boiler blowdown water caused the original MISA classification of this effluent to be "combined" which is defined as an effluent resulting from the intentional combination of process effluent (boiler blowdown) with cooling water.

The current PPD effluent is continuously sampled at a location after the oil/water separator using an automatic composite sampler which takes aliquots every 15 minutes.

Note: The effluent sampling location is located after all treatment (the oil/water separator) but prior to contributions of roof storm water (no oil contamination concerns) and prior to reaching the Ottawa River.

Power House Discharge (PPD) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
1	Chemical Oxygen Demand (COD) Oil/water separator	p	Monitored: (1993 - present) p: 1993: Monitored as CRL was identified as having a significant fraction of the total loading COD in the Electrical Power Generating Sector from its process effluents [2].	M	Quarterly 24hr Composite ***	1. Frequency: 1993: Quarterly to align with site effluent COD monitoring already in place [2] and would capture seasonal variability in the service water. Sample Type: 24 hr Composite will capture variability in effluent throughout day while various processes take place (e.g. pumps turning off and on). 2. N/A

REDACTED

Power House Discharge (PPD) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
3	pH No Treatment	p	Monitored: (1991 - present) p: 1991: Core parameter required under MISA specifically for this location as a gross indicator of effluent quality [1].	M	Daily 24hr Composite ***	1. Frequency: 1991: MISA recommends daily for combined effluents as a scan for other potential problems which may be occurring [1], [5]. 2014 Note: Despite no longer being a combined effluent (boiler blowdown has been redirected), variation in pH levels of this effluent justify the continuation of daily monitoring [8]. Sample Type: 24 hr Composite will capture variability in effluent throughout day while various processes take place (e.g. pumps turning off and on). 2. N/A
4a	Ammonium, Total Filter React (ionized + un-ionized) N/A	N/A	Not Monitored: (was from 1993 – 2014) p: 1993: Added as CRL was identified as having a significant fraction of the total loading of this parameter in the Electrical Power Generating Sector and boiler blowdown effluent streams are sources [2]. 2014: Removed as after boiler blowdown was re-routed (1996), there was a significant decrease in ammonia for this effluent and has been ≤LMDL consistently for years now (also well below the CWQG and PWQO) with negligible contribution to the overall site loading [8].	N/A	N/A	1. Frequency: 1993: Added monthly at each of the process and combined effluents for characterization [2]. 2014: Removed. [8]. 2. N/A
4b	Nitrates, Total Filter Reactive N/A	N/A	Not Monitored: (was from 1991 – 2014) p: 1991: Core parameter required under MISA specifically for this location as it was a combined effluent [1]. 1996: Despite the redirection of the boiler blowdown to the sanitary sewer, monitoring remained to observe any effects. 2014: Removed as there is no longer a known source and results to data have been comparable to levels in River water and far below the CWQG guideline limit [8].	N/A	N/A	1. Frequency: 1991: Monthly as a scan [1], [5]. 2014: Removed [8]. 2. N/A

REDACTED

Power House Discharge (PPD) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
5a	Dissolved Organic Carbon (DOC) No Treatment	p	Monitored: (1991 – present) p: 1991: Core parameter required under MISA specifically for this location as this effluent has the potential to be contaminated with hydraulic oils, greases, lubricating oils etc. as it is primarily cooling water used for various equipment and accepts boiler blowdown [1]. 1996: Boiler blowdown redirected to Sanitary Sewer, thereby removing one potential source and resulting in notable reduction in 1997: The potential source in the cooling water however remained [7], [8]. Note: DOC, TSS and Solvent Extractables all remained on the routine monitoring program.	M	Monthly 24hr Composite *** ***	1. Frequency: 1991: Weekly for characterization purposes [1]. 1992: Remained weekly as a scan for spills/leaks and the boiler blowdown variations due to operational changes. 1997: Remained weekly to monitor that the oily/water separator was functioning properly (aligning with TSS and solvent extractables monitoring frequencies) [7]. 2016: Reduced to Monthly as variation in results is limited [11]. Sample Type: 24 hr Composite will capture variability in effluent throughout day while various processes take place (e.g. pumps turning off and on). 2. N/A
5b	Total Organic Carbon (TOC) No Treatment	p	Monitored: (1991 – 1996; 2014 - present) p: 1991: Core parameter required under MISA specifically for this location as this effluent has the potential to be contaminated with hydraulic oils, greases, lubricating oils etc. as it is primarily cooling water used for various equipment and accepts boiler blowdown [1]. 1996: Removed as the Boiler blowdown was redirected to the Sanitary Sewer and it was suspected that the TSS would be low. Note: DOC, TSS and Solvent Extractables, all remained in the routine monitoring program [9]. 2014: Re-establish this monitoring as there are instances when the TSS of this effluent is >15mg/L [8].	M	Monthly 24hr Composite *** ***	1. Frequency: 1991: Weekly for characterization purposes [1]. 1996: Removed [9]. 2014: Re-established as weekly to verify oily/water separator is functioning accordingly - monthly aligns with the monitoring of TSS, DOC and solvent extractables on this effluent [8]. 2016: Reduced to Monthly as variation in results is limited [11]. Sample Type: 24 hr Composite will capture variability in effluent throughout day while various processes take place (e.g. pumps turning off and on). 2. N/A
6	Phosphorus, Unfiltered Total N/A	N/A	Not Monitored: (was from 1991 – 2014) 1991: Core parameter required under MISA specifically for this location as a gross indicator of effluent quality. Known source in the boiler blowdown feed which contains phosphates and organophosphates [1], [6].	N/A	N/A	1. Frequency: 1991: Monthly as expected to see changes through the year based on boiler blowdown frequency (increases in winter) [1], [6]. 2014: Removed [8]. 2. N/A

REDACTED

Power House Discharge (PPD) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
			1996: Boiler blowdown redirected to Sanitary Sewer, thereby removing phosphorus source to this waste stream [7]. 2014: Removed as no significant levels noted in 10 years and there is no longer a source for this effluent [8].			
7	Conductivity, @ [redacted] No Treatment	p	Monitored: (1991 – present) p: 1991: Core parameter required under MISA specifically for this location as a gross indicator of effluent quality [1].	M	Daily 24hr Composite ***	1. Frequency: 1991: Daily as MISA recommended daily for process and combined effluents as this parameter is useful as a gross indicator of effluent quality to be used as a screening tool [5]. 2014 Note: Despite no longer being a combined effluent, variation in conductivity levels of this effluent justify the continuation of daily monitoring. Sample Type: 24 hr Composite will capture variability in effluent throughout day while various processes take place (e.g. pumps turning off and on). 2. N/A
8	Volatile Suspended Solids (VSS) Oil/water separator	p	Monitored: (2014 – present) p: 2014: MISA recommends to monitor on process effluent streams with oily/water separators in place. Note: when MISA program was set up, the oily/water separator was not in place yet [5], [8].	M	Quarterly 24hr Composite ***	1. Frequency: 2014: Added monthly as a scan. Note: VSS is a component of TSS and there is normally not a lot of variation in the TSS of this effluent and therefore it is expected that there will not be a lot of variation in VSS [8]. 2016: Reduced to quarterly as none of the monthly results from scan were detectable [11]. Sample Type: 24 hr Composite will capture variability in effluent throughout day while various processes take place (e.g. pumps turning off and on). 2. N/A
8	Total Suspended Solids (TSS) No Treatment	i,p	Monitored: (1994 – present) p: 1994: Core parameter required under MISA specifically for this location as a gross indicator of effluent quality. Note: Appropriate for effluents which use oily/water separators [3]. i: Identified as a COPC (screened in) in 2024 ERA – Table 25 [18].	M	Weekly 24hr Composite ***	1. Frequency: 1994: Weekly for characterization [3]. 1995: Continued weekly as a scan - aligns with DOC and solvent extractables [10]. Sample Type: 24 hr Composite will capture variability in effluent throughout day while various processes take place (e.g. pumps turning off and on).

REDACTED

Power House Discharge (PPD) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
						2. N/A
9	Aluminium, Unfiltered Total No Treatment	i, p	Monitored: (1991 – present) p: 1991: (Metals) Core parameter required under MISA specifically for this combined effluent [1]. 1996: No longer a combined effluent but parameter is known to have a high background for CRL justifying the continuation of its monitoring. i: Identified as a COPC (screened in) in 2024 ERA – Table 25 [18].	M	Monthly 24hr Composite *** [redacted]	1. Frequency: 1991: Monthly as a routine scan for metals as it is not expected to vary greatly in this effluent [1]. Sample Type: 24 hr Composite will capture variability in effluent throughout day while various processes take place (e.g. pumps turning off and on). 2. N/A
9	Boron, Unfiltered Total & Chromium, Unfiltered Total & Lithium, Unfiltered Total & Nickel, Unfiltered Total & Strontium, Unfiltered Total & Vanadium, Unfiltered Total No Treatment	p	Monitored: (1991 – present) p: 1991: (Metals) Core parameter required under MISA specifically for this location [1]. 1996: No longer a combined effluent but all of parameters in ATG 9 are available from analysis.	M	Monthly 24hr Composite *** [redacted]	1. Frequency: 1991: Monthly as a routine scan for metals as it is not expected to vary greatly in this effluent [1]. Sample Type: 24 hr Composite will capture variability in effluent throughout day while various processes take place (e.g. pumps turning off and on). 2. N/A
9	Cadmium, Unfiltered Total & Lead, Unfiltered Total No Treatment	i, p	Monitored: (1991 – present) p: 1991: (Metals) Core parameter required under MISA specifically for this location [1]. 1996: No longer a combined effluent but all of parameters in ATG 9 are available from analysis. i: Identified as a COPC (screened in) in 2024 ERA – Table 25 [18].	M	Monthly 24hr Composite *** [redacted]	3. Frequency: 1991: Monthly as a routine scan for metals as it is not expected to vary greatly in this effluent [1]. Sample Type: 24 hr Composite will capture variability in effluent throughout day while various processes take place (e.g. pumps turning off and on). 4. N/A
9	Copper, Unfiltered Total	i, p	Monitored: (1991 – present)	M	Monthly	1. Frequency:

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Power House Discharge (PPD) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
	No Treatment		p: 1991: (Metals) Core parameter required under MISA specifically for this combined effluent [1]. 1996: No longer a combined effluent but parameter of concern for the electrical power generating sector. Note: All of parameters in ATG 9 are available from analysis. i: Identified as a COPC (screened in) in 2024 ERA – Table 25 [18].		24hr Composite *	1991: Monthly as a routine scan for metals as it is not expected to vary greatly in this effluent [1]. Sample Type: 24 hr Composite will capture variability in effluent throughout day while various processes take place (e.g. pumps turning off and on). 2. N/A
9	Silver, Unfiltered Total N/A	N/A	Not Monitored: (was from 1991 – 1993) p: 1991: (Metals) Core parameter required under MISA specifically for this location [1]. 1993: Removed from monitoring as levels were found below LMDL and silver is not identified as a parameter of concern to the electrical power generating sector [2].	N/A	N/A	1. Frequency: 1991: Monthly as scan [1]. 1993: Removed [2]. 2. N/A
9	Zinc, Unfiltered Total No Treatment	i, p	Monitored: (1991 – present) p: 1991: (Metals) Core parameter required under MISA specifically for this combined effluent [1]. 1996: No longer a combined effluent but parameter is known to have a high background for CRL justifying the continuation of its monitoring. Note: All of parameters in ATG 9 are available from analysis. i: Identified as a COPC (screened in) in 2024 ERA – Table 25 [18].	M	Monthly 24hr Composite *	1. Frequency: 1991: Monthly as a routine scan for metals as it is not expected to vary greatly in this effluent [1]. Sample Type: 24 hr Composite will capture variability in effluent throughout day while various processes take place (e.g. pumps turning off and on). 2. N/A
9a	Iron, Unfiltered Total No Treatment	p	Monitored: (1991 – present) p: 1991: (Metals) Core parameter required under MISA specifically for this combined effluent [1]. 1996: No longer a combined effluent but parameter is known to have a high background for CRL justifying the continuation of its monitoring. Note: All of parameters in ATG 9 are available from analysis.	M	Monthly 24hr Composite ***	1. Frequency: 1991: Monthly as a routine scan for metals as it is not expected to vary greatly in this effluent although has been known to exceed CNL Guidelines [1]. Sample Type: 24 hr Composite will capture variability in effluent throughout day while various processes take place (e.g. pumps turning off and on). 2. N/A

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Power House Discharge (PPD) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
9a	Uranium, Unfiltered Total N/A	N/A	Not Monitored: Not suspected to be a contaminant in this effluent stream as the water comprising the effluent never leaves the Power House or the supervised area.	N/A	N/A	N/A
12	Mercury, Unfiltered Total N/A	N/A	Not Monitored: (was from 2011-2014) 2011: Added to be conservative as Hg is present in hydrocarbons used at the Power House (identified potential source) [4]. 2014: Removed as there is no longer a source of mercury being used at the Power House [8].	N/A	N/A	1. Frequency: 2011: Monthly as potential for occurrence is low and other metals at PPD are monthly [4]. 2014: Removed [8]. 2. N/A
14	Phenolics, Unfiltered React No Treatment	p	Monitored (1991 - present) p: 1991: Core parameter required under MISA specifically for this location as it may potentially be concentrated through the boiler water demineralization process [1]. 2014 Note: Despite the boiler blowdown not being directed through this effluent anymore, phenolics is also associated with oils in oily/water separators, therefore monitoring should be kept at this location. Phenolics functions as a general indicator of treatment success [8].	M	Weekly 24hr Composite ***	1. Frequency: 1991: Weekly to capture effects of routine discharges of boiler blowdown to this waste stream [1]. 2014 Note: Weekly to capture effects of oily/water separator performance [8]. Sample Type: 24 hr Composite will capture variability in effluent throughout day while various processes take place (e.g. pumps turning off and on). 2. N/A
25	Solvent Extractables Oil/water separator	p	Monitored: (1990 – present) p: 1990: Core parameter required under MISA specifically for this location due to: (1) the potential for contamination from the use of lubricating oils and greases in the Power House with a high potential of contact with the cooling wastewater and (2) for boiler blowdown effluents [1]. 1996: Despite the re-routing of the boiler blowdown water from this waste stream to the sanitary sewer, and the installation of the oily/water separator, monitoring is still required due to (1) above. Monitoring now serves as	M	Weekly 24hr Composite ***	1. Frequency: 1990: Weekly for characterization purposes [1]. 1991: Remained weekly as a scan for spills/leaks and for the boiler blowdown [6]. 1997: Remained weekly to ensure oily/water separator were functioning accordingly Note: aligns with TSS and DOC monitoring frequencies [7]. Sample Type: 24 hr Composite will capture variability in effluent throughout day while various processes take place (e.g. pumps turning off and on). 2. N/A

REDACTED

Power House Discharge (PPD) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
			confirmation that the oily/water separator equipment is functioning accordingly as opposed to trying to identify spills [8].			
27	Polychlorinated Biphenyls (PCB) N/A	N/A	Not Monitored: (was from 1990 – 1997) p: 1990: Monitored due to potential contaminants resulting from a spill or leak on site [6]. 1997: Removed from monitoring as all results were ≤ LMDL and no known source of contamination on the site. Also, being monitored under the GWMP with no contamination noted [7].	N/A	N/A	1. Frequency: 1990: Quarterly as scan [1], [6]. 1997: Removed [7]. 2. N/A
--	Flow Rate (m^3/day) N/A	j, p, q	Monitored: (1991 to present) j: Flow rate is needed to determine dilution factor for use in risk assessment. p: 1991: Core physical characteristic under MISA for process effluents used to determine loading from the source [1] 1996: After renovations (redirection of the boiler blowdown and installation of oily/water separator), the flow measurement system was not reinstalled since it required a redesign and re-specification. An estimate was made at this time and has been reviewed and revised as necessary since then. q: 2020: Monitoring is required to potentially report under the Global Reporting Initiative – Water [15].	E	Estimated as required N/A	1. Frequency: 1991: MISA recommended daily for combined effluents [5]. 1996: Estimation put in place and revised as necessary. 2. Estimation acceptable because flows are not expected to vary widely based on the design which includes the treatment through the oil/water separator as well as the MISA well which acts as an equalization tank.
--	Acute Rainbow Trout Toxicity Testing N/A	h	Monitored: (2018 – present) h: 2018: REGDOC 2.9.1: "the licensee shall ensure that the effluent and emission monitoring demonstrate that controlled releases to water frequented by fish are not acutely toxic" [12], [13].	M	Quarterly **** Grab	1. Frequency: 2018: Quarterly as the source of effluent is primarily river water and quarterly will capture any seasonal variation [13]. Quarterly also aligns with sampling frequency required for the Sewage Treatment Plant. 2024: Failure of a mortality single concentration test now requires *an additional LC50 test without delay*, followed by the bi-weekly LC50 tests, until three consecutive passes are achieved under the WSER for STP

REDACTED

Power House Discharge (PPD) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
			NOTE: Multi-concentration tests are triggered in the event of a single concentration test failure. ****			effluent. This approach is being adopted for all effluent streams requiring toxicity testing including PPD [17]. Sample Type: Grab sample specified for toxicity testing under MISA [14]. 2. N/A
--	Mortality test additional suite: total and dissolved metals, anions (nitrate, nitrite, sulphate, phosphate, chloride, fluoride), total suspended solids, total dissolved solids, dissolved organic carbon, total organic carbon, total ammonia, unionized ammonia, sulphide, alkalinity, hardness, biological oxygen demand, chemical oxygen demand, carbonaceous oxygen demand)	q	Monitored: (2024 – present) q: Monitoring commenced to align with the acutely toxicity tests in efforts to help identify the cause of toxicity, if toxicity were to occur.	M	Quarterly **** Grab	1. Frequency: 2024: Quarterly - taken at the same time as toxicity tests. Sample Type: Grab sample to align with the sample type of the acute toxicity testing samples being taken. 2. N/A

REDACTED

Power House Discharge (PPD) *						
ATG	Parameter Name Treatment	Parameter Criteria **	Justification for Monitoring (or not Monitoring) of Parameter	Measurement or Estimation	Monitoring Frequency & Sample Type	Justification for: 1. Monitoring Frequency & Sample Type 2. Estimation over Measurement

Notes:

LMDL - Laboratory Method Detection Level; MISA - Municipal/Industrial Strategy of Abatement; ATG – Analytical Test Group; GWMP – Groundwater Monitoring Program

* Current as of issuing date of document. Always refer to the latest version of EVMP Monitoring Schedule (CRL-509200-062-000-0004).

** See Table 15 *Parameter Monitoring Criteria for the Effluent Verification Monitoring Program*

*** The Automatic sampler in [redacted] located on the 4" waterline after the oil/water separator (specific to non-rad program only). Sample of fixed size is taken every 15 minutes and is not dependant on effluent flow. All are 24 hour composite samples (8:30am to 8:30am the following day). For example, Weekly is a 24hour composite from one day of the week; Monthly is a 24 hour composite from one day of the month; Quarterly is a 24 composite from one day of the quarter.

**** Toxicity Testing - Failure of a mortality single concentration test will result in an additional LC50 test without delay, followed by bi-weekly LC50 tests, until three consecutive passes are achieved.

References:

[1] *Non-Radiological Liquid Effluent Monitoring at CRL: Summary of the Monitoring Results for the Period 1991 May to 1992 December*, RC-1086, 1993 December.
[2] *Non-Radiological Liquid Effluent Monitoring at CRL: Results for the Period 1993 January to December,* NSN-ESRSD-117, 1995 January. 22506084
[3] *Non-radiological Liquid Effluent Monitoring at CRL: The Results for 1994,* NSN-ESRSD-151, 1995 August. 22507951
[4] *ETB Monitoring Services in Support of Non-Radiological Liquid Effluent Monitoring Program at CRL (CY 2011),* EnvP-11-008, 2011 January. 22973179
[5] *The Development Document for the Effluent Monitoring Regulation for the Electric Power Generation Sector,* MISA, 1990.
[6] *MISA Liquid Effluent Monitoring at CRL: Summary of Monitoring Results for the Period 1990 June to 1991 May,* RC-809, 1992 March. 14601444
[7] *Non-Radiological Liquid Effluent Monitoring at CRL: The Results for 1997,* AECL-MISC-397-97, 1998 September. 22869405
[8] *Non-Radioactive Monitoring Schedule for CRL,* CRL-509200-062-000-0001, Rev 6, 2013 December. 23651723
[9] *Non-radiological Liquid Effluent Monitoring at CRL: The Results for 1996,* AECL-MISC-397-96, 1997 October. 22769857
[10] *Non-radiological Liquid Effluent Monitoring at CRL: The Results for 1995,* AECL-MISC-397-95, 1996 August.
[11] *Effluent Sampling Schedule for CRL - Liquid (Non-radiological),* CRL-509200-062-000-0004, Rev 3 2016 January. 22730333
[12] *Environmental Protection: Environmental Principles, Assessments and Protection Measures,* version 1.1, CNSC, REGDOC-2.9.1, 2017 April.
[13] *Effluent Verification Monitoring Program Sampling Schedule for CRL & NPD,* CRL-509200-062-000-0004, Rev11, 2018 Feb 08. 40635477
[14] *Municipal/Industrial Strategy for Abatement (MISA), Protocol for the Sampling and Analysis of Industrial/Municipal Wastewater,* Version 2.0 2016 January.
[15] Global Sustainability Standards Board, *Global Reporting Initiative 303: Water and Effluent,* 2018.
[16] *Revised Flow Estimate for the Powerhouse Discharge (PPD) Effluent Monitoring Location*, EnvP-23-080, 2023 August. 62154270
[17] Canada Gazette*, Regulations Amending the Wastewater Systems Effluent Regulations*, SOR/2024-97, 2024 May 27.
[18] EnvP-509220-REPT-006396, *2024 Environmental Risk Assessment of Chalk River Laboratories*, Rev 0, 2025 January 69264691

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4.3.2.2.1.3 Process Outfall

Table 22: Detailed Design – Process Outfall (PRO)

Description: The Process Outfall is a Once Through Cooling Water (OTCW) system designed to collect large volumes of untreated cooling water from the NRU reactor as well as relatively small inputs from the treated water from the Waste Treatment Center (WTC) and its associated facilities (small in volume but contribute the majority of the company's contaminants in the PRO effluent) and some floor and roof drains and sumps.
The Process Outfall effluent discharges through a 48" diameter pipe to the Ottawa River approximately 80m offshore at a depth of approximately 17.5m. At the end of the discharge pipe, there are three diffusers (30, 32 and 33" in diameter) on the top which force the effluent upward toward the surface of the river creating a visible swirl at the surface.
Source Term: There are two main source of waterborne non-radiological contaminants in the final effluent. Note: the cooling water from the river is not a source of non-radiological contaminants.

1. Waste Treatment Center Liquid Waste Evaporator (WTC_LWE); and,
2. Waste Treatment Centre associated facility [redacted].

Potential Non-radiological Contaminants: Metals, phenolics and solvent extractables
Discharge Characteristics: The characteristic of this effluent are expected to routinely change to some degree with the change of seasons (when the influent water from the River undergoes changes) and potentially during WTC facility discharges which are not continuous but instead are batch discharges.
With the shutdown of NRU in 2018 the volume of water from NRU has reduced approximately four-fold to current levels of ~ 20,000 m3/day in 2023. Further reductions in NRU flow through water are anticipated.
Effluent Treatment: None.
Monitoring Strategy: Monitored since the inception of the Non-Radioactive Monitoring Program in 1990, the Process Outfall continues to be monitored under the program. The WTC discharges are so small in volume compared to the overall PRO flow that detectable levels of contaminants are masked. For this reason, batch discharges from the WTC and its associated facilities are sampled prior to their discharge into the Process Outfall collection system. With the monitoring of these batch discharges, the general parameters of the PRO effluent need not be monitored in a high frequency, however key physical characteristics of OTCW systems which are dependent on operations of the site are monitored more frequently. As PRO is the final effluent downstream of all contaminant contributors, the flow rate is monitored here and is not monitored at the upstream contributors.
PRO effluent sampling takes using an automatic sampler in [redacted] which is located after all contributions to the effluent but prior to reaching the Ottawa River using an automatic composite sampler. Daily composite sample of a fixed volume every 15 minutes (not flow proportionate) over a 24-hour period (~08:30 to 08:30 the following day). This interval is adequate to capture any changes in operations such as: equipment cooling water additions or subtractions (e.g. start-up of AC units in warm season); routine batch discharges from facilities (e.g. WTC_LWE) or non-routine batch discharges (e.g. manhole pump-outs) as none are expected to occur in less than 15 minutes.

Process Outfall (PRO) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
3	pH No Treatment	h, p	Monitored: (1990 - present) p: 1990: Core parameter required under MISA specifically for this location as a gross indicator of effluent quality [1]. h: 2006: Site Licence Limit came into effect making this monitoring a legal requirement [2].	M	Weekly 24hr composite *****	1. Frequency: 1990: Monthly as recommended by MISA for characterization purposes [3]. 1991: Reduced to quarterly after characterization in order capture seasonal variation [4].

REDACTED

Process Outfall (PRO) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
						2006: Monthly as Site Licence Limit is for monthly average and useful as a gross indicator of effluent quality to be monitored at an increased frequency [2]. 2022: Increased to weekly in order to be able to calculate a regulatory monthly average [17]. Sample Type: 24-hour composite is representative of the day's effluent which may vary based on discharges into the Process Outfall collection System. 2. N/A
4b	Nitrates, Total Filter Reactive N/A	N/A	Not Monitored: (1990-2016) p: 1990: Core parameter required under MISA specifically for this location as a gross indicator of effluent quality [1]. 2016: Removed as results are well characterized over the years, are consistent with ORC (river) nitrate levels and there are no known sources of nitrate entering this effluent stream [5].	N/A	N/A	1. Frequency: 1990: Monthly as recommended by MISA for characterization purposes [3] 1991: Reduced to quarterly after characterization in order to capture seasonal variation [4]. 2016: Removed [5]. 2. N/A
5a	Dissolved Organic Carbon (DOC) No Treatment	p	Monitored: (1990 - present) p: 1990: Core parameter required under MISA specifically for this location as a gross indicator of effluent quality [1].	M	Quarterly 24hr composite ***	1. Frequency: 1990: Monthly as recommended by MISA for characterization purposes [3]. 1991: Reduced to quarterly after characterization in order to capture seasonal variation [4]. Sample Type: 24-hour composite is representative of the day's effluent which may vary based on discharges into the Process Outfall collection System. 2. N/A
5b	Total Organic Carbon (TOC) No Treatment	p	Monitored: (1990 - present) p: 1990: Core parameter required under MISA specifically for this location as a gross indicator of effluent quality [1].	M	Quarterly 24hr composite ***	1. Frequency: 1990: Monthly as recommended by MISA for characterization purposes [3]. 1991: Reduced to quarterly after characterization in order to capture seasonal variation [4]. Sample Type: 24-hour composite is representative of the day's effluent which may vary based on discharges into the Process Outfall collection System. 2. N/A
6	Phosphorus, Unfiltered Total N/A	N/A	Not Monitored: (was from 1990 - 2016) p: 1990: Core parameter required under MISA specifically for this location as a gross indicator of effluent quality and known potential source from WTC_LWE [1].	N/A	N/A	1. Frequency: 1990: Monthly as recommended by MISA for characterization purposes [3]. 1991: Reduced to quarterly after characterization in order to capture seasonal variation [4]. 2016: Removed [5].

REDACTED

Process Outfall (PRO) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
			2016: Removed as has been non-detectable at the WTC_LWE for over 5 years. Still be monitored at the WTC_LWE [5].			2. N/A
7	Conductivity, @ 25˚C No Treatment	p	Monitored: (1990 - present) p: 1990: Core parameter required under MISA specifically for this location as a gross indicator of effluent quality [1].	M	Monthly 24hr composite ***	1. Frequency: 1990: Monthly as recommended by MISA for characterization purposes [3]. 1991: Reduced to quarterly after self-monitoring [3]. 2012: Increased to monthly as this parameter is useful as a gross indicator of effluent quality to be monitored at an increased frequency [4]. Sample Type: 24-hour composite is representative of the day's effluent which may vary based on discharges into the Process Outfall collection System. 2. N/A
8	Total Suspended Solids (TSS) No Treatment	p	Monitored: (1990 - present) p: 1990: Core parameter required under MISA specifically for this location as a gross indicator of effluent quality [1].	M	Semi-annual 24hr composite ***	1. Frequency: 1990: Monthly as recommended by MISA for characterization purposes [3]. 1993: Reduced to quarterly after characterization in order to capture seasonal variation [6]. 2016: Reduced to Semi-annual as results are consistently very low [5]. Sample Type: 24-hour composite is representative of the day's effluent which may vary based on discharges into the Process Outfall collection System. 2. N/A
9	Aluminium, Unfiltered Total No Treatment	p	Monitored: (1990 - present) p: 1990: (Metals) Core parameter required under MISA specifically for this location [1].	M	Semi-annual 24hr composite ***	1. Frequency: 1990: Monthly as recommended by MISA for characterization purposes [3]. 1991: Reduced to quarterly after characterization in order to capture seasonal variation [4]. 2016: Reduced to Semi-annual as results are consistent with background levels [5]. Sample Type: 24-hour composite is representative of the day's effluent which may vary based on discharges into the Process Outfall collection System. 2. N/A
9	Boron, Unfiltered Total No Treatment	q	Monitored: (2010 – present) q: 2010: Added to align with ORC sampling in order to align parameters between ORC and PRO for comparison purposes. Also results are available for all of ATG 9 due to analytical method being used [7].	M	Semi-annual 24hr composite ***	1. Frequency: 2010: Quarterly to align with PRO sampling in place to capture seasonal variation [7]. 2016: Reduced to Semi-annual as results are consistently at or below the detection limit [5]. Sample Type: 24-hour composite is representative of the day's effluent which may vary based on discharges into the Process Outfall collection System.

REDACTED

Process Outfall (PRO) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
						2. N/A
9	Cadmium, Unfiltered Total No Treatment	q	Monitored: (2010 – present) q: 2010: Added to align with ORC sampling in order to align parameters between ORC and PRO for comparison purposes. Also results are available for all of ATG 9 due to analytical method being used [7].	M	Semi-annual 24hr composite ***	1. Frequency: 2010: Quarterly to align with PRO sampling in place to capture seasonal variation [7]. 2016: Reduced to Semi-annual as results are consistently very low [5]. Sample Type: 24-hour composite is representative of the day's effluent which may vary based on discharges into the Process Outfall collection System. 2. N/A
9	Chromium & Lead & Lithium & Nickel & Vanadium Unfiltered Totals No Treatment	q	Monitored: (2010 – present) q: 2010: Added to align with ORC sampling in order to align parameters between ORC and PRO for comparison purposes. Also results are available for all of ATG 9 due to analytical method being used [7].	M	Semi-annual 24hr composite ***	1. Frequency: 2010: Quarterly to align with PRO sampling in place to capture seasonal variation [7]. 2016: Reduced to Semi-annual as results are consistently below the detection limit [5]. Sample Type: 24-hour composite is representative of the day's effluent which may vary based on discharges into the Process Outfall collection System. 2. N/A
9	Copper, Unfiltered Total No Treatment	p	Monitored: (1990-present) p: 1990: (Metals) Core parameter required under MISA specifically for this location [1].	M	Semi-annual 24hr composite ***	1. Frequency: 1990: Monthly as recommended by MISA for characterization purposes [3]. 1991: Reduced to quarterly after characterization in order to capture seasonal variation [4]. 2016: Reduced to Semi-annual as results are consistently very low [5]. Sample Type: 2. N/A

REDACTED

Process Outfall (PRO) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
9	Silver, Unfiltered Total No Treatment	N/A	Not Monitored: (2010 – 2014) 2010: Added to align with ORC sampling in order to align parameters between ORC and PRO for comparison purposes [7]. 2014: Removed as never detected either at PRO or ORC and not a suspected contaminant on site [8].	N/A	N/A	1. Frequency: 2010: Quarterly to align with PRO sampling in place to capture seasonal variation [7]. 2014: Removed [8]. 2. N/A
9	Strontium, Unfiltered Total No Treatment	q	Monitored: (2010 – present) q: 2010: Added to align with ORC sampling in order to align parameters between ORC and PRO for comparison purposes. Also results are available for all of ATG 9 due to analytical method being used [7].	M	Semi-annual 24hr composite ***	1. Frequency: 2010: Quarterly to align with PRO sampling in place to capture seasonal variation [7]. 2016: Reduced to Semi-annual as results are consistently similar to background concentrations [5]. Sample Type: 24-hour composite is representative of the day's effluent which may vary based on discharges into the Process Outfall collection System. 2. N/A
9	Zinc, Unfiltered Total No Treatment	p	Monitored: (1990-present) p: 1990: (Metals) Core parameter required under MISA specifically for this location [1].	M	Semi-annual 24hr composite ***	1. Frequency: 1990: Monthly as recommended by MISA for characterization purposes [3]. 1991: Reduced to quarterly after characterization in order to capture seasonal variation [4]. 2016: Reduced to Semi-annual as results are consistently very low [5]. Sample Type: 24-hour composite is representative of the day's effluent which may vary based on discharges into the Process Outfall collection System. 2. N/A
9a	Iron, Unfiltered Total No Treatment	p	Monitored: (1990-present) p: 1990: (Metals) Core parameter required under MISA specifically for this location [1].	M	Semi-annual 24hr composite ***	1. Frequency: 1990: Monthly as recommended by MISA for characterization purposes [3]. 1991: Reduced to quarterly after characterization in order to capture seasonal variation [4]. 2016: Reduced to Semi-annual as results are consistent with background values [5]. Sample Type: 24 hour composite is representative of the day's effluent which may vary based on discharges into the Process Outfall collection System. 2. N/A

REDACTED

Process Outfall (PRO) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
9a	Uranium, Unfiltered Total No Treatment	q	Monitored: (2007-present) q: 2007: Added based on SRC comment as EnvP was monitoring this in the radioactive program but not the non-radioactive program [9].	M	Semi-annual 24hr composite ***	1. Frequency: 2010: Quarterly to align with PRO sampling in place to capture seasonal variation [7]. 2016: Reduced to Semi-annual as results are consistently very low [5]. Sample Type: 24-hour composite is representative of the day's effluent which may vary based on discharges into the Process Outfall collection System. 2. N/A
12	Mercury, Unfiltered Total No Treatment	i, q	Monitored: (2001-present) q: 2001: Added in order to determine the effect, if any, of the WTC discharge into the Process Outfall [10]. i: Identified as a COPC (screened in) in 2024 ERA – Table 25 [19].	M	Monthly 24hr composite ***	1. Frequency: 2001: Daily and weekly were felt to be too frequent as source is not that frequent. Monthly was felt to be appropriate as discharges from WTC were taking place at least once per month and each batch discharged is monitored for mercury [10]. Sample Type: 24-hour composite is representative of the day's effluent which may vary based on discharges into the Process Outfall collection System. 2. N/A
14	Phenolics, Unfiltered React No Treatment	p	Monitored: (1990-present) p: 1990: Core parameter required under MISA specifically for this location due to known source in the WTC_LWE effluent being discharged to this waste stream [1].	M	Quarterly 24hr composite ***	1. Frequency: 1990: Monthly as recommended by MISA for characterization purposes [3]. 1991: Reduced to quarterly after characterization in order to capture any seasonal variability and to serve as a screening of known source [4]. Quarterly was felt to be appropriate as each batch from the WTC is monitored for phenolics. Sample Type: 24-hour composite is representative of the day's effluent which may vary based on discharges into the Process Outfall collection System. 2. N/A
25	Solvent Extractables No Treatment	p	Monitored: (1990-present) p: 1990: Core parameter required under MISA specifically for this location [1].	M	Semi-annual 24hr composite ***	1. Frequency: 1990: Monthly as recommended by MISA for characterization purposes [3]. 1991: Reduced to quarterly after characterization in order to capture seasonal variation [4]. 2016: Reduced to Semi-annual as results are consistently very low [5]. Sample Type: 24-hour composite is representative of the day's effluent which may vary based on discharges into the Process Outfall collection System. 2. N/A
31	Total Residual Chlorine	N/A	Not Monitored: (was from 1990 – 2019)	N/A	N/A	1. Frequency: 1990: Daily as chlorination was taking place daily [3].

REDACTED

Process Outfall (PRO) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
	N/A		p: 1990: Core parameter under MISA for Process effluents which use chlorine for disinfection or defouling [1]. i: 2012: Parameter with a potential risk above acceptable exposure thresholds in 2012 ERA [11]. 2019: Removed as disinfection through chlorination is no longer taking place, therefore chlorine is no longer a source and monitoring is no longer required [12].			2001: Changed to per event when daily chlorination of their effluent stream stopped and instead a twice per week shock chlorination was established [10]. 2019: Removed [12]. 2. N/A
--	Flow Rate (m^3/day) N/A	j, p, q	Monitored: (1990 - present) j: Flow rate is needed to determine dilution factor for use in risk assessment. p: 1990: Core physical characteristic under MISA for process effluents; used to determine loading from the source [1]. q: Global Sustainability Standards Board, Global Reporting Initiative 303: Water and Effluent 2018 [16].	E	Daily N/A	1. Frequency: 1990: Daily required under MISA and variable based on site operations [3]. 2. The cost and effort that would be required to implement and carry out empirical flow monitoring capability is not justified given that the dominant upstream effluent contaminant contributor [redacted] are subject to empirical volume measurements (tank level readings).
95	Temperature Effluent Maximum & Temperature Rise Mean N/A	N/A	Not Monitored: (was from 1990 - 2018) p: 1990: Core physical characteristic measuring any thermal effects of OTCW systems on aquatic environment [1]. 2018: Removed as the shutdown of NRU has removed the thermal emissions concern from the PRO Outfall [12].	N/A	N/A	1. Frequency: 1990: Daily required under MISA and variable based on site operations as well as natural changes in influent water temperature [3]. 2018: Removed [12]. N/A

REDACTED

Process Outfall (PRO) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
--	Acute Rainbow Trout Toxicity Testing N/A	h	Monitored: (2018 – present) h: 2018: REGDOC 2.9.1: "the licensee shall ensure that the effluent and emission monitoring demonstrate that controlled releases to water frequented by fish are not acutely toxic" [13], [14]. NOTE: Multi-concentration tests are triggered in the event of a single concentration test failure. ****	M	Quarterly **** Grab	1. Frequency: 2018: Quarterly as the source of effluent is primarily river water and quarterly will capture any seasonal variation [13]. Quarterly also aligns with sampling frequency required for the Sewage Treatment Plant under the WSER [15]. 2024: Failure of a mortality single concentration test now requires *an additional LC50 test without delay*, followed by the bi-weekly LC50 tests, until three consecutive passes are achieved under the WSER for STP effluent. This approach is being adopted for all effluent streams requiring toxicity testing, including PRO [18]. Sample Type: Grab sample again aligns with that specified by the *Wastewater Systems Effluent Regulations* [15] for the Sewage Treatment Plant. 2. N/A
--	Mortality test additional suite: total and dissolved metals, anions (nitrate, nitrite, sulphate, phosphate, chloride, fluoride), total suspended solids, total dissolved solids, dissolved organic carbon, total organic carbon, total ammonia, unionized ammonia, sulphide, alkalinity,	q	Monitored: (2024 – present) q: Monitoring commenced to align with the acutely toxicity tests in efforts to help identify the cause of toxicity, if toxicity were to occur.	M	Quarterly **** Grab	1. Frequency: 2024: Quarterly - taken at the same time as toxicity tests. Sample Type: Grab sample to align with the sample type of the acute toxicity testing samples being taken. 2. N/A

REDACTED

Process Outfall (PRO) *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
	hardness, biological oxygen demand, chemical oxygen demand, carbonaceous oxygen demand)					

Notes:

OTCW - Once Through Cooling Water; ORC - Ottawa River Clearwell; WTC - Waste Treatment Centre; ATG - Analytical Test Group; MISA - Municipal/Industrial Strategy for Abatement

* Current as of issuing date of document. Always refer to the latest version of EVMP Monitoring Schedule (CRL-509200-062-000-0004).

** See Table 15 *Parameter Monitoring Criteria for the Effluent Verification Monitoring Program*

*** Automatic sampler in [redacted] (shared with radioactive EVMP). Daily composite sample of a fixed volume every 15 minutes (not flow proportionate) over a 24 hour period (8:30am to 8:30am the following day). Monthly and quarterly samples are on set day of month or quarter. This interval is adequate to capture any changes in operations such as: equipment cooling water additions or subtractions (e.g. start-up of AC units in warm season); routine batch discharges from facilities (e.g. WTC_LWE) or non-routine batch discharges (e.g. manhole pump-outs) as none are expected to occur in less than 15 minutes.

**** Toxicity Testing - Failure of a mortality single concentration test will result in an additional LC50 test without delay, followed by bi-weekly LC50 tests, until three consecutive passes are achieved.

References:

[1] *MISA Liquid Effluent Monitoring at CRL: Summary of Monitoring Results for the Period 1990 June to 1991 May*, RC-809, 1992 March. 14601444
[2] *Nuclear Research and Testing Establishment Operating Licence and Handbook: Chalk River Laboratories,* NRTEOL-LCH-01, 2011 November.
[3] *The Development Document for the Effluent Monitoring Regulation for the Electric Power Generation Sector,* MISA, 1990.
[4] *Non-Radiological Liquid Effluent Monitoring at CRL: Summary of the Monitoring Results for the Period 1991 May to 1992 December,* RC-1086, 1993 December. 40793178
[5] *Effluent Sampling Schedule for CRL – Liquid (Non-Radiological),* CRL-509200-062-000-0004, Rev3, 2016 January. 22730333
[6] *Non-Radiological Liquid Effluent Monitoring at CRL: Results for the Period 1993 January to December,* NSN-ESRSD-117, 1995 January. 22506084
[7] *Non-Radiological Program Review in 2010,* CRL-509244-QAPR-001, 2011 April. 22425224
[8] *Non-Radiological Monitoring Schedule for CRL,* CRL-509200-062-000-0001, Rev6, 2013 December. 23651723
[9] *SRC Acceptance of the Annual Program Report - Non-Radiological Effluent Monitoring in 2005 at Chalk River Laboratories,* SRCM-62-059, 2006 August.
[10] *Non-radiological Emission Monitoring at CRL: The Results for 2001,* AECL-MISC-421-01, 2002 March. 22385849
[11] *Environmental Risk Assessment of Chalk River Laboratories-2012,* EnvP-509220-REPT-001, 2013 December. 22319006
[12] *Effluent Verification Monitoring Program Sampling Schedule for CRL & NPD,* CRL-509200-062-000-0004, Rev12, 2018 Dec 14. 42016713
[13] *Effluent Verification Monitoring Program Sampling Schedule for CRL & NPD,* CRL-509200-062-000-0004, Rev11, 2018 Feb 08. 40635477
[14] *Environmental Protection: Environmental Principles, Assessments and Protection Measures,* version 1.1, CNSC, REGDOC-2.9.1, 2017 April.
[15] *Wastewater Systems Effluent Regulations,* SOR/2012-139, 2012 June.
[16] Global Sustainability Standards Board, *Global Reporting Initiative 303: Water and Effluent,* 2018.
[17] *Effluent Verification Monitoring Program Sampling Schedule for CRL & NPD,* CRL-509200-062-000-0004, Rev22, 2022 Dec. 59487716
[18] Canada Gazette*, Regulations Amending the Wastewater Systems Effluent Regulations*, SOR/2024-97, 2024 May 27 Canada Gazette
[19] EnvP-509220-REPT-006396, *2024 Environmental Risk Assessment of Chalk River Laboratories*, Rev 0, 2025 January 69264691

REDACTED

4.3.2.2.2 Storm Outfalls

4.3.2.2.2.1 [redacted] Storm Outfall

Table 23: Detailed Design - [redacted] Storm Outfall

Description: Storm water is released to the Ottawa River after passing through a wet pond which allows for the settling of sediments prior to discharge as well as have the ability to hold back water from being discharged in the event of an incident affecting the stormwater.
Source Term: The [redacted] Storm Outfall collection system extends to a number of buildings in the Supervised Area and the Controlled Area. It collects surface runoff from a series of roads in the built-up area, run-off from some site parking lots, cooling water and roof and foundation drainage.
Note: Historically, the primary source of the volume of [redacted] effluent was not from the above mentioned sources, but instead from a stream entering the site which is then channeled through this series of pipes. This stream was known as [redacted] stream and is not monitored independently of [redacted] storm outfall. This stream consists of natural runoff from a watershed northwest of the built-up-area of the site but is primarily fed by a CRL created source. This anthropogenic source is fire water which is being pumped up from the river into a holding tower northwest of the site and then released continuously to the drainage basin of [redacted] stream. This continuous "overflow" is intentional in order to prevent freezing and fouling of the fire water. In 2013 December, a construction project was completed which redirected all of the [redacted] stream flow from entering the [redacted] storm outfall collection system and instead now by-passes the built-up are of the site by flowing directly into [redacted] stream before entering the Ottawa River. Note: [redacted] Stream is a monitoring point under the CRL Non-Radioactive Environmental Monitoring Program.
Potential Non-radiological Contaminants: Solids, oil/grease, chlorides and metals.
Discharge Characteristics: Continuous discharge. The flow rate is variable as it is dependent on local precipitation events and related weather conditions (snow melting). Flow is monitored with an on-line flow meter which takes measurements every 15 minutes and is reported as a daily average.
Effluent Treatment: Settling Ponds. Note: There are also upstream stormsceptors located in the parking lots which are designed to prevent petroleum products and sand/dirt from entering this storm collection system.
Monitoring Strategy: This monitoring point was part of the original MISA program where it is classified as a "*Storm Sewer";* routine monitoring began in 1990 and has been monitored consistently since then with minor changes to the parameters and frequency of monitoring. This final effluent monitoring location is at the outfall of the final pond prior to entering the Ottawa River. Semi-annual (spring and fall) to align with all storm water monitoring on the site. This strategy is intended to capture high flows in spring and lower flows in fall.
Note: There are a number of barriers in place across the site for this collection system including: labelling of storm drains in buildings; CRL has acceptability criteria which must be met for liquid discharges entering these drains; the site has a well-established spill response (both notification and clean-up); and, there are precautions in place in the more high risk areas (i.e. stormsceptors in key locations).

REDACTED

[redacted] Storm Outfall *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
3	pH No Treatment	p	Monitored: (1990 – present) p: 1990: Core parameter required under MISA specifically for this location and other storm outfalls as a gross indicator of effluent quality [1], [5]. p: 2014 Note: Confirmed to be required parameter under the *Storm Water Control Study* (Reg 215/95), therefore monitoring kept [6].	M	Semi-annual Grab	1. Frequency: 1990: Monthly (within the few hours following a rain event (>5mm/day) or a thaw, if possible) in efforts to characterize the stream [1]. 1991: Reduced to semi-annual after characterization of effluent was complete [2]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
4b	Nitrates, Total Filter Reactive N/A	N/A	Not Monitored: (was from 1990 – 2014) p: 1990: Core parameter required under MISA specifically for this location [1], [5]. 2014: Removed as not a required monitoring parameter under the *Storm Water Control Study* (Reg 215/95) and results have shown very low and seemingly stable concentrations over a number of years which were well below the CWQG [6].	N/A	N/A	1. Frequency: 1990: Monthly (within the few hours following a rain event (>5mm/day) or a thaw, if possible) [1]. 1991: Reduced to semi-annual after characterization of effluent was complete [2]. 2014: Removed [6]. 2. N/A
5a	Dissolved Organic Carbon (DOC) N/A	N/A	Not Monitored: (was from 1990 – 2014) p: 1990: Core parameter required under MISA specifically for this location [1]. 2014: Removed as not a required monitoring parameter under the *Storm Water Control Study* [5]; consistent concentrations observed over many years; and very similar to levels seen in river water (background) [6].	N/A	N/A	1. Frequency: 1990: Monthly (within the few hours following a rain event (>5mm/day) or a thaw, if possible) in efforts to characterize the stream [1]. 1991: Reduced to semi-annual after characterization of effluent was complete [2]. 2014: Removed [6]. 2. N/A
5b	Total Organic Carbon (TOC) N/A	N/A	Not Monitored: (was from 1990 – 2014) p: 1990: Core parameter required under MISA specifically for this location [1], [5]. 2014: Removed as not a required monitoring parameter under the *Storm Water Control Study* [5]; consistent concentrations observed over many years; and very similar to levels seen in river water (background) [6].	N/A	N/A	1. Frequency: 1990: Monthly (within the few hours following a rain event (>5mm/day) or a thaw, if possible) in efforts to characterize the stream [1]. 1991: Reduced to semi-annual after characterization of effluent was complete [2]. 2014: Removed [6]. 2. N/A

REDACTED

[redacted] Storm Outfall *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
6	Phosphorus, Unfiltered Total No Treatment	p, q	Monitored: (1990 – present) p: 1990: Core parameter required under MISA specifically for this location [1], [5]. q: 2014 Note: Although not part of the required monitoring parameters under the *Storm Water Control Study* [5], some variability in the results over the years indicate a potential source of contamination; therefore the parameter was kept in routine monitoring program [6].	M	Semi-annual Grab	1. Frequency: 1990: Monthly (within the few hours following a rain event (>5mm/day) or a thaw, if possible) in efforts to characterize the stream [1]. 1991: Reduced to semi-annual after characterization of effluent was complete [2]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
7	Conductivity, @[redacted] No Treatment	p, q	Monitored: (1990 – present) p: 1990: Core parameter required under MISA specifically for this location as a gross indicator of effluent quality [1], [5]. q: 2014 Note: Although not a required monitoring parameter under the *Storm Water Control Study* [5], this parameter was kept under the routine monitoring program as it is a good indicator of water quality and is used to screen for other potential issues with parameters not under the routine monitoring program [6].	M	Semi-annual Grab	1. Frequency: 1990: Monthly (within the few hours following a rain event (>5mm/day) or a thaw, if possible) in efforts to characterize the stream [1]. 1991: Reduced to semi-annual after characterization of effluent was complete [2]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
8	Total Suspended Solids (TSS) Settling pond	i, p	Monitored: (1990 – present) p: 1990: Core parameter required under MISA specifically for this location as a gross indicator of effluent quality [1], [5]. p: 2014 Note: Confirmed to be a required parameter under the *Storm Water Control Study* [5]. i: Identified as a COPC (screened in) in 2024 ERA – Table 46 [11]. Would indicate a potential upset in the operation of the settling pond designed to remove suspended solids.	M	Monthly Grab	1. Frequency: 1990: Monthly (within the few hours following a rain event (>5mm/day) or a thaw, if possible) in efforts to characterize the stream [1]. 1991: Reduced to semi-annual after characterization of effluent was complete [2]. 2022: Increased to monthly in order to capture variability in the effluent as an indication of the operation of the pond [11]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A

REDACTED

[redacted] Storm Outfall *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
9	Aluminium, Unfiltered Total No Treatment	p, q	Monitored: (1990 – present) p: 1990: Core parameter required under MISA specifically for this location [1], [5]. q: 2014: Although not part of the required monitoring parameters under the *Storm Water Control Study* [5], there has been relatively high concentrations observed over the past years with a large degree of variability and Al is known to be high in background concentrations in this area, therefore the parameter was kept in the routine monitoring program [6].	M	Semi-annual Grab	1. Frequency: 1990: Monthly (within the few hours following a rain event (>5mm/day) or a thaw, if possible) [1]. 1991: Reduced to semi-annual after characterization of effluent was complete [2]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
9	Cadmium, Unfiltered Total No Treatment	i	Monitored: (2025 - present) i: Identified as a COPC (screened in) in 2024 ERA – Table 46 [11].	M	Semi-annual Grab	1. Frequency: 2025: Semi-annual to align with all other stormwater monitoring under the program [12]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
9	Copper, Unfiltered Total No Treatment	i, p, q	Monitored: (1990 – present) p: 1990: Core parameter required under MISA specifically for this location [1], [5]. q: 2014: Although not part of the required monitoring parameters under the *Storm Water Control Study* [5], there are detectable concentrations with some variability noted over the past number of years. All resulting concentrations are still well below the CNL Guideline however, due to the potential source in piping and knowing that when the analysis is run for ATG9, it includes Cu, the parameter was kept in routine monitoring program [6]. i: Identified as a COPC (screened in) in 2024 ERA – Table 46 [11].	M	Semi-annual Grab	1. Frequency: 1990: Monthly (within the few hours following a rain event (>5mm/day) or a thaw, if possible) in efforts to characterize the stream [1]. 1991: Reduced to semi-annual after characterization of effluent was complete [2]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
9	Lead, Unfiltered Total No Treatment	i, q	Monitored: (1997 – present) q: 1997: Added due to the lead shop being located in this storm sewer's drainage basin. q: 2014 Note: Despite not being a required monitoring	M	Semi-annual Grab	1. Frequency: 1997: Semi-annual to align with all other monitoring at this location [4]. Sample Type: A grab sample is considered representative of the final

REDACTED

[redacted] Storm Outfall *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
			parameters under the *Storm Water Control Study* [5], and concentrations observed over many years being at or below the LMDL, since lead is widely used across the site and the lead handling shop remains in this storm sewer's drainage area and the analysis for other metals in ATG 9 are already being completed, this parameter was kept in the routine monitoring program [6]. Note: Lead shop now decommissioned but keeping monitoring with rest of ATG 9. i: Identified as a COPC (screened in) in 2024 ERA – Table 46 [11].			effluent. 2. N/A
9	Zinc, Unfiltered Total No Treatment	i, p, q	Monitored: (1990 – present) p: 1990: Core parameter required under MISA specifically for this location [1], [5]. q: 2014 Note: Although not part of the required monitoring parameters under the *Storm Water Control Study* [5], there are detectable concentrations with some variability noted over the past number of years. All resulting concentrations are still well below the CNL Guideline however, due to the potential source in piping and knowing that when the analysis is completed for ATG 9, it includes Zn, the parameter was kept in routine monitoring program [6]. i: Identified as a COPC (screened in) in 2024 ERA – Table 46 [11].	M	Semi-annual Grab	1. Frequency: 1990: Monthly (within the few hours following a rain event (>5mm/day) or a thaw, if possible) in efforts to characterize the stream [1]. 1991: Reduced to semi-annual after characterization of effluent was complete [2]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
9a	Iron, Unfiltered Total No Treatment	p, n	Monitored: (1990 – present) p: 1990: Core parameter required under MISA specifically for this location [1], [5]. n: 2014 Note: Confirmed to be a required parameter under the *Storm Water Control Study* [5]; this requirement and consistently detectable results which occasionally exceed the CNL Guideline meant that this parameter was kept under the routine monitoring program [6].	M	Semi-annual Grab	1. Frequency: 1990: Monthly (within the few hours following a rain event (>5mm/day) or a thaw, if possible) in efforts to characterize the stream [1]. 1991: Reduced to semi-annual after characterization of effluent was complete [2]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A

REDACTED

[redacted] Storm Outfall *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
16	Chloroform N/A	N/A	Not Monitored: (was in 1990 – 2017) p: 1990: Monitored at major storm sewers across site which are known to collect cooling water etc. as it is present in cleaning products used across the site and therefore there is a potential for it to enter these storm systems [1], [5]. q: 2014 Note: Although not a required parameter for stormwater monitoring under Ontario Regulation 215/95 [5], monitoring of this effluent continues to show consistent levels above the CWQG and it is a known result of site operations, therefore it has been kept in the routine monitoring program [6]. 2017: Removed as all results are well below the ERA Benchmark value [7].	N/A	N/A	1. Frequency: 1990: Monthly (within the few hours following a rain event (>5mm/day) or a thaw, if possible) in efforts to characterize the stream [1]. 1991: Reduced to semi-annual after characterization of effluent was complete [2]. 2017: Removed [7]. 2. N/A
25	Solvent Extractables Settling Ponds	p, q	Monitored: (1990 – present) p: 1990: Core parameter required under MISA specifically for this location, therefore added to monitoring program [1], [5]. q: 2014 Note: Confirmed to be a required parameter for the *Storm Water Control Study* (Reg 215/95). Some variability has been noted in monitoring results over the years but all results were well below CNL Guideline; routine operations are a known potential source on site, therefore it has been kept in the routine monitoring program [6].	M	Semi-annual Grab	1. Frequency: 1990: Monthly (within the few hours following a rain event (>5mm/day) or a thaw, if possible) in efforts to characterize the stream [1]. 1991: Reduced to semi-annual after characterization of effluent was complete [2]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
27	Polychlorinated Biphenyls (PCB) N/A	N/A	Not Monitored: (was from 1990 – 1997) p: 1990: Required to be monitored at this location by MISA in efforts to check for contamination resulting from a leak or spill [1], [5]. 1997: Removed from monitoring as did not detect any levels of concern (at or below LMDL) and no known source on site [4]. 2014: Although part of the required monitoring parameters under the *Storm Water Control Study* (Reg 215/95), the parameter is not part of the routine	N/A	N/A	1. Frequency: 1990: Quarterly as a scan [1]. 1997: Removed [4]. 2. N/A

REDACTED

[redacted] Storm Outfall *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
			program based on non-detectable previous monitoring results in all major storm sewers on site, including 03 storm sewer, and the fact that there is no known or suspected source on site. Also, being monitored under the GWMP with no contamination noted [6].			
30	Chloride No Treatment	i, q, n	Monitored: (2007 – present) q: 2007: Added to determine road salt effects, if any, on effluent (based on an SRC Comment) [3], [5]. n: 2014 Note: Although not a required parameter under Reg 215/95 and relatively low concentrations have been observed to date, it is a known contaminant source currently being used on site, therefore kept in routine monitoring program [6]. i: Identified as a COPC (screened in) in 2024 ERA – Table 46 [11].	M	Semi-annual Grab	1. Frequency: 2007: Semi-annual to align with all other monitoring at this location [3]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
35	Escherichia coli (E. coli) No Treatment	q	Monitored: (2017 – present) q: 2017: Added for due diligence as there is a lot of construction taking place in this portion of the site at this time and elevated levels may be able to help identify a sanitary leak to this storm sewer [8].	M	Weekly Grab	1. Frequency: 2017: Weekly as trying to identify an event from construction which is ongoing [8]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
--	Flow Rate (m^3/day) N/A	p, q	Monitored: (1990 – present) p: 1990: Core physical characteristic under MISA used to determine loading from the source [1], [5]. Note: Confirmed to be a required parameter under the *Storm Water Control Study* [5] to determine loading from the source. q: 2020: Monitoring is required to potentially report under the Global Reporting Initiative – Water [9].	M	Daily Continuous	1. Frequency: 1990: Monthly (within the few hours following a rain event (>5mm/day) or a thaw, if possible) in efforts to characterize the stream [1]. 1991: Reduced to semi-annual after characterization of effluent was complete [2]. 2022 – Flow meter installed in 2022 October. Flow data is collected every 10 minutes, and daily averages are calculated and used for loading as required. The new flow measurements were applied for the [redacted] Storm Outfall starting in the 2023 CY [10]. Sample Type: Continuous measurement provides thorough characterization of effluent stream. 2. N/A

REDACTED

[redacted] Storm Outfall *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**

Notes:

LMDL - Laboratory Method Detection Level; SRC - Safety Review Committee; CRL - Chalk River Laboratory; CWQG - Canadian Water Quality Guideline; MISA - Municipal/Industrial Strategy for Abatement; ATG - Analytical Test Group; GWMP – Groundwater Monitoring Program.

* Current as of issuing date of document. Always refer to the latest version of EVMP Monitoring Schedule (CRL-509200-062-000-0004).

** See Table 15 *Parameter Monitoring Criteria for the Effluent Verification Monitoring Program*

References:

[1] *MISA Liquid Effluent Monitoring at CRL: Summary of Monitoring Results for the Period 1990 June to 1991 May*, RC-809, 1992 March. 14601444

[2] *Non-Radiological Liquid Effluent Monitoring at CRL: Summary of the Monitoring Results for the Period 1991 May to 1992 December,* RC-1086, 1993 December. 40793178

[3] *SRC Acceptance of the Annual Program Report - Non-Radiological Effluent Monitoring in 2005 at Chalk River Laboratories,* SRCM-62-059, AECL-MISC-397-97, 2006 August.

[4] *Non-Radiological Liquid Effluent Monitoring at CRL: The Results for 1997*, 1998 September.

[5] *Effluent Monitoring and Effluent Limits - Electric Power Generation Sector,* Ontario Regulation 215/95.

[6] *Non-Radioactive Monitoring Schedule for CRL,* CRL-509200-062-000-0001, Rev 6, 2013 December. 23651723

[7] *Effluent Verification Monitoring Program Sampling Schedule for CRL,* CRL-509200-062-000-0004, Rev 7, 2016 August. 22726453

[8] *Effluent Verification Monitoring Program Sampling Schedule for CRL,* CRL-509200-062-000-0004, Rev 10, 2017 August. 22732039

[9] *Global Sustainability Standards Board, Global Reporting Initiative 303: Water and Effluent,* 2018.

[10] *Effluent Verification Monitoring Program Sampling Schedule for CRL, NPD & DP,* Rev 22, 2022 Dec.

[11] EnvP-509220-REPT-006396, *2024 Environmental Risk Assessment of Chalk River Laboratories*, Rev 0, 2025 January 69264691

[12] Current CRL-509200-062-000-0004, *Effluent Verification Monitoring Program Sampling Schedule for CRL, NPD & DP* as of Plan update. 59487716

REDACTED

4.3.2.2.2.2 [redacted] Storm Outfall

Table 24: Detailed Design - [redacted] Storm Outfall

Description: The [redacted] Storm Outfall is on the northwest portion of the Controlled Area and is essentially an open ditch collecting a small area of local runoff.
Source Term: Note: Up until 2018 September, the [redacted] Storm Outfall collection system extended to a small number of buildings in the northern built-up portion of the Controlled Area. It collected surface runoff from a series of roads as well as some roof and foundation drainage, and discharged these to the Ottawa River. By September of 2018, as part of a larger site-wide Stormwater Diversion Project, all of the [redacted] Storm Outfall collection system had been re-routed to the [redacted] Storm Outfall collection system (which feeds into the [redacted] Storm Water retention pond prior to release to the Ottawa River via a 30 cm pipe). The remaining [redacted] Storm Outfall collects a small area of local runoff.
Potential Non-radiological Contaminants: Phosphorus, solids, oil/grease, chlorides and metals.
Discharge Characteristics: Continuous discharge. The flow rate is variable as it is dependent on local precipitation events and related weather conditions (snow melting). Monitoring is completed semi-annually and is approximately 150 m^3/day.
Effluent Treatment: None. The [redacted] Storm Outfall discharges directly into the Ottawa River with no prior treatment.
Monitoring Strategy: This final effluent monitoring location is prior to entering the Ottawa River. This monitoring point was part of the original MISA program where it is classified as a "*Storm Sewer";* Routine monitoring began in 1990 and has been monitored consistently since then.
Note: There are a number of barriers in place across the site for this collection system including a well-established spill response (both notification and clean-up).

[redacted] Storm Outfall *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
3	pH No Treatment	p	Monitored: (1990 – present) p: 1990: Core parameter required under MISA specifically for this location [1]. 2014 Note: Confirmed to be a required *Storm Water Control Study* parameter under Reg 215/95 [3], [4].	M	Semi-annual Grab	1. Frequency: 1990: Monthly (within the few hours following a rain event (>5mm/day) or a thaw, if possible) in efforts to characterize the stream [1]. 1991: Reduced to semi-annual after characterization of effluent was complete [2]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
4b	Nitrates, Total Filter Reactive N/A	N/A	Not Monitored: (was from 1990 – 2014) 1990: Core parameter required under MISA specifically for this location [1]. 2014: Removed as not a required monitoring parameter under the *Storm Water Control Study* (Reg 215/95); very low and seemingly stable concentrations over a number of years; and, well below the CWQG [3], [4].	N/A	N/A	1. Frequency: 1990: Monthly (within the few hours following a rain event (>5mm/day) or a thaw, if possible) in efforts to characterize the stream [1]. 1991: Reduced to semi-annual after characterization of effluent was complete [2]. 2014: Removed [3]. 2. N/A

REDACTED

[redacted] Storm Outfall *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
5a	Dissolved Organic Carbon (DOC) N/A	N/A	Not Monitored: (was from 1990 – 2014) p: 1990: Core parameter required under MISA specifically for this location [1]. 2014: Removed as not a required monitoring parameter under the *Storm Water Control Study* (Reg 215/95); very low and seemingly stable concentrations over a number of years; comparable concentration to background river water [3], [4].	N/A	N/A	1. Frequency: 1990: Monthly (within the few hours following a rain event (>5mm/day) or a thaw, if possible) in efforts to characterize the stream [1]. 1991: Reduced to semi-annual after characterization of effluent was complete [2]. 2014: Removed [3]. 2. N/A
5b	Total Organic Carbon (TOC) N/A	N/A	Not Monitored: (was from 1990 – 2014) p: 1990: Core parameter required under MISA specifically for this location [1]. 2014: Removed as not a required monitoring parameter under the *Storm Water Control Study* (Reg 215/95); very low and seemingly stable concentrations over a number of years; comparable concentration to background river water [3], [4].	N/A	N/A	1. Frequency: 1990: Monthly (within the few hours following a rain event (>5mm/day) or a thaw, if possible) in efforts to characterize the stream [1]. 1991: Reduced to semi-annual after characterization of effluent was complete [2]. 2014: Removed [3]. 2. N/A
6	Phosphorus, Unfiltered Total No Treatment	n, q	Monitored: (1990 – present) p: 1990: Core parameter required under MISA specifically for this location [1]. n, q: 2014 Note: Although not part of the required monitoring parameters under the *Storm Water Control Study* (Reg 215/95), variability in the results over the years indicate potential source of contamination [3], [4].	M	Semi-annual Grab	1. Frequency: 1990: Monthly (within the few hours following a rain event (>5mm/day) or a thaw, if possible) in efforts to characterize the stream [1]. 1991: Reduced to semi-annual after characterization of effluent was complete [2]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
7	Conductivity, @ [redacted] No Treatment	q	Monitored: (1990 – present) p: 1990: Core parameter required under MISA specifically for this location [1]. q: 2014 Note: Although not a required monitoring parameter under the *Storm Water Control Study* (Reg 215/95) this parameter was kept under the routine monitoring program as it is a good indicator of water quality and is used to screen for other potential issues with parameters not under the routine monitoring program [3], [4].	M	Semi-annual Grab	1. Frequency: 1990: Monthly (within the few hours following a rain event (>5mm/day) or a thaw, if possible) in efforts to characterize the stream [1]. 1991: Reduced to semi-annual after characterization of effluent was complete [2]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A

REDACTED

[redacted] Storm Outfall *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
8	Total Suspended Solids (TSS) No Treatment	p, n	Monitored: (1990 – present) p: 1990: Core parameter required under MISA specifically for this location [1]. p, n: 2014 Note: Confirmed to be a required parameter under the *Storm Water Control Study* (Reg 215/95); highly variable and known to exceed CNL Guidelines [3], [4].	M	Semi-annual Grab	1. Frequency: 1990: Monthly (within the few hours following a rain event (>5mm/day) or a thaw, if possible) in efforts to characterize the stream [1]. 1991: Reduced to semi-annual after characterization of effluent was complete [2]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
9	Aluminium, Unfiltered Total No Treatment	q	Monitored: (1990 – present) p: 1990: Core parameter required under MISA specifically for this location [1]. q: 2014 Note: Aluminium is not part of the required monitoring parameters under the *Storm Water Control Study* (Reg 215/95), there has been relatively high concentrations observed over the past years with a large degree of variability and Al is known to be high in background concentrations in this area [3], [4].	M	Semi-annual Grab	1. Frequency: 1990: Monthly (within the few hours following a rain event (>5mm/day) or a thaw, if possible) in efforts to characterize the stream [1]. 1991: Reduced to semi-annual after characterization of effluent was complete [2]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
9	Copper, Unfiltered Total No Treatment	q	Monitored: (1990 – present) p: 1990: Core parameter required under MISA specifically for this location [1]. q: 2014 Note: Copper is not part of the required monitoring parameters under the *Storm Water Control Study* (Reg 215/95) and there has some variability noted over the past few years. All resulting concentrations are relatively low however, when the analysis is run for Al, it is also run for Cu. Also, the potential source in piping is known [3], [4].	M	Semi-annual Grab	1. Frequency: 1990: Monthly (within the few hours following a rain event (>5mm/day) or a thaw, if possible) in efforts to characterize the stream [1]. 1991: Reduced to semi-annual after characterization of effluent was complete [2]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
9	Lead, Unfiltered Total No Treatment	q	Monitored: (2014 – present) q: 2014: Lead is not a required monitoring parameter under the *Storm Water Control Study* (Reg 215/95) and therefore has not been previously monitored at this location. Despite not being a required parameter, and the majority of storm sewers on site having < LMDL concentrations, the use of lead on site and the fact that that lead results are available through monitoring of	M	Semi-annual Grab	1. Frequency: 2014: Semi-annual being added to align with all other storm water monitoring [3]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A

REDACTED

[redacted] Storm Outfall *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
			other metals in ATG 9, justifies adding this parameter at this location [3], [4].			
9	Zinc, Unfiltered Total No Treatment	i, q	Monitored: (1990 – present) p: 1990: Core parameter required under MISA specifically for this location [1]. q: 2014 Note: Although not part of the required monitoring parameters under the *Storm Water Control Study* (Reg 215/95), there has some variability noted over the past few years. All resulting concentrations are relatively low however, when the analysis is run for Al, it is also run for Zn, therefore the parameter was kept in routine monitoring program. Also, the potential source in piping is known [3], [4]. i: Identified as a COPC (screened in) in 2024 ERA – Table 25 [7].	M	Semi-annual Grab	1. Frequency: 1990: Monthly (within the few hours following a rain event (>5mm/day) or a thaw, if possible) in efforts to characterize the stream [1]. 1991: Reduced to semi-annual after characterization of effluent was complete [2]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
9a	Iron, Unfiltered Total No Treatment	p, n	Monitored: (1990 – present) p: 1990: Core parameter required under MISA specifically for this location [1]. p, n: 2014 Note: Confirmed to be a required parameter under the *Storm Water Control Study* parameter under Reg 215/95; highly variable and known to exceed the CNL Guideline, therefore continue routine monitoring [3], [4].	M	Semi-annual Grab	1. Frequency: 1990: Monthly (within the few hours following a rain event (>5mm/day) or a thaw, if possible) in efforts to characterize the stream [1]. 1991: Reduced to semi-annual after characterization of effluent was complete [2]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
16	Chloroform	N/A	Not monitored: (was from 2014 – 2017) n: 2014: not previously measured as not a major storm sewer therefore not thought to be inputs into it from cleaning supplied used on site however, should screen for it as it is present in other site storm sewers [3]. 2017: Removed as all results are well below the ERA Benchmark value [6].	N/A	N/A	1. Frequency: 2014: Semi-annual in line with other stormwater monitoring [3]. 2017: Removed [6]. 2. N/A
25	Solvent Extractables No Treatment	p, n	Monitored: (1990 – present) p: 1990: Core parameter required under MISA specifically for this location [1]. p, n: 2014 Note: Confirmed to be a required parameter	M	Semi-annual Grab	1. Frequency: 1990: Monthly (within the few hours following a rain event (>5mm/day) or a thaw, if possible) in efforts to characterize the stream [1]. 1991: Reduced to semi-annual after characterization of effluent was

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[redacted] Storm Outfall *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
			under the *Storm Water Control Study* (Reg 215/95). Some variability noted in monitoring results over the years but all well below CNL Guideline; known potential source on site through routine operations therefore kept in routine program [3], [4].			complete [2]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
27	Polychlorinated Biphenyls (PCB) N/A	N/A	Not Monitored: As a result of being a required monitoring parameter in Reg 215/95 for storm sewers, monitoring of the site's largest storm sewers took place with no contamination found. There is no suspected or known source on site, therefore not added to the routine monitoring program. Also, being monitored under the GWMP with no contamination noted [5].	N/A	N/A	N/A
30	Chloride No Treatment	n, q	Monitored: (2014 – present) n, q: 2014: Added based on 2007 comment from SRC as known contaminant source currently being applied in the area [3].	M	Semi-annual Grab	1. Frequency: 2014: Semi-annual to align with all other stormwater monitoring of this effluent [3]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
--	Flow Rate (m^3/day) N/A	p	Monitored: (1990 – present) p: 1990: Core physical characteristic under MISA used to determine loading from the source [1]. Note Confirmed to be a required parameter under the *Storm Water Control Study (*Reg 215/95) to determine loading from the source [3], [4].	M	Semi-annual N/A	1. Frequency: 1990: Monthly (within the few hours following a rain event (>5mm/day) or a thaw, if possible) in efforts to characterize the stream [1]. 1991: Reduced to semi-annual after characterization of effluent was complete [2]. Sample Type: N/A - Dye dilution gauging is used to measure the flow rate. 2. N/A

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[redacted] Storm Outfall *						
ATG	Parameter Name Treatment	Parameter Criteria **	Justification for Monitoring (or not Monitoring) of Parameter	Measurement or Estimation	Monitoring Frequency & Sample Type	Justification for: 1. Monitoring Frequency & Sample Type 2. Estimation over Measurement

Notes:

LMDL - Laboratory Method Detection Level; SRC - Safety Review Committee; CRL - Chalk River Laboratory; CWQG - Canadian Water Quality Guideline; MISA - Municipal/Industrial Strategy for Abatement; ATG - Analytical Test Group; GWMP – Groundwater Monitoring Program.

* Current as of issuing date of document. Always refer to the latest version of EVMP Monitoring Schedule (CRL-509200-062-000-0004).

** See Table 15 *Parameter Monitoring Criteria for the Effluent Verification Monitoring Program*

References:

[1] *MISA Liquid Effluent Monitoring at CRL: Summary of Monitoring Results for the Period 1990 June to 1991 May*, RC-809, 1992 March. 14601444

[2] *Non-Radiological Liquid Effluent Monitoring at CRL: Summary of the Monitoring Results for the Period 1991 May to 1992 December*, RC-1086, 1993 December. 40793178

[3] *Non-Radioactive Monitoring Schedule for CRL,* CRL-509200-062-000-0001, Rev 6, 2013 December. 23651723

[4] *Effluent Monitoring and Effluent Limits - Electric Power Generation Sector,* Ontario Regulation 215/95.

[5] *Non-Radiological Liquid Effluent Monitoring at CRL: The Results for 1997*, AECL-MISC-397-97, 1998 September. 22869405

[6] *Effluent Verification Monitoring Program Sampling Schedule for CRL*, CRL-509200-062-000-0004, Rev 7, 2016 August. 22726453

[7] EnvP-509220-REPT-006396, *2024 Environmental Risk Assessment of Chalk River Laboratories*, Rev 0, 2025 January 69264691

REDACTED

4.3.2.2.2.3 [redacted] Storm Outfall

Table 25: Detailed Design - [redacted] Storm Outfall

Description: Storm water discharges to the Ottawa River after passing through a series of two dry ponds which allow for the settling of sediments prior to discharge as well as have the ability to hold back water from being discharged in the event of an incident affecting the stormwater.
Source Term: The [redacted] Storm Outfall collection system receives runoff from a small portion of the northern built-up portion of the Controlled Area (runoff from [redacted] and supervised area. The collection consists of surface runoff along roads in the built-up area, some cooling water and roof and foundation drainage.
Note: In 2018, a construction project was completed which redirected these lower elevation stormwater effluent pipes to a set of refurbished dry ponds prior to their release from the ponds into the Ottawa River. Prior to 2019, this effluent went out to the environment through either [redacted] Storm Outfall or an unmonitored effluent stream.
Potential Non-radiological Contaminants: Phosphorus, solids, oil/grease, chlorides and metals.
Discharge Characteristics: Continuous discharge. The flow rate is variable as it is dependent on local precipitation events and related weather conditions (snow melting). Monitoring is completed semi-annually and is approximately 22 m^3/day.
Effluent Treatment: Settling Pond.
Monitoring Strategy: This final effluent monitoring location is at the outfall of the final pond prior to entering the Ottawa River. Semi-annual (spring and fall) monitoring is in place to align with all storm water monitoring on the site. This strategy is intended to capture high flows in spring and lower flows in fall. The new station, [redacted] was added to the monitoring program in August 2018.
Note: There are a number of barriers in place across the site for this collection system including: labelling of storm drains in buildings; CRL has acceptability criteria which must be met for liquid discharges entering these drains; the site has a well-established spill response (both notification and clean-up); and, there are precautions in place in the more high risk areas (i.e. stormsceptors in key locations).

[redacted] Storm Outfall *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
3	pH No treatment	p	Monitored: (2018 – present) p: 2018: Core parameter required under MISA for storm outfalls as a gross indicator of effluent quality [1]. Aligns with current monitoring of site storm waters.	M	Semi-Annual Grab	1. Frequency: 2018: Semi-annual (spring and fall) to align with all storm water monitoring on the site. Should capture high flows in spring and lower flows in fall [1]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A

REDACTED

[redacted] Storm Outfall *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
4b	Nitrates, Total Filter Reactive (Nitrate + Nitrite) No treatment	i	Monitored: (2025 – present) i: Identified as a COPC (screened in) in 2024 ERA – Table 46 [4].	M	Semi-Annual Grab	1. Frequency: 2025: Semi-annual (spring and fall) to align with all storm water monitoring on the site. Should capture high flows in spring and lower flows in fall. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
6	Phosphorus, Unfiltered Total No treatment	q	Monitored: (2018 – present) q: 2018: Although not part of the required monitoring parameters under the *Storm Water Control Study* (Reg 215/95) [2], a potential source of contamination exists in activities on site which include the use of soaps and some variability is evident in the monitoring results, therefore the parameter was included in routine monitoring program as with other storm outfalls on site [1]. Aligns with current monitoring of site storm waters.	M	Semi-Annual Grab	1. Frequency: 2018: Semi-annual (spring and fall) to align with all storm water monitoring on the site. Should capture high flows in spring and lower flows in fall [1]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
7	Conductivity, @ [redacted] No treatment	p	Monitored: (2018 – present) p: 2018: Core parameter required under MISA as a gross indicator of effluent quality and used to screen for other potential issues with parameters not under the routine monitoring program [1]. Aligns with current monitoring of site storm waters.	M	Semi-Annual Grab	1. Frequency: 2018: Semi-annual (spring and fall) to align with all storm water monitoring on the site. Should capture high flows in spring and lower flows in fall [1]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
8	Total Suspended Solids (TSS) Settling pond	p	Monitored: (2018 – present) p: 2018: Core parameter required under MISA for storm sewers as a gross indicator of effluent quality [1]. Increase would indicate a potential upset in the operation of the settling pond designed to remove suspended solids. Aligns with current monitoring of site storm waters.	M	Semi-Annual Grab	1. Frequency: 2018: Semi-annual (spring and fall) to align with all storm water monitoring on the site. Should capture high flows in spring and lower flows in fall [1]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A

REDACTED

[redacted] Storm Outfall *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
9	Aluminium, Unfiltered Total & Copper, Unfiltered Total & Lead, Unfiltered Total No treatment	p	Monitored: (2018 – present) p: 2018: Core parameters for CRL's storm sewers under MISA [1]. Aligns with current monitoring of site storm waters.	M	Semi-Annual Grab	1. Frequency: 2018: Semi-annual (spring and fall) to align with all storm water monitoring on the site. Should capture high flows in spring and lower flows in fall [1]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
9	Cadmium, Unfiltered Total No Treatment	i	Monitored: (2025 - present) i: Identified as a COPC (screened in) in 2024 ERA – Table 46 [4].	M	Semi-annual Grab	2. Frequency: 2025: Semi-annual to align with all other stormwater monitoring under the program [5]. Sample Type: A grab sample is considered representative of the final effluent. N/A
9	Zinc, Unfiltered Total No treatment	i, p	Monitored: (2018 – present) p: 2018: Core parameters for CRL's storm sewers under MISA [1]. Aligns with current monitoring of site storm waters. i: Identified as a COPC (screened in) in 2024 ERA – Table 46 [4].	M	Semi-Annual Grab	1. Frequency: 2018: Semi-annual (spring and fall) to align with all storm water monitoring on the site. Should capture high flows in spring and lower flows in fall [1]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
9a	Iron, Unfiltered Total No treatment	p	Monitored: (2018 – present) p: 2018: Core parameter required under the *Storm Water Control Study* (Reg 215/95) [1], [2]. Aligns with current monitoring of site storm waters.	M	Semi-Annual Grab	1. Frequency: 2018: Semi-annual (spring and fall) to align with all storm water monitoring on the site. Should capture high flows in spring and lower flows in fall [1]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
25	Solvent Extractables Settling Ponds	p	Monitored: (2018 – present) p: 2018: Core parameter required under MISA Storm Water Control Study (Reg 215/95) [2]; routine operations are a known potential source on site [1]. Aligns with current monitoring of site storm	M	Semi-Annual Grab	1. Frequency: 2018: Semi-annual to align with all other stormwater monitoring at CRL [1]. Sample Type: A grab sample is considered representative of the final effluent. 2. N /A

REDACTED

[redacted] Storm Outfall *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
			waters.			
30	Chloride No treatment	i, n, q	Monitored: (2018 – present) n, q: 2018: Added to determine road salt effects, if any, on effluent also it is a known contaminant source currently being used on site [1]. i: Identified as a COPC (screened in) in 2024 ERA – Table 46 [4]. Aligns with current monitoring of site storm waters.	M	Semi-Annual Grab	1. Frequency: 2018: Semi-annual to align with all other stormwater monitoring at CRL [1]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
--	Flow Rate (m^3/day) N/A	p	Monitored: (2018 – present) p: 2018: Core physical characteristic under MISA used to determine loading from the source [1]. Note: Confirmed to be a required parameter under the Storm Water Control Study (Reg 215/95) to determine loading from the source [2].	M	Monthly Direct Capture	1. Frequency: 2018: Semi-annual (spring and fall) to align with all storm water monitoring on the site. Should capture high flows in spring and lower flows in fall [1]. 2021: Monthly which is required under the radiological monitoring program. Note: flow is used for both the Radiological and Non-radiological programs where possible [3]. Sample Type: Flow rate is low enough that direct capture can be used on this storm effluent which is a very accurate measurement method. 2. N/A

Notes:
Municipal/Industrial Strategy for Abatement; ATG - Analytical Test Group.
* Current as of issuing date of document. Always refer to the latest version of EVMP Monitoring Schedule (CRL-509200-062-000-0004).
** See Table 15 *Parameter Monitoring Criteria for the Effluent Verification Monitoring Program*

References:

[1] *Effluent Verification Monitoring Program Sampling Schedule for CRL & NPD*, CRL-509200-062-000-0004, Rev 12, 2018 Dec. 42016713
[2] *Effluent Monitoring and Effluent Limits - Electric Power Generation Sector,* Ontario Regulation 215/95.
[3] *Effluent Verification Monitoring Program Sampling Schedule for CRL & NPD*, CRL-509200-062-000-0004, Rev 19, 2021 Dec. 56138000
[4] EnvP-509220-REPT-006396, *2024 Environmental Risk Assessment of Chalk River Laboratories*, Rev 0, 2025 January 69264691
[5] Current CRL-509200-062-000-0004, *Effluent Verification Monitoring Program Sampling Schedule for CRL, NPD & DP* as of Plan update. 59487716

REDACTED

4.3.2.2.2.4 Manhole [redacted]

Table 26: Detailed Design - Manhole [redacted]

Description: The [redacted] Storm Outfall collection system is a small system extending to the electrical storage yard and the area around the Power House with an arm extending into the Controlled Area. Manhole [redacted] is the last manhole in this system before the effluent is discharged to the Ottawa River.
Source Term: The system collects surface and groundwater discharges as well as building discharges.
Potential Non-radiological Contaminants: Phosphorus, solids, oil/grease, chlorides and metals.
Discharge Characteristics: Continuous discharge. Manhole [redacted] is the last manhole in this system before the effluent is discharged to the Ottawa River and there is no prior treatment of this effluent before it is discharged. The flow from this manhole is relatively consistent at ~475 m^3/day.
Effluent Treatment: None. MH [redacted] discharges directly into the Ottawa River with no prior treatment.
Monitoring Strategy: This final effluent monitoring location is at the last manhole prior to entering the Ottawa River. Semi-annual (spring and fall) to align with all storm water monitoring on the site. This strategy is intended to capture high flows in spring and lower flows in fall.
This monitoring point was not part of the original MISA program. Instead, its effluent was reviewed through a Special Investigation which took place monthly during 2008. As a result of the special investigation monitoring, none of the parameters met the criteria for monitoring and therefore this monitoring point was not added to the routine monitoring program at that time. A review of this location's monitoring took place again in 2013 resulting in the addition of this monitoring point to the routine program in 2014.
Note: There are a number of barriers in place across the site for this collection system including: labelling of storm drains in buildings; CRL has acceptability criteria which must be met for liquid discharges entering these drains; the site has a well-established spill response (both notification and clean-up); and, there are precautions in place in the more high risk areas (i.e. stormsceptors in key locations).

Manhole [redacted] *

ATG	Parameter Name Treatment	Parameter Criteria **	Justification for Monitoring (or not Monitoring) of Parameter	Measurement or Estimation	Monitoring Frequency & Sample Type	Justification for: 1. Monitoring Frequency & Sample Type 2. Estimation over Measurement
3	pH No Treatment	q	Monitored: (2008; 2014 to present) p: 2008: Core parameter for CRL's storm sewers therefore, special investigation monitoring and found to be comparable to other CRL storm sewers (close to neutral) and within the CNL Guideline acceptable range. As a result, routine monitoring was not implemented [1]. q: 2014: As a result of the review of the effluent monitoring program, core parameters under Reg 215/95 [4] were added to the monitoring program [2].	M	Semi-annual Grab	1. Frequency: 2008: Monthly for characterization purposes [1]. 2009: Removed [1]. 2014: Semi-annual to align with all other stormwater monitoring under the program [2]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
4b	Nitrates, Total Filter Reactive N/A	N/A	Not Monitored: (was in 2008) p: 2008: Core parameter for CRL's storm sewers therefore, special investigation monitoring and found to be comparable to other CRL storm sewers. As a result, routine monitoring	N/A	N/A	1. Frequency: 2008: Monthly for characterization purposes [1]. 2009: Removed [1]. 2. N/A

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Manhole [redacted] *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
			was not implemented [1]. Note: This is not a core parameter under the *Storm Water Control Study* (Reg 215/95) [4].			
5a	Dissolved Organic Carbon (DOC) N/A	N/A	Not Monitored: (was in 2008) p: 2008: Core parameter for CRL's storm sewers therefore, special investigation monitoring and found to be comparable to other CRL storm sewers. As a result, routine monitoring was not implemented [1]. Note: This is not a core parameter under the *Storm Water Control Study* (Reg 215/95) [4].	N/A	N/A	1. Frequency: 2008: Monthly for characterization purposes [1]. 2009: Removed [1]. 2. N/A
5b	Total Organic Carbon (TOC)	N/A	Not Monitored: (was in 2008) p: 2008: Core parameter for CRL's storm sewers therefore, special investigation monitoring and found to be comparable to other CRL storm sewers. As a result, routine monitoring was not implemented [1]. Note: This is not a core parameter under the *Storm Water Control Study* (Reg 215/95) [4].	N/A	N/A	1. Frequency: 2008: Monthly for characterization purposes [1]. 2009: Removed [1]. 2. N/A
6	Phosphorus, Unfiltered Total No Treatment	q	Monitored: (2008; 2014 – present) p: 2008: Core parameter for CRL's storm sewers therefore completed special investigation monitoring; found to be comparable to other CRL storm sewers and as a result, routine monitoring was not implemented [1]. q: 2014: Although not part of the required monitoring parameters under the *Storm Water Control Study* (Reg 215/95) [4], a potential source of contamination exists in activities on site which include the use of soaps and some variability is evident in the monitoring results, therefore the parameter was included in routine monitoring program [2].	M	Semi-annual Grab	1. Frequency: 2008: Monthly for characterization purposes [1]. 2009: Removed [1]. 2014: Semi-annual to align with all other stormwater monitoring under the program [2]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
7	Conductivity, @ [redacted] No Treatment	q	Monitored: (2008; 2014 – present) q: 2008: Core parameter for CRL's storm sewers therefore was part of special investigation monitoring. Found to have some variability but comparable to other CRL storm sewers. As a result, routine monitoring was not implemented [1]. q: 2014: Although not a required monitoring parameter under the *Storm Water Control Study* (Reg 215/95) [4] monitoring of this parameter was started up again as it is a good indicator of water quality and is used to screen for other potential issues with parameters not under the routine	M	Semi-annual Grab	1. Frequency: 2008: Monthly for characterization purposes [1]. 2009: Removed [1]. 2014: Semi-annual to align with all other stormwater monitoring under the program [2]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A

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Manhole [redacted] *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
			monitoring program. Levels in this storm sewer also tend to be elevated [2].			
8	Total Suspended Solids (TSS) No Treatment	p	Monitored: (2008; 2014 – present) p: 2008: Core parameter for CRL's storm sewers therefore, special investigation monitoring and found to be comparable to other CRL storm sewers. As a result, routine monitoring was not implemented [1]. p: 2014: Confirmed to be a required parameter under the *Storm Water Control Study* (Reg 215/95) [4] therefore routine monitoring commenced despite 2008 results indicated levels were low and relatively stable [2].	M	Semi-annual Grab	1. Frequency: 2008: Monthly for characterization purposes [1]. 2009: Removed [1]. 2014: Semi-annual to align with all other stormwater monitoring under the program [2]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
9	Aluminium, Unfiltered Total No Treatment	q	Monitored: (2008; 2014 – present) p: 2008: Core parameter for CRL's storm sewers therefore, special investigation monitoring and found to be comparable to other CRL storm sewers. As a result, routine monitoring was not implemented [1]. q: 2014: Although not part of the required monitoring parameters under the *Storm Water Control Study* (Reg 215/95) [4], concentrations are seemingly stable and are approaching the ERA Benchmark Value; therefore the parameter was added to the routine monitoring program [2].	M	Semi-annual Grab	1. Frequency: 2008: Monthly for characterization purposes [1]. 2009: Removed [1]. 2014: Semi-annual to align with all other stormwater monitoring under the program [2]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
9	Cadmium, Unfiltered Total No Treatment	i	Monitored: (2025 - present) i: Identified as a COPC (screened in) in 2024 ERA – Table 25 [7].	M	Semi-annual Grab	1. Frequency: 2025: Semi-annual to align with all other stormwater monitoring under the program [6][2]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
9	Copper, Unfiltered Total No Treatment	i, q	Monitored: (2008; 2014 – present) p: 2008: Core parameter for CRL's storm sewers therefore special investigation monitoring was completed. Concentrations were seemingly stable, comparable to other CRL storm sewers and well below the CNL Guideline. As a result, routine monitoring was not implemented [1]. q: 2014: Despite copper not being a core parameter under the *Storm Water Control Study* (Reg 215/95) [4], since it is detectable with some variability and it is already being analysed for with the rest of ATG9, it is being kept at this monitoring location [2].	M	Semi-annual Grab	1. Frequency: 2008: Monthly for characterization purposes [1]. 2009: Removed [1]. 2014: Semi-annual to align with all other stormwater monitoring under the program [2]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A

REDACTED

Manhole [redacted] *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
			i: Identified as a COPC (screened in) in 2024 ERA – Table 25 [7].			
9	Lead, Unfiltered Total No Treatment	q	Monitored: (2008; 2014 – present) p: 2008: Core parameter for CRL's storm sewers therefore special investigation monitoring was completed. All results were at or below LMDL; therefore routine monitoring was not implemented [1]. q: 2014: Despite lead not being a core parameter under the *Storm Water Control Study* (Reg 215/95) [4], since it is already being analysed for with the rest of ATG9, it is being kept at this monitoring location [2].	M	Semi-annual Grab	1. Frequency: 2008: Monthly for characterization purposes [1]. 2009: Removed [1]. 2014: Semi-annual to align with all other stormwater monitoring under the program [2]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
9	Zinc, Unfiltered Total No Treatment	i, q	Monitored: (2008; 2014 – present) p: 2008: Core parameter for CRL's storm sewers therefore, special investigation monitoring and found to be quite variable and higher than the other CRL storm sewers on average but still well below the CNL Guideline. As a result, routine monitoring was not implemented [1]. q: 2014: Despite not being a required parameter under the *Storm Water Control Study* (Reg 215/95) [4], the known variability in this effluent warrants its inclusion in the routine monitoring program. There is also the potential source in the piping [1], [2]. i: Identified as a COPC (screened in) in 2024 ERA – Table 25 [7].	M	Semi-annual Grab	1. Frequency: 2008: Monthly for characterization purposes [1]. 2009: Removed [1]. 2014: Semi-annual to align with all other stormwater monitoring under the program [2]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
9a	Iron, Unfiltered Total No Treatment	q	Monitored: (2008; 2014 – present) p: 2008: Core parameter for CRL's storm sewers therefore, special investigation monitoring and found the average to be comparable to other CRL storm sewers. Despite one month exceeding the CNL monthly Guideline, routine monitoring was not implemented [1]. q: 2014: As a result of the review of the effluent monitoring program, core parameters under Reg 215/95 [4] were added to the monitoring program; also the observed variability and elevated levels warrant its further monitoring [2].	M	Semi-annual Grab	1. Frequency: 2008: Monthly for characterization purposes [1]. 2009: Removed [1]. 2014: Semi-annual to align with all other stormwater monitoring under the program [2]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
16	Chloroform N/A	N/A	Not Monitored: (was in 2008) p: 2008: Core parameter for CRL's major storm sewers therefore, special investigation monitoring and although found to be detectable, the concentrations were fairly stable and well below the CWQG for the parameter. As a result,	N/A	N/A	1. Frequency: 2008: Monthly for characterization purposes [1]. 2009: Removed [1]. 2. N/A

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Manhole [redacted] *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
			routine monitoring was not implemented [1]. Note: Chloroform is not a required parameter under the *Storm Water Control Study* (Reg 215/95) [4].			
25	Solvent Extractables No Treatment	p	Monitored: (2008; 2014 – present) p: 2008: Core parameter for CRL's storm sewers therefore, special investigation monitoring and although found to be similar to other storm sewers, all measurements were well below the CNL Guideline. As a result, routine monitoring was not implemented [1]. p: 2014: As a result of the review of the effluent monitoring program, core parameters under Reg 215/95 [4] were added to the monitoring program; also known potential source on site through routine operations therefore added to routine program [2].	M	Semi-annual Grab	1. Frequency: 2008: Monthly for characterization purposes [1]. 2009: Removed [1]. 2014: Semi-annual to align with all other stormwater monitoring under the program [2]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
27	Polychlorinated Biphenyls (PCB) N/A	N/A	Not Monitored. As a result of being a required monitoring parameter in Reg 215/95 [4] for storm sewers, monitoring of the site's largest storm sewers took place with no contamination found. There is no suspected or known source on site; therefore this parameter was not added to the routine monitoring program. Also, being monitored under the GWMP with no contamination noted [3].	N/A	N/A	N/A
30	Chloride No Treatment	i, n, q	Monitored: (2008; 2014 – present) p: 2008: Core parameter for CRL's storm sewers therefore, special investigation monitoring and found to be relatively low compared to other storm sewers and well below the CWQG, therefore routine monitoring was not implemented [1]. 2009 removed as monitoring of stream was determined to not be required. n, q: 2014: Although not a core parameter under Reg215/95 [4], it is a known contaminant source currently being used on site, therefore kept in routine monitoring program [2]. i: Identified as a COPC (screened in) in 2024 ERA – Table 25 [7].	M	Semi-annual Grab	1. Frequency: 2008: Monthly for characterization purposes [1]. 2009: Removed [1]. 2014: Semi-annual to align with all other stormwater monitoring under the program [2]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
--	Flow Rate (m^3/day) N/A	q	Monitored: (2008; 2014 – present) q: 2008: Monitored for presence/absence only during the Special Investigation [1]. 2009: Removed as stream determined to not require reporting [1]. q: 2014: As a result of the review of the effluent monitoring	E	Semi-annual N/A	1. Frequency: 2008: Monthly for characterization purposes [1]. 2009: Removed [1]. 2014: Semi-annual estimate to align with all other stormwater monitoring under the program [2]. 2. Measurement is not physically possible with current

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Manhole [redacted]*						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
			program, core monitoring required under Reg 215/95 [4], was added to the monitoring program; in this case, to determine loading from the source [2].			configuration.

Notes:
LMDL - Laboratory Method Detection Level; CRL - Chalk River Laboratory; CWQG - Canadian Water Quality Guideline; MISA - Municipal/Industrial Strategy for Abatement; ATG - Analytical Test Group; GWMP – Groundwater Monitoring Program.
* Current as of issuing date of document. Always refer to the latest version of EVMP Monitoring Schedule (CRL-509200-062-000-0004).
** See Table 15 *Parameter Monitoring Criteria for the Effluent Verification Monitoring Program*

References:

[1] *Response to Letter on Licence Condition 7.15,* EnvP-09-113, EnvP-ACNO-09-0017-L, 2009 August. 22443369
[2] *Non-Radioactive Monitoring Schedule for CRL*, CRL-509200-062-000-0001, Rev 6, 2013 December. 23651723
[3] *Non-Radiological Liquid Effluent Monitoring at CRL: The Results for 1997*, AECL-MISC-397-97, 1998 September. 22869405
[4] *Effluent Monitoring and Effluent Limits - Electric Power Generation Sector,* Ontario Regulation 215/95.
[5] EnvP-509220-REPT-006396, *2024 Environmental Risk Assessment of Chalk River Laboratories*, Rev 0, 2025 Jan. 69264691
[6] Current CRL-509200-062-000-0004, *Effluent Verification Monitoring Program Sampling Schedule for CRL, NPD & DP* as of Plan update. 59487716
[7] EnvP-509220-REPT-006396, *2024 Environmental Risk Assessment of Chalk River Laboratories*, Rev 0, 2025 January 69264691

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4.3.2.2.2.5 Manhole [redacted]

Table 27: Detailed Design - Manhole [redacted]

Description: The Manhole [redacted] Storm Outfall collection system is a small system extending to the area around the Power House in the Controlled Area collecting surface and groundwater drainage.
Source Term: Surface and groundwater drainage from the within the Controlled Area.
Potential Non-radiological Contaminants: Phosphorus, solids, oil/grease, chlorides, sulphate and metals.
Discharge Characteristics: Continuous discharge. The flow rate is variable as it is dependent on local precipitation events and related weather conditions (snow melting). The flow from this manhole is <1 m^3/day.
Effluent Treatment: None. MH [redacted] discharges directly into the Ottawa River with no prior treatment.
Monitoring Strategy: This final effluent monitoring location is at the last manhole prior to entering the Ottawa River. Semi-annual (spring and fall) to align with all storm water monitoring on the site. This strategy is intended to capture high flows in spring and lower flows in fall.
This monitoring point was not part of the original MISA program. Instead, its effluent was reviewed through a Special Investigation which took place monthly during 2008. As a result of the special investigation monitoring, this monitoring point and a certain set of parameters which were considered significant were added to the routine monitoring program in 2009. A review of this location's monitoring took place in 2013 resulting in further changes to the program for 2014.
Note: There are a number of barriers in place across the site for this collection system including: labelling of storm drains in buildings; CRL has acceptability criteria which must be met for liquid discharges entering these drains; the site has a well-established spill response (both notification and clean-up); and, there are precautions in place in the more high risk areas (i.e. stormsceptors in key locations).

Manhole [redacted] *

ATG	Parameter Name Treatment	Parameter Criteria **	Justification for Monitoring (or not Monitoring) of Parameter	Measurement or Estimation	Monitoring Frequency & Sample Type	Justification for: 1. Monitoring Frequency & Sample Type 2. Estimation over Measurement
3	pH No Treatment	q	Monitored: (2008; 2014 to present) p: 2008: Core parameter for CRL's storm sewers therefore underwent special investigation monitoring and found to be comparable to other CRL storm sewers (close to neutral) and within the CNL Guideline acceptable range. As a result, routine monitoring was not implemented [1]. q: 2014: As a result of the review of the effluent monitoring program, core parameters under Reg 215/95 [4] were added to the monitoring program [2].	M	Semi-annual Grab	1. Frequency: 2008: Monthly for characterization purposes [1]. 2009: Removed [1]. 2014: Semi-annual being implemented to align with other stormwater monitoring [2]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
4b	Nitrates, Total Filter Reactive N/A	N/A	Not Monitored: (was in 2008) p: 2008: Core parameter for CRL's storm sewers therefore underwent special investigation monitoring and found to be comparable to other CRL storm sewers. As a result, routine monitoring was not implemented [1].	N/A	N/A	1. Frequency: 2008: Monthly for characterization purposes [1]. 2009: Removed [1]. 2. N/A

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Manhole [redacted] *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
			Note: This is not a core parameter under the *Storm Water Control Study* (Reg 215/95) [4].			
5a	Dissolved Organic Carbon (DOC) N/A	N/A	Not Monitored: (was in 2008) p: 2008: Core parameter for CRL's storm sewers therefore underwent special investigation monitoring and found to be consistently negligible (comparable to the Ottawa River intake results). As a result, routine monitoring was not implemented [1]. Note: This is not a core parameter under the *Storm Water Control Study* (Reg 215/95) [4].	N/A	N/A	1. Frequency: 2008: Monthly for characterization purposes [1]. 2009: Removed [1]. 2. N/A
5b	Total Organic Carbon (TOC) N/A	N/A	Not Monitored: (was in 2008) p: 2008: Core parameter for CRL's storm sewers therefore underwent special investigation monitoring and found to be consistently negligible (comparable to the Ottawa River intake results). As a result, routine monitoring was not implemented [1]. Note: This is not a core parameter under the *Storm Water Control Study* (Reg 215/95) [4].	N/A	N/A	1. Frequency: 2008: Monthly for characterization purposes [1]. 2009: Removed [1]. 2. N/A
6	Phosphorus, Unfiltered Total No Treatment	q	Monitored: (2008; 2014 to present) p: 2008: Core parameter for CRL's storm sewers therefore completed special investigation monitoring; found to be well below the CNL Guideline and as a result, routine monitoring was not implemented [1]. q: 2014 Note: Although not part of the required monitoring parameters under the *Storm Water Control Study* (Reg 215/95) [4], a potential source of contamination exists in activities on site which include the use of soaps and some variability is evident in special investigation monitoring results, therefore the parameter was included in routine monitoring program [2].	M	Semi-annual Grab	1. Frequency: 2008: Monthly for characterization purposes [1]. 2009: Removed [1]. 2014: Semi-annual to align with all other stormwater monitoring under the program [2]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
7	Conductivity, @ [redacted] No Treatment	q	Monitored: (2008 - present) p: 2008: Core parameter required under MISA to be monitored for all of CRL's storm sewers. Found to exceed Guidelines (PWQG) therefore added to Monitoring Program [1]. q: 2014 Note: Although not a required monitoring parameter under the *Storm Water Control Study* (Reg 215/95) [4] this parameter was kept under the routine monitoring program as it is a good indicator of water quality and is used to screen for other potential issues with	M	Semi-annual Grab	1. Frequency: 2008: Monthly for characterization purposes [1]. 2009: Semi-annual to align with all other stormwater monitoring under the program [2]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A

REDACTED

Manhole [redacted] *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
			parameters not under the routine monitoring program. Levels in this storm sewer also tend to be elevated [2].			
8	Total Suspended Solids (TSS) No Treatment	n, p	Monitored: (2008 - present) n, p: 2008: Core parameter required under MISA to be monitored for all of CRL's storm sewers. Found to be highly variable with regular exceedances of the CNL Guideline, therefore was added to the routine monitoring program [1]. p: 2014 Note: Confirmed to be a required parameter under the *Storm Water Control Study (*Reg 215/95) [2], [4].	M	Semi-annual Grab	1. Frequency: 2008: Monthly for characterization purposes [1]. 2009: Semi-annual to align with all other stormwater monitoring under the program [2]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
9	Aluminium, Unfiltered Total No Treatment	q	Monitored: (2008; 2014 to present) p: 2008: Special investigation monitoring and observed some high results but the majority were less than the LMDL, therefore not added to the routine monitoring program [1]. q: 2014: Although not part of the required monitoring parameters under the *Storm Water Control Study* (Reg 215/95) [4], the variability noted during the special investigation and the known potential source in the systems piping meant that monitoring of the parameter was once again commenced [2].	M	Semi-annual Grab	1. Frequency: 2008: Monthly for characterization purposes [1]. 2009: Removed [1]. 2014: Semi-annual to align with all other stormwater monitoring under the program [2]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
9	Cadmium, Unfiltered Total No Treatment	i	Monitored: (2025 - present) i: Identified as a COPC (screened in) in 2024 ERA – Table 25 [9].	M	Semi-annual Grab	3. Frequency: 2025: Semi-annual to align with all other stormwater monitoring under the program [8]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
9	Copper, Unfiltered Total No Treatment	i, q	Monitored: (2008; 2014 to present) p: 2008: Core parameter for storm sewers therefore underwent special investigation monitoring and although there was some variability in the results, they were comparable to other CRL storm sewers and all were well below the CNL Guideline. As a result, routine monitoring was not implemented [1]. q: 2014 Note: Despite not being a required parameter under the *Storm Water Control Study* (Reg 215/95) [4], the variability noted in this effluent and the analysis of copper is done in conjunction with other metals in ATG 9 warrants its inclusion in the routine	M	Semi-annual Grab	1. Frequency: 2008: Monthly for characterization purposes [1]. 2009: Removed [1]. 2014: Semi-annual to align with all other stormwater monitoring under the program [2]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A

REDACTED

Manhole [redacted] *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
			monitoring program [2]. i: Identified as a COPC (screened in) in 2024 ERA – Table 25 [9].			
9	Lead, Unfiltered Total No Treatment	q	Monitored: (2008; 2014 to present) p: 2008: Core parameter for CRL's storm sewers therefore underwent special investigation monitoring and although there was some variability in the results, all results were below the CNL Guideline. As a result, routine monitoring was not implemented [1]. q: 2014 Note: Despite not being a required parameter under the *Storm Water Control Study* (Reg 215/95) [4], the variability noted in this effluent as well as levels which approach the CNL Guideline warrants its inclusion in the routine monitoring program. There is also the known potential source in the piping and the use of lead on site [2].	M	Semi-annual Grab	1. Frequency: 2008: Monthly for characterization purposes [1]. 2009: Removed [1]. 2014: Semi-annual to align with all other stormwater monitoring under the program [2]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
9	Zinc, Unfiltered Total No Treatment	i, q	Monitored: (2008; 2014 to present) p: 2008: Core parameter for storm sewers therefore underwent special investigation monitoring and although there was some variability in the results, all results were well below the CNL Guideline. As a result, routine monitoring was not implemented [1]. q: 2014 Note: Despite not being a required parameter under the *Storm Water Control Study* (Reg 215/95) [4], the variability noted in this effluent warrants its inclusion in the routine monitoring program. There is also the known potential source in the piping [2]. i: Identified as a COPC (screened in) in 2024 ERA – Table 25 [9].	M	Semi-annual Grab	1. Frequency: 2008: Monthly for characterization purposes [1]. 2009: Removed [1]. 2014: Semi-annual to align with all other stormwater monitoring under the program [2]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
9a	Iron, Unfiltered Total No Treatment	i, q	Monitored: (2008 - present) n, p: 2008: Core parameter for CRL's storm sewers therefore underwent special investigation monitoring. All measurements exceeded the CNL Guideline and as a result, routine monitoring was implemented [1]. q: 2014: As a result of the review of the effluent monitoring program, core parameters under Reg 215/95 [4]. i: Identified as a COPC (screened in) in 2024 ERA – Table 25 [9].	M	Semi-annual Grab	1. Frequency: 2008: Monthly for characterization purposes [1]. 2009: Semi-annual to align with all other stormwater monitoring under the program [2]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
16	Chloroform N/A	N/A	Not Monitored: (was in 2008; 2014-2017) p: 2008: Core parameter for CRL's major storm sewers therefore,	N/A	N/A	1. Frequency: 2008: Monthly for characterization purposes [1]. 2009: Removed [1].

REDACTED

Manhole [redacted] *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
			special investigation monitoring and found most results to be less than or equal to the LMDL. As a result, routine monitoring was not implemented [1]. n, q: 2014: Despite not being a required parameter under the *Storm Water Control Study* (Reg 215/95) [4], the variability in the effluent indicates that there is a source of chloroform in this effluent and one of the results was above the CWQG thereby warranting its inclusion in the routine monitoring program [2]. 2017: Removed as all results very low and none above CWQG [5].			2014: Semi-annual being implemented to align with other stormwater monitoring [2]. 2017: Removed [5]. 2. N/A
25	Solvent Extractables No Treatment	p	Monitored: (2008; 2014 – present) p: 2008: Core parameter for CRL's storm sewers therefore, special investigation monitoring and although found to be similar to other storm sewers, all measurements were well below the CNL Guideline. As a result, routine monitoring was not implemented [1]. p: 2014: As a result of the review of the effluent monitoring program, core parameters under Reg 215/95 [4] were added to the monitoring program; also known potential source on site through routine operations justifies its addition to the routine monitoring program [2].	M	Semi-annual Grab	1. Frequency: 2008: Monthly for characterization purposes [1]. 2009: Removed [1]. 2014: Semi-annual being implemented to align with other stormwater monitoring [2]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
27	Polychlorinated Biphenyls (PCB) N/A	N/A	Not Monitored. As a result of being a required monitoring parameter in Reg 215/95 [4] for storm sewers, monitoring of the site's largest storm sewers took place with no contamination found. No suspected or known source at this location, therefore it has not been added to the routine monitoring program. Also, being monitored under the GWMP with no contamination noted [1], [3].	N/A	N/A	N/A
30	Chloride No Treatment	i, n, q	Monitored: (2008 - present) n, q: 2008: Special Investigation monitoring and found to be relatively high compared to other CRL storm sewers and above CWQG at times and road salt use on site is a known source therefore it was added to the routine monitoring program [1]. i: Identified as a COPC (screened in) in 2024 ERA – Table 25 [9].	M	Semi-annual Grab	1. Frequency: 2008: Monthly for characterization purposes [1]. 2009: Semi-annual to align with all other site stormwater monitoring [1]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A

REDACTED

Manhole [redacted] *						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ****	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
30	Sulphates No Treatment	q	Monitored: (2012 - present) q: 2012: Added to program as high sulphate concentrations were being observed in the groundwater in the vicinity of Power House and this groundwater is believed to be infiltrating into [redacted] [6].	M	Semi-annual Grab	1. Frequency: 2012: Semi-annual to align with all other stormwater monitoring on site [6]. Sample Type: A grab sample is considered representative of the final effluent. 2. N/A
--	Flow Rate (m^3/day) N/A	p	Monitored: (2008; 2014 – present) p: 2008: Monitored for presence/absence only during the Special Investigation [1]. 2009: Removed as determined to be low. 2014 Note: As a result of the review of the effluent monitoring program, core parameters under the *Storm Water Control Study* (Reg 215/95) [4] were added to the monitoring program in order to determine loading from the source [2].	M	Monthly Direct Capture	1. Frequency: 2008: Monthly for characterization purposes [1]. 2009: Removed [1]. 2014: Semi-annual to align with all other stormwater monitoring under the program [2]. 2020: Monthly which is required under the radiological monitoring program. Note: flow is used for both the Radiological and Non-radiological programs where possible [7]. Sample Type: Flow rate is low enough that direct capture can be used on this storm effluent which is a very accurate measurement method. 2. N/A

Notes:
LMDL - Laboratory Method Detection Level; CRL - Chalk River Laboratory; CWQG - Canadian Water Quality Guideline; MISA - Municipal/Industrial Strategy for Abatement; ATG - Analytical Test Group; GWMP – Groundwater Monitoring Program; PWQG - Provincial Water Quality Guidelines.
* Current as of issuing date of document. Always refer to the latest version of EVMP Monitoring Schedule (CRL-509200-062-000-0004).
** See Table 15 *Parameter Monitoring Criteria for the Effluent Verification Monitoring Program*

References:

[1] *Response to Letter on Licence Condition 7.15,* EnvP-09-113, EnvP-ACNO-09-0017-L, 2009 August. 22443369
[2] *Non-Radioactive Monitoring Schedule for CRL*, CRL-509200-062-000-0001, Rev 6, 2013 December. 23651723
[3] *Non-Radiological Liquid Effluent Monitoring at CRL: The Results for 1997*, AECL-MISC-397-97, 1998 September. 22869405
[4] *Effluent Monitoring and Effluent Limits - Electric Power Generation Sector,* Ontario Regulation 215/95
[5] *Effluent Verification Monitoring Program Sampling Schedule for CRL*, CRL-509200-062-000-0004, Rev 7, 2016 August. 22726453
[6] *Non-Radioactive Monitoring Schedule for CRL,* CRL-509200-062-000-0001, Rev 4, 2012 January. 23651789
[7] *Effluent Verification Monitoring Program Sampling Schedule for CRL & NPD*, CRL-509200-062-000-0004, Rev 14, 2020 April 30. 52061668
[8] Current CRL-509200-062-000-0004, *Effluent Verification Monitoring Program Sampling Schedule for CRL, NPD & DP* as of Plan update.
[9] EnvP-509220-REPT-006396, *2024 Environmental Risk Assessment of Chalk River Laboratories*, Rev 0, 2025 January 69264691

REDACTED

4.3.3 Airborne Emissions

4.3.3.1 WMA [redacted]

Table 28: Detailed Design – WMA [redacted]

Description: The tileholes in WMA [redacted] emit mercury airborne emissions and the vehicles used in the management area are used daily for operations. Also fuel is used to heat buildings.

Source term & Potential Non-radiological Contaminants: Airborne releases include: (1) Hg emissions from tileholes where waste emplacement and retrievals are ongoing, and (2) vehicle exhaust emissions from operational use; and (3) emissions from the burning of fuel for building heating.

Discharge Characterization: Mercury airborne emissions from tileholes are typically approx. 1% of site's Hg airborne emissions. Emissions from vehicle use are tracked as part of the site's total Transportation emissions (see Section 4.3.3.8) and are therefore not captured in this table. Emissions from fuel burning to heat buildings are tracked as part of the site's total fuel use (see Sections 0 & 0) and are therefore not captured in this table.

Monitoring Strategy: A campaign to measure mercury emissions was completed over a number of year (2013 and 2014). Annual estimations are used based on this sampling campaign. Vehicle emissions are tracked annually based on fuel use as part of the CNL fleet and are therefore not tracked individually (as a result, not covered in this facility specific table but instead see On-site Vehicle Transportation Table in Section 4.3.3.8). Emissions from fuel burning to heat buildings are tracked annually as part of the site's total fuel use (as a result, not covered in this facility-specific table but instead see Sections 0 & 0.

Parameter Name	Parameter Monitoring Criteria *	Justification for Monitoring (or Not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification for: 1. Monitoring Frequency 2. Estimation over Measurement
NPRI Part 1B Substances – Alternative Threshold Substances					
Mercury (Hg)	h, q	Monitored: h: Total Hg emissions from all site releases may be reportable under Environment Canada's *National Pollutant Release Inventory* Notices [1]. q: Total Hg emissions from all site activities may be reportable under the Global Reporting Initiative as an "Other Significant Emission" [2].	Estimate	Annual & N/A	1. Environment Canada's *National Pollutant Release Inventory* Notices [1] require reporting annually if reporting threshold is met for site Hg emissions. GRI reporting is also annual [2]. 2. Estimation of Hg emissions is acceptable by the federal NPRI Notice [1].

* See Table 15 *Parameter Monitoring Criteria for the Effluent Verification Monitoring Program* (Criteria h-q)

References:

[1] Environment Canada, *National Pollutant Release Inventory*, Annual Notices.

[2] Global Sustainability Standards Board, *Global Reporting Initiative 305: Emissions*, 2016.

REDACTED

4.3.3.2 Van de Graaff Accelerator

Table 29: Detailed Design – Van de Graaff Accelerator

Description: The Van de Graaff accelerator uses CO_2 and SF_6 which is a potent Greenhouse Gas. Each time the accelerator is opened for maintenance and repair, there is a release of these gases which then need to be recharged. The amount of gas recharged into the accelerator is tracked.

Source term & Potential Non-radiological Contaminants: Airborne releases of SF_6 and CO_2 occur during maintenance activities (manually completed and on an as-needed basis).

Discharge Characterization: Typically, 2-8% of site's CO_2e emissions (almost exclusively from the SF_6 released). Variation depends on the number of maintenance repair activities required in the given year.

Monitoring Strategy: Monitoring emissions are not possible however volume of gases contained in accelerator are known and it is known that once opened, all gases are released, therefore tracking volume of gases in the accelerator as well as number of maintenance/repairs where the system was required to be opened each year is an adequate estimation method for releases. Emission factors used for SF_6 are provided by the GHGRP [2].

Parameter Name	Parameter Monitoring Criteria *	Justification for Monitoring (or Not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification for: 1. Monitoring Frequency 2. Estimation over Measurement
Greenhouse Gases (GHGs)					
Carbon Dioxide equivalent (CO_2e) & Carbon Dioxide (CO_2) & Sulphur Hexaflouride (SF_6)	h, i, q	Monitored: h: Total CO_2e emissions (consisting of CO_2 and SF_6 emissions) from all site activities may be reportable under Environment Canada's Greenhouse Gas Reporting Notices (GHGRP) [2]. I: Estimated emissions are used for exposure assessment in the site's Environmental Risk Assessment. q: Total CO_2 emissions are used for reporting under the Global Reporting Initiative [1]. Emissions are estimated based on the quantity of SF_6 and CO_2 charged into the system after repair. Estimation is of loading (Tonnes/year) as required by the Federal GHG Reporting Notice [2].	Estimate	Annual & N/A	1. Environment Canada's Greenhouse Gas Reporting Notices [2] require reporting annually if reporting threshold is met for site CO_2e emissions. GRI reporting is also annual [1]. 2. Estimation of emissions based on quantity charged into system is acceptable industry practice for both the Federal GHG Notice [2] and the GRI reporting guidance [1].

* See Table 15 *Parameter Monitoring Criteria for the Effluent Verification Monitoring Program* (Criteria h-q)

References:

[1] Global Sustainability Standards Board, *Global Reporting Initiative 305: Emissions*, 2016.

[2] Environment Canada, *Greenhouse Gas Reporting,* Annual Notices.

REDACTED

4.3.3.3 [redacted] Fuel Oil Used by Powerhouse Boilers

Table 30: Detailed Design – [redacted] Fuel Oil

Description: [redacted] Fuel was previously the main source of fuel used in the Power House boilers producing heat and steam for the site however this has now been switched to natural gas. [redacted] fuel oil is now used solely as a backup fuel for the Power House Boilers.

Source term & Potential Non-radiological Contaminants: Airborne contaminants from the burning of [redacted] Fuel oil include: (CO_2e, Pb, Hg, NO_x, SO_2, CO, TPM, PM_{10}, $PM_{2.5}$ and VOCs).

Discharge Characterization: When [redacted] Fuel was previously the main source of fuel used in the Power House boilers, the site was burning approximately 11 million liters per year, but now as backup fuel only, the site is typically burning <100,000L/year.

GHG emissions of CO_2e are <2% of the site's annual CO_2e emissions.

Recent levels of fuel use results in relatively insignificant NPRI emissions of Pb and Hg, NO_x, TPM, PM_{10}, $PM_{2.5}$ and VOCs and relatively significant NPRI emissions for SO_2.

Monitoring Strategy: Fuel use is tracked throughout the calendar year. Emission estimates are completed annually using specific emission factors where available and generic emission factors where site-specific are not available. Significant air emissions, if any, reported under the GRI are equivalent to those meeting NPRI reporting thresholds. Emission estimates of CO_2e are included in with the site's emissions from all activities and are used for reporting under the Global Reporting Initiative [1].

[redacted] Fuel Oil					
Parameter Name	**Parameter Monitoring Criteria ***	**Justification for Monitoring (or Not Monitoring) of Parameter**	**Measured or Estimated**	**Monitoring Frequency & Sample Type**	**Justification for:** 1. **Monitoring Frequency** 2. **Estimation over Measurement**
Greenhouse Gases (GHGs)					
Carbon Dioxide Equivalent (CO_2e) ($CO_2 + CH_4 + N_2O$)	h, i, q	Monitored: h: Total CO_2e emissions from all site activities may be reportable under Environment Canada's Greenhouse Gas Reporting Notices [2]. i: Estimated emissions are used for exposure assessment in the site's Environmental Risk Assessment. q: Total CO_2e emissions from all site activities are used for reporting under the Global Reporting Initiative [1]. CO_2e emissions are estimated based on annual consumption of [redacted] Fuel oil on site. Estimation is of loading (Tonnes/year) as required by the Federal GHGRP Notice [2].	Estimate	Annual & N/A	1. Environment Canada's Greenhouse Gas Reporting Notices [2] require reporting annually if reporting threshold is met for site CO_2e emissions. GRI reporting is also annual [1]. 2. Estimation of CO_2e emissions is based on fuel consumption is standard industry practice and acceptable by both the Federal GHG Notice [2] and the GRI reporting guidance [1].
NPRI Part 1B Substances – Alternative Threshold Substances					

REDACTED

[redacted] Fuel Oil					
Parameter Name	**Parameter Monitoring Criteria ***	**Justification for Monitoring (or Not Monitoring) of Parameter**	**Measured or Estimated**	**Monitoring Frequency & Sample Type**	**Justification for:** 1. **Monitoring Frequency** 2. **Estimation over Measurement**
Mercury (Hg) & Lead (Pb)	h, i, q	Monitored: h: Total Hg and Pb emissions from all site releases may be reportable under Environment Canada's *National Pollutant Release Inventory* Notices [3]. i: Estimated emissions are used for exposure assessment in the site's Environmental Risk Assessment. q: Total Hg and Pb emissions from all site activities may be reportable under the Global Reporting Initiative as an "Other Significant Emission" [1]. Hg and Pb emissions are estimated based on annual consumption of the site's [redacted] fuel oil. Estimation is of loading (kg/year) as required by the Federal NPRI Notice [3].	Estimate	Annual & N/A	1. Environment Canada's *National Pollutant Release Inventory* Notices [3] require reporting annually if reporting threshold is met for site Hg and/or Pb emissions. GRI reporting is also annual [1]. 2. Estimation of Hg and Pb emissions are based on fuel consumption is standard industry practice and acceptable by the federal NPRI Notice [3].
NPRI Part 4 Substances - Criteria Air Contaminants (CACs)					

REDACTED

[redacted] Fuel Oil					
Parameter Name	**Parameter Monitoring Criteria ***	**Justification for Monitoring (or Not Monitoring) of Parameter**	**Measured or Estimated**	**Monitoring Frequency & Sample Type**	**Justification for:** 1. **Monitoring Frequency** 2. **Estimation over Measurement**
Nitrogen Oxides (NO_x) & Sulphur Dioxide (SO_2) & Carbon Monoxide (CO) & Total Particulate Matter (TPM) & Particulate Matter 10 micron (PM_{10}) & Particulate Matter 2.5 micron ($PM_{2.5}$) & Volatile Organic Compounds (VOCs)	h, i, o, q	Monitored: h: Total NO_x, SO_2, CO, TPM, PM_{10}, $PM_{2.5}$ and VOC emissions from all site operations may be reportable under Environment Canada's *National Pollutant Release Inventory* Notices [3]. h: Public reporting is required of site NO_x & SO_2 [6]. i: Estimated emissions are used for exposure assessment in the site's Environmental Risk Assessment. Total NO_x, SO_2, CO, TPM and VOC emissions are estimated based on annual consumption of the site's [redacted] Fuel oil use using generic emission factors. Estimation is of loading (Tonnes/year) as required by the Federal NPRI Notice [3]. o: The site's use of [redacted] Fuel oil typically results in >10% of each of the site's SO_2 emissions and is therefore considered a significant source of these emissions [4]. q: Total NO_x, SO_2, CO, TPM, PM_{10}, $PM_{2.5}$ and VOC emissions from all site activities may be reportable under the Global Reporting Initiative as an "Other Significant Emission" [1].	Estimate	Annual & N/A	1. Environment Canada's *National Pollutant Release Inventory* Notices [3] require reporting annually if reporting threshold is met for site Total NO_x, SO_2, CO, TPM , PM_{10}, $PM_{2.5}$ and/or VOC emissions. Annual review of significant airborne emissions which were estimated is recommended by CSA N288.5:22 [5]. Annual reporting to the Public is required for NO_x & SO_2 [6]. 2. Estimation of Total NO_x, SO_2, CO, TPM, PM_{10}, $PM_{2.5}$ and VOC emissions are based on fuel oil consumption is standard industry practice and acceptable by both the federal NPRI Notice [3] and the GRI guidance reporting [1].
NPRI Part 5 Substances – Speciated Volatile Organic Compounds					
Speciated Volatile Organic Compounds (VOCs)	h	Monitored: h: Speciate VOCs emissions from all site operations (including burning fuel) may be reportable under Environment Canada's *National Pollutant Release Inventory* Notices [1]. Estimation is of loading (Tonnes/year) as required by the Federal NPRI Notice [1].	Estimate	Annual & N/A	1. Environment Canada's *National Pollutant Release Inventory* Notices [1] require reporting annually if reporting threshold is met for speciated VOC emissions under Part 5. 2. Estimation of VOC emissions released to atmosphere is standard industry practice and acceptable by the federal NPRI Notice [1].

REDACTED

[redacted] Fuel Oil					
Parameter Name	**Parameter Monitoring Criteria ***	**Justification for Monitoring (or Not Monitoring) of Parameter**	**Measured or Estimated**	**Monitoring Frequency & Sample Type**	**Justification for:** 1. **Monitoring Frequency** 2. **Estimation over Measurement**

* See Table 15*Parameter Monitoring Criteria for the Effluent Verification Monitoring Program* (Criteria h-q)

References:

[1] Global Sustainability Standards Board, *Global Reporting Initiative 305: Emissions,* 2016.
[2] Environment Canada, *Greenhouse Gas Reporting,* Annual Notices.
[3] Environment Canada, *National Pollutant Release Inventory,* Annual Notices.
[4] *2023 CRL NPRI Release Estimates. CRL-509212-055-000,* 67890210
[5] Canadian Standards Association, *Effluent and Emissions Monitoring Programs at Nuclear Facilities*, CSA N288.5-22, 2022 February.
[6] *Public Information Program for CNL*, CW-513430-REPT-001. 53749225

REDACTED

4.3.3.4 Site Propane Use

Table 31: Detailed Design – Site Propane Use

Description: Propane is typically used for heating buildings across the site as well as other process type operations. Heating is for those remote buildings not supplied by the central natural gas network. Annual propane fuel usage is tracked.

Source term: Airborne contaminants from the burning of propane.

Potential Non-radiological Contaminants: By-products from propane combustion include CO_2e, NO_x, CO, TPM, PM_{10} and $PM_{2.5}$. Emissions are determined by tracking the propane use and using generic emission factors for the burning of propane.

Discharge Characterization: Recent annual propane use across the site is approximately 50,000 litres with insignificant releases of contaminants compared to site totals (CO_2e, NO_x, CO, TPM, PM_{10} and $PM_{2.5}$), therefore propane is not considered a significant source of any of these emissions.

Monitoring Strategy: Fuel use is tracked throughout the calendar year. Estimation of emissions are done annually using generic emission factors as site-specific are not available. Propane product consumption in Megajoules is also tracked for reporting under the Global Reporting Initiative. Significant site air emissions reported under the GRI are equivalent to those meeting NPRI reporting thresholds and would include contributions from propane use.

Propane					
Parameter Name	**Parameter Monitoring Criteria ***	**Justification for Monitoring (or Not Monitoring) of Parameter**	**Measured or Estimated**	**Monitoring Frequency & Sample Type**	**Justification for:** 1. **Monitoring Frequency** 2. **Estimation over Measurement**
Greenhouse Gases (GHGs)					
Carbon Dioxide Equivalent (CO_2e) ($CO_2 + CH_4 + N_2O$)	h, i, q	Monitored: h: Total CO_2e emissions from all site activities may be reportable under Environment Canada's Greenhouse Gas Reporting Notices [2]. i: Estimated emissions are used for exposure assessment in the site's Environmental Risk Assessment. q: Total CO_2e emissions from all site activities are used for reporting under the Global Reporting Initiative [1]. CO_2e emissions are estimated based on annual consumption of propane fuel used on site (using standard emission factors). Estimation is of loading (Tonnes/year) as required by the Federal GHG Notice [2].	Estimate	Annual & N/A	1. Environment Canada's Greenhouse Gas Reporting Notices [2] require reporting annually if reporting threshold is met for site CO_2e emissions. GRI reporting is also annual [1]. 2. Estimation of CO_2e emissions is based on fuel consumption is standard industry practice and acceptable by both the Federal GHG Notice [2] and the GRI reporting guidance [1].
NPRI Part 4 Substances - Criteria Air Contaminants (CACs)					

REDACTED

Propane					
Parameter Name	**Parameter Monitoring Criteria ***	**Justification for Monitoring (or Not Monitoring) of Parameter**	**Measured or Estimated**	**Monitoring Frequency & Sample Type**	**Justification for:** 1. **Monitoring Frequency** 2. **Estimation over Measurement**
Nitrogen Oxides (NO_x) & Carbon Monoxide (CO) & Total Particulate Matter (TPM) & Particulate Matter 10 micron (PM_{10}) & Particulate Matter 2.5 micron ($PM_{2.5}$)	h, i, q	Monitored: h: Total NO_x, CO, TPM, PM_{10} and $PM_{2.5}$ emissions from all site operations may be reportable under Environment Canada's *National Pollutant Release Inventory* Notices [3]. h: Public reporting is required of site NO_x [4] i: Estimated emissions are used for exposure assessment in the site's Environmental Risk Assessment. Emissions are estimated based on annual consumption of the site's propane use using generic emission factors. Estimation is of loading (Tonnes/year) as required by the Federal NPRI Notice [3]. q: Total NO_x, CO, TPM, PM_{10} and $PM_{2.5}$ emissions from all site activities may be reportable under the Global Reporting Initiative as an "Other Significant Emission" [1].	Estimate	Annual & N/A	1. Environment Canada's *National Pollutant Release Inventory* Notices [3] require reporting annually if reporting threshold is met for site NO_x, CO, TPM, PM_{10} and $PM_{2.5}$ emissions. Annual reporting of Public reporting is required of site NO_x [4]. 2. Estimation of NO_x, CO, TPM, PM_{10} and $PM_{2.5}$ emissions are based on fuel oil consumption is standard industry practice and acceptable by the federal NPRI Notice [3] and the GRI guidance reporting [1].

* See Table 15 *Parameter Monitoring Criteria for the Effluent Verification Monitoring Program* (Criteria h-q)

References:

[1] Global Sustainability Standards Board, *Global Reporting Initiative 305: Emissions,* 2016.
[2] *Environment Canada, Greenhouse Gas Reporting,* Annual Notices.
[3] Environment Canada, *National Pollutant Release Inventory,* Annual Notices.
[4] *Public Information Program for CNL*, CW-513430-REPT-001. 53749225

REDACTED

4.3.3.5 Site Natural Gas Use

Table 32: Detailed Design – Site Natural Gas Use

Description: Natural Gas is the main source of heating and steam production on the CRL site and is supplied to various buildings including the Power House (previously used [redacted] fuel oil primarily). Equipment used includes various types of boilers and heaters.

Source term & Potential Non-radiological Contaminants: Airborne contaminants from the burning of natural gas include: (CO_2e, Pb, Hg, NO_x, SO_2, CO, TPM, PM_{10}, $PM_{2.5}$ and VOCs).

Discharge Characterization: Natural gas consumption is approximately 10 millions m^3/yr at the CRL site.

GHG emissions (CO_2e) from the burning of Natural Gas are significant at approximately 70% of the total site's CO_2e emissions.

NPRI emissions of Pb and Hg are insignificant. The 2023 CY saw site significant emissions for NO_x (~40%), CO (~35%) and VOCs (~20%) and insignificant emissions (≤10%) for SO_2, TPM, PM_{10} and $PM_{2.5}$.

Monitoring Strategy: Fuel use is tracked throughout the calendar year by each equipment type (boiler type, heaters etc.). Estimation of emissions is done annually using generic emission factors for each equipment type. Significant air emissions reported under the GRI are equivalent to those meeting NPRI reporting thresholds. Total CO_2e emissions from all site activities are used for reporting under the Global Reporting Initiative [1].

Natural Gas					
Parameter Name	**Parameter Monitoring Criteria ***	**Justification for Monitoring (or Not Monitoring) of Parameter**	**Measured or Estimated**	**Monitoring Frequency & Sample Type**	**Justification for:** 1. **Monitoring Frequency** 2. **Estimation over Measurement**
Greenhouse Gases (GHGs)					
Carbon Dioxide Equivalent (CO_2e) ($CO_2 + CH_4 + N_2O$)	h, i, q	Monitored: h: Total CO_2e emissions from all site activities may be reportable under Environment Canada's Greenhouse Gas Reporting Notices [2]. i: Estimated emissions are used for exposure assessment in the site's Environmental Risk Assessment. q: Total CO_2e emissions from all site activities are used for reporting under the Global Reporting Initiative [1]. CO_2e emissions are estimated based on annual consumption of natural gas on site (using standard emission factors). Estimation is of loading (Tonnes/year) as required by the Federal GHG Notice [2]	Estimate	Annual & N/A	1. Environment Canada's Greenhouse Gas Reporting Notices [2] require reporting annually if reporting threshold is met for site CO_2e emissions. GRI reporting is also annual [1]. Annual review of significant airborne emissions which were estimated is recommended by CSA N288.5:22 [3]. 2. Estimation of CO_2e emissions is based on fuel consumption is standard industry practice and acceptable by both the Federal GHG Notice [2] and the GRI reporting guidance [1].

REDACTED

Natural Gas					
Parameter Name	**Parameter Monitoring Criteria ***	**Justification for Monitoring (or Not Monitoring) of Parameter**	**Measured or Estimated**	**Monitoring Frequency & Sample Type**	**Justification for:** 1. **Monitoring Frequency** 2. **Estimation over Measurement**
NPRI Part 1B Substances – Alternative Threshold Substances					
Mercury (Hg) & Lead (Pb)	h, i, q	Monitored: h: Total Hg and Pb emissions from all site releases may be reportable under Environment Canada's *National Pollutant Release Inventory* Notices [4]. i: Estimated emissions are used for exposure assessment in the site's Environmental Risk Assessment. q: Total Hg and Pb emissions from all site activities may be reportable under the Global Reporting Initiative as an "Other Significant Emission" [1]. Hg and Pb emissions are estimated based on annual consumption of the site's natural gas (using standard emission factors). Estimation is of loading (kg/year) as required by the Federal NPRI Notice [4].	Estimate	Annual & N/A	1. Environment Canada's *National Pollutant Release Inventory* Notices [4] require reporting annually if reporting threshold is met for site Hg and/or Pb emissions. GRI reporting is also annual [1]. 2. Estimation of Hg and Pb emissions are based on fuel consumption is standard industry practice and acceptable by the federal Notice [4].
NPRI Part 4 Substances - Criteria Air Contaminants (CACs)					

REDACTED

Natural Gas					
Parameter Name	**Parameter Monitoring Criteria ***	**Justification for Monitoring (or Not Monitoring) of Parameter**	**Measured or Estimated**	**Monitoring Frequency & Sample Type**	**Justification for:** 1. **Monitoring Frequency** 2. **Estimation over Measurement**
Sulphur Dioxide (SO_2) & Total Particulate Matter (TPM) & Particulate Matter 10 micron (PM_{10}) & Particulate Matter 2.5 micron ($PM_{2.5}$)	h, i, q	Monitored: h: Total SO_2, TPM, PM_{10} and $PM_{2.5}$ emissions from all site operations may be reportable under Environment Canada's *National Pollutant Release Inventory* Notices [4]. h: Public reporting is required of site SO_2 [6]. i: Estimated emissions are used for exposure assessment in the site's Environmental Risk Assessment. Total SO_2, TPM, PM_{10} and $PM_{2.5}$ emissions are estimated based on annual consumption of the site's natural gas use using generic emission factors. Estimation is of loading (Tonnes/year) as required by the Federal NPRI Notice [4]. q: Total SO_2, TPM PM_{10} and $PM_{2.5}$ emissions from all site activities may be reportable under the Global Reporting Initiative as an "Other Significant Emission" [1].	Estimate	Annual & N/A	1. Environment Canada's *National Pollutant Release Inventory* Notices [4] require reporting annually if reporting threshold is met for site Total SO_2, TPM, PM_{10} and $PM_{2.5}$ emissions. Annual review of significant airborne emissions which were estimated is recommended by CSA N288.5:22 [3]. Annual reporting of Public reporting is required of site SO_2 [6]. 2. Estimation of Total SO_2, TPM, PM_{10} and $PM_{2.5}$ emissions are based on fuel oil consumption is standard industry practice and acceptable by both the federal NPRI Notice [4] and the GRI guidance reporting [1].

REDACTED

Natural Gas					
Parameter Name	**Parameter Monitoring Criteria ***	**Justification for Monitoring (or Not Monitoring) of Parameter**	**Measured or Estimated**	**Monitoring Frequency & Sample Type**	**Justification for:** 1. **Monitoring Frequency** 2. **Estimation over Measurement**
Nitrogen Oxides (NO_x) & Carbon Monoxide (CO) & Volatile Organic Compounds (VOCs)	h, i, o, q	Monitored: h: Total NO_x, CO and VOC emissions from all site operations may be reportable under Environment Canada's *National Pollutant Release Inventory* Notices [4]. h: Public reporting is required of site NO_x [6]. i: Estimated emissions are used for exposure assessment in the site's Environmental Risk Assessment. o: The site's use of natural gas typically results in >10% of NO_x, CO and VOCs NPRI reporting thresholds emissions being over the NPRI reporting and are therefore considered a significant source of these emissions [5]. NO_x, CO and VOC emissions are estimated based on annual consumption of the site's natural gas use using generic emission factors. Estimation is of loading (Tonnes/year) as required by the Federal NPRI Notice [4]. q: Total NO_x, CO and VOC emissions from all site activities may be reportable under the Global Reporting Initiative as an "Other Significant Emission" [1].	Estimate	Annual & N/A	1. Environment Canada's *National Pollutant Release Inventory* Notices [5] require reporting annually if reporting threshold is met for site NO_x, CO and VOC emissions. Annual review of significant airborne emissions which were estimated is recommended by CSA N288.5:22 [3]. Annual reporting of Public reporting is required of site NO_x [6]. 2. Estimation of NO_x, CO and VOC emissions are based on fuel oil consumption is standard industry practice and acceptable by the federal NPRI Notice [5] and the GRI guidance reporting [1].
NPRI Part 5 Substances – Speciated Volatile Organic Compounds					
Speciated Volatile Organic Compounds (VOCs)	h	Monitored: h: Speciate VOCs emissions from all site operations (including burning fuel) may be reportable under Environment Canada's *National Pollutant Release Inventory* Notices [1]. Estimation is of loading (Tonnes/year) as required by the Federal NPRI Notice [1].	Estimate	Annual & N/A	1. Environment Canada's *National Pollutant Release Inventory* Notices [1] require reporting annually if reporting threshold is met for speciated VOC emissions under Part 5. Estimation of VOC emissions released to atmosphere is standard industry practice and acceptable by the federal NPRI Notice [1].

REDACTED

Natural Gas					
Parameter Name	**Parameter Monitoring Criteria ***	**Justification for Monitoring (or Not Monitoring) of Parameter**	**Measured or Estimated**	**Monitoring Frequency & Sample Type**	**Justification for:** 1. **Monitoring Frequency** 2. **Estimation over Measurement**

* See Table 15 *Parameter Monitoring Criteria for the Effluent Verification Monitoring Program* (Criteria h-q)

References:

[1] *GRI Standards*, GRI 305: *Emissions* 2016

[2] Environment Canada, *Greenhouse Gas Reporting,* Annual Notices.

[3] Canadian Standards Association, *Effluent and Emissions Monitoring Programs at Nuclear Facilities*, CSA N288.5:22, 2022 February.

[4] Environment Canada, *National Pollutant Release Inventory,* Annual Notices.

[5] *2023 CRL NPRI Release Estimates.* CRL-509212-055-000, 67890210

[6] *Public Information Program for CNL*, CW-513430-REPT-001. 53749225

REDACTED

4.3.3.6 Site Diesel Generators

Table 33: Detailed Design – Site Diesel Generators

Description: Four types of diesel generators are typically in use on the CRL site:

1. **Emergency Power Standby Stationary Diesel Generators:** Burning of diesel fuel in back-up situations for power failures, electrical shutdowns and typically started weekly for testing. Annual diesel fuel usage tracked.
2. **Emergency Power Standby Portable Diesel Generators:** Burning of diesel fuel in back-up situations and for remote needs (e.g. light standards, high volume air samplers etc.). Tested Routinely. Annual diesel fuel usage tracked.
3. **Other Diesel Generators (Power House):** Burning of diesel fuel for use as cold start light up fuel for the Power House's oil-fired boilers. Tested Routinely. Annual diesel fuel usage tracked.
4. **Contractor Owned Diesel Generator**: Burning of fuel for various projects on site. Routine operation. Annual diesel fuel usage tracked and/or estimated.

Source term & Potential Non-radiological Contaminants: Airborne contaminants from the burning of diesel fuel oil in the various site generators include (CO_2e, Hg, NO_x, SO_2, CO, TPM, PM_{10}, $PM_{2.5}$ and VOCs).

Discharge Characterization: GHG emissions resulting from recent diesel fuel use across the site is insignificant (accounts for <2% or overall CO2e emissions). NPRI Hg emissions (Hg) are typically insignificant; however other resulting NPRI emissions were significant for the site.

Monitoring Strategy: Tracking of fuel use is done throughout the calendar year. Estimation of emissions are completed annually using and generic emission factors for diesel generators as site-specific are not available. Diesel product consumption in Megajoules is also tracked for reporting under the Global Reporting Initiative. Significant air emissions, if any, reported under the GRI are equivalent to those meeting NPRI reporting thresholds.

Reportability:

1. **Emergency Power Standby Stationary Diesel Generators:** Reportable under the NPRI, GHG and GRI.
2. **Emergency Power Standby Portable Diesel Generators:** Reportable under the NPRI and GRI.
3. **Other Diesel Generators (Power House):** Reportable under the NPRI, GHG and GRI.
4. **Contractor Owned Diesel Generator**: Reportable under the NPRI and GRI.

Diesel Generators					
Parameter Name	**Parameter Monitoring Criteria ***	**Justification for Monitoring (or Not Monitoring) of Parameter**	**Measured or Estimated**	**Monitoring Frequency & Sample Type**	**Justification for:** 1. **Monitoring Frequency** 2. **Estimation over Measurement**
Greenhouse Gases (GHGs)					

REDACTED

Diesel Generators					
Parameter Name	**Parameter Monitoring Criteria ***	**Justification for Monitoring (or Not Monitoring) of Parameter**	**Measured or Estimated**	**Monitoring Frequency & Sample Type**	**Justification for:** 1. **Monitoring Frequency** 2. **Estimation over Measurement**
Carbon Dioxide Equivalent (CO_2e) ($CO_2 + CH_4 + N_2O$)	h, i, q	Monitored: h: Total CO_2e emissions from all site activities may be reportable under Environment Canada's Greenhouse Gas Reporting Notices [2]. i: Estimated emissions are used for exposure assessment in the site's Environmental Risk Assessment. q: Total CO_2e emissions from all site activities are used for reporting under the Global Reporting Initiative [1]. CO_2e emissions are estimated based on annual consumption of diesel fuel used on site (using standard emission factors). Estimation is of loading (Tonnes/year) as required by the Federal GHG Notice [2].	Estimate	Annual & N/A	1. Environment Canada's Greenhouse Gas Reporting Notices [2] require reporting annually if reporting threshold is met for site CO_2e emissions. GRI reporting is also annual [1]. 2. Estimation of CO_2e emissions is based on fuel consumption is standard industry practice and acceptable by both the Federal GHG Notice [2] and the GRI reporting guidance [1].
NPRI Part 1B Substances – Alternative Threshold Substances					
Mercury (Hg)	h, i, q	Monitored: h: Total Hg emissions from all Site releases may be reportable under Environment Canada's *National Pollutant Release Inventory* Notices [4]. i: Estimated emissions are used for exposure assessment in the site's Environmental Risk Assessment. q: Total Hg emissions from all site activities may be reportable under the Global Reporting Initiative as an "Other Significant Emission" [1]. Hg emissions are estimated based on annual consumption of the site's diesel use (using standard emission factors). Estimation is of loading (kg/year) as required by the Federal NPRI Notice [4].	Estimate	Annual & N/A	1. Environment Canada's *National Pollutant Release Inventory* Notices [4] require reporting annually if reporting threshold is met for site Hg emissions. GRI reporting is also annual [1]. 2. Estimation of Hg emissions is based on fuel consumption is standard industry practice and acceptable by the federal Notice [4].
NPRI Part 4 Substances - Criteria Air Contaminants (CACs)					

REDACTED

Diesel Generators					
Parameter Name	**Parameter Monitoring Criteria ***	**Justification for Monitoring (or Not Monitoring) of Parameter**	**Measured or Estimated**	**Monitoring Frequency & Sample Type**	**Justification for:** 1. **Monitoring Frequency** 2. **Estimation over Measurement**
Nitrogen Oxides (NO_x) & Sulphur Dioxide (SO_2) & Carbon Monoxide (CO) & Total Particulate Matter (TPM) & Particulate Matter 10 micron (PM_{10}) & Particulate Matter 2.5 micron ($PM_{2.5}$) & Volatile Organic Compounds (VOCs)	h, i, o, q	Monitored: h: Total NO_x, SO_2, CO, TPM, PM_{10}, $PM_{2.5}$ and VOC emissions from all site operations may be reportable under Environment Canada's *National Pollutant Release Inventory* Notices [4]. h: Public reporting is required of site NO_x and SO_2 emissions [6]. i: Estimated emissions are used for exposure assessment in the site's Environmental Risk Assessment. o: The site's use of diesel in diesel generators is typically >10% of each of the site's NO_x, SO_2, CO, TPM, PM_{10}, $PM_{2.5}$ and VOC NPRI reporting thresholds and are therefore considered a significant source of these emissions [5]. Emissions are estimated based on annual consumption of the site's diesel use using generic emission factors. Estimation is of loading (Tonnes/year) as required by the Federal NPRI Notice [4]. q: Total NO_x, SO_2, CO, TPM, PM_{10}, $PM_{2.5}$ and VOC emissions from all site activities may be reportable under the Global Reporting Initiative as an "Other Significant Emission" [1].	Estimate	Annual & N/A	1. Environment Canada's *National Pollutant Release Inventory* Notices [4] require reporting annually if reporting threshold is met for site Total NO_x, SO_2, CO, TPM, PM_{10}, $PM_{2.5}$ and VOC emissions. Annual review of significant airborne emissions which were estimated is recommended by CSA N288.5 [2]. Annual reporting of Public reporting is required of site NO_x and SO_2 [6]. 2. Estimation of Total SO_2 and TPM emissions are based on fuel oil consumption is standard industry practice and acceptable by both the federal NPRI Notice [4] and the GRI guidance reporting [1].
NPRI Part 5 Substances – Speciated Volatile Organic Compounds					
Speciated Volatile Organic Compounds (VOCs)	h	Monitored: h: Speciate VOCs emissions from all site operations (including burning fuel) may be reportable under Environment Canada's *National Pollutant Release Inventory* Notices [1]. Estimation is of loading (Tonnes/year) as required by the	Estimate	Annual & N/A	1. Environment Canada's *National Pollutant Release Inventory* Notices [1] require reporting annually if reporting threshold is met for speciated VOC emissions under Part 5. 2. Estimation of VOC emissions released to

REDACTED

Diesel Generators					
Parameter Name	**Parameter Monitoring Criteria ***	**Justification for Monitoring (or Not Monitoring) of Parameter**	**Measured or Estimated**	**Monitoring Frequency & Sample Type**	**Justification for:** 1. **Monitoring Frequency** 2. **Estimation over Measurement**
		Federal NPRI Notice [1].			atmosphere is standard industry practice and acceptable by the federal NPRI Notice [1].

* See Table 15 *Parameter Monitoring Criteria for the Effluent Verification Monitoring Program* (Criteria h-q)

References:

[1] *Global Sustainability Standards Board, Global Reporting Initiative* 305: Emissions, 2016.

[2] *Environment Canada, Greenhouse Gas Reporting, Annual Notices*.

[3] Canadian Standards Association, *Effluent and Emissions Monitoring Programs at Nuclear Facilities*, CSA N288.5-22, 2022 February.

[4] *Environment Canada, National Pollutant Release Inventory, Annual Notices*.

[5] 2023 *CRL NPRI Release Estimates*. CRL-509212-055-000, 67890210

[6] *Public Information Program for CNL*, CW-513430-REPT-001. 53749225

REDACTED

4.3.3.7 [redacted] Fuel Oil use to Cold Start Boilers in [redacted]

Table 34: Detailed Design – [redacted] Fuel Oil use to Cold Start Boilers in [redacted]

Description: The Power House boilers run on natural gas primarily with [redacted] fuel oil as a backup. These boilers however also use a minor amount of [redacted] fuel oil as cold start light up fuel. The burning of this fuel releases non-radiological airborne emissions.

Source term & Potential Non-radiological Contaminants: Airborne contaminants from the burning of [redacted] Fuel oil include CO_2e, NO_x, SO_2, CO, TPM, PM_{10}, $PM_{2.5}$ and VOCs.

Discharge Characterization: Recent [redacted] fuel use in [redacted] resulted in: insignificant (i.e. <1%) of the site's CO_2e emissions; minor emissions (<10% of site's total) for each of the NPRI contaminants.

Monitoring Strategy: Tracking the Power House's fuel oil use is done throughout the calendar year. Emission estimates are calculated annually using generic emission factors as site-specific are not available. Emission estimates are completed in line with NPRI [3], GHG [2] and GRI reporting [1].

[redacted] Fuel Oil use to Cold Start Boilers in [redacted]					
Parameter Name	**Parameter Monitoring Criteria ***	**Justification for Monitoring (or Not Monitoring) of Parameter**	**Measured or Estimated**	**Monitoring Frequency & Sample Type**	**Justification for:** 1. **Monitoring Frequency** 2. **Estimation over Measurement**
Greenhouse Gases (GHGs)					
Carbon Dioxide Equivalent (CO_2e) ($CO_2 + CH_4 + N_2O$)	h, i, q	Monitored: h: Total CO_2e emissions from all site activities may be reportable under Environment Canada's Greenhouse Gas Reporting Notices [2]. i: Estimated emissions are used for exposure assessment in the site's Environmental Risk Assessment. q: Total CO_2e emissions from all site activities are used for reporting under the Global Reporting Initiative [1]. CO_2e emissions are estimated based on annual consumption of [redacted] Fuel oil used on site (using standard emission factors). Estimation is of loading (Tonnes/year) as required by the Federal GHG Notice [2].	Estimate	Annual & N/A	1. Environment Canada's Greenhouse Gas Reporting Notices [2] require reporting annually if reporting threshold is met for site CO_2e emissions. GRI reporting is also annual [1]. 2. Estimation of CO_2e emissions is based on fuel consumption is standard industry practice and acceptable by both the Federal GHG Notice [2] and the GRI reporting guidance [1].
NPRI Part 1B Substances – Alternative Threshold Substances					

REDACTED

[redacted] Fuel Oil use to Cold Start Boilers in [redacted]					
Parameter Name	**Parameter Monitoring Criteria ***	**Justification for Monitoring (or Not Monitoring) of Parameter**	**Measured or Estimated**	**Monitoring Frequency & Sample Type**	**Justification for:** 1. **Monitoring Frequency** 2. **Estimation over Measurement**
Mercury (Hg)	h, i, q	Monitored: h: Total Hg emissions from all site releases may be reportable under Environment Canada's *National Pollutant Release Inventory* Notices [4]. i: Estimated emissions are used for exposure assessment in the site's Environmental Risk Assessment. q: Total Hg emissions from all site activities may be reportable under the Global Reporting Initiative as an "Other Significant Emission" [1]. Hg emissions are estimated based on annual consumption of the site's [redacted] fuel use (using standard emission factors). Estimation is of loading (kg/year) as required by the Federal NPRI Notice [4].	Estimate	Annual & N/A	1. Environment Canada's *National Pollutant Release Inventory* Notices [4] require reporting annually if reporting threshold is met for site Hg emissions. GRI reporting is also annual [1]. 2. Estimation of Hg emissions are based on fuel consumption is standard industry practice and acceptable by the federal Notice [4].
NPRI Part 4 Substances - Criteria Air Contaminants (CACs)					

REDACTED

[redacted] Fuel Oil use to Cold Start Boilers in [redacted]					
Parameter Name	**Parameter Monitoring Criteria ***	**Justification for Monitoring (or Not Monitoring) of Parameter**	**Measured or Estimated**	**Monitoring Frequency & Sample Type**	**Justification for:** 1. **Monitoring Frequency** 2. **Estimation over Measurement**
Nitrogen Oxides (NO_x) & Sulphur Dioxide (SO_2) & Carbon Monoxide (CO) & Total Particulate Matter (TPM) & Particulate Matter 10 micron (PM_{10}) & Particulate Matter 2.5 micron ($PM_{2.5}$) & Volatile Organic Compounds (VOCs)	h, i, q	Monitored: h: Total NO_x, SO_2, CO, TPM, PM_{10}, $PM_{2.5}$ and VOC emissions from all site operations may be reportable under Environment Canada's *National Pollutant Release Inventory* Notices [3]. h: Public reporting is required of site NO_x & SO_2 [4]. i: Estimated emissions are used for exposure assessment in the site's Environmental Risk Assessment. NO_x, SO_2, CO, TPM, PM_{10}, $PM_{2.5}$ and VOC emissions are estimated based on annual consumption of the site's [redacted] Fuel oil by the Power House boilers. Estimation is of loading (Tonnes/year) as required by the Federal NPRI Notice [3]. q: Total NO_x, SO_2, CO, TPM, PM_{10}, $PM_{2.5}$ and VOC emissions from all site activities may be reportable under the Global Reporting Initiative as an "Other Significant Emission" [1].	Estimate	Annual & N/A	1. Environment Canada's *National Pollutant Release Inventory* Notices [3] require reporting annually if reporting threshold is met for site NO_x, SO_2, CO, TPM, PM_{10}, $PM_{2.5}$ and VOC emissions. Annual reporting of Public reporting is required of site NO_x & SO_2 [4]. 2. Estimation of NO_x, SO_2, CO, TPM, PM_{10}, $PM_{2.5}$ and VOC emissions are based on fuel oil consumption is standard industry practice and acceptable by the federal NPRI Notice [3] and the GRI guidance reporting [1].
NPRI Part 5 Substances – Speciated Volatile Organic Compounds					
Speciated Volatile Organic Compounds (VOCs)	h	Monitored: h: Speciate VOCs emissions from all site operations (including burning fuel) may be reportable under Environment Canada's *National Pollutant Release Inventory* Notices [1]. Estimation is of loading (Tonnes/year) as required by the Federal NPRI Notice [1].	Estimate	Annual & N/A	1. Environment Canada's *National Pollutant Release Inventory* Notices [1] require reporting annually if reporting threshold is met for speciated VOC emissions under Part 5. 2. Estimation of VOC emissions released to atmosphere is standard industry practice and acceptable by the federal NPRI Notice [1].

REDACTED

[redacted] Fuel Oil use to Cold Start Boilers in [redacted]					
Parameter Name	**Parameter Monitoring Criteria ***	**Justification for Monitoring (or Not Monitoring) of Parameter**	**Measured or Estimated**	**Monitoring Frequency & Sample Type**	**Justification for:** 1. **Monitoring Frequency** 2. **Estimation over Measurement**

* See Table 15 *Parameter Monitoring Criteria for the Effluent Verification Monitoring Program* (Criteria h-q)

References:

[1] Global Sustainability Standards Board, *Global Reporting Initiative 305: Emissions,* 2016.
[2] Environment Canada, *Greenhouse Gas Reporting,* Annual Notices.
[3] Environment Canada, *National Pollutant Release Inventory,* Annual Notices.
[4] *Public Information Program for CNL*, CW-513430-REPT-001. 53749225

REDACTED

4.3.3.8 On-Site Vehicle Transportation

Table 35: Detailed Design – On-Site Vehicle Transportation

Description: Vehicles/equipment travelling on the CRL site are a result of the operations on site. On-site transportation includes the CNL Fleet of vehicles, CNL staff personal vehicles and Contractors.

Source term: Airborne contaminants from the burning of fuel in vehicles as well as particulates from these vehicles travelling on unpaved roads (i.e. road dust).

Potential Non-radiological Contaminants: By-products from fuel (e.g. diesel and gasoline) combustion (CO_2e, NO_x, SO_2, CO, TPM, PM_{10}, $PM_{2.5}$ and VOCs) as well as particulates (TPM, PM_{10}, $PM_{2.5}$) and from travelling on unpaved roads. Emissions are determined by tracking/estimating fuel type and use as well as tracking vehicle types and distances travelling on unpaved roads on CRL property.

Discharge Characterization: Emission vary annually depending on activity on the site. Recent CO_2e from on-site transportation emissions was approximately 8% of the site's GHG emissions. Road dust resulting from on-site transportation (CNL and Non-CNL vehicles) was a significant portion of the site's overall TPM (>90%), PM_{10} (>80%) and $PM_{2.5}$ (>30%) emissions.

Monitoring Strategy: For GHG emission estimates, tracking the quantity of fuel used by fuel type is done throughout the year. Emission estimates are completed annually. Total CO_2e emissions from all site activities are used for reporting under the Global Reporting Initiative [1].

For NPRI particulate emission estimates, the distance each vehicle category travelled on unpaved roads is estimated and their emissions are calculated using the road dust calculator provided by the NPRI. The total Vehicle Kilometers Traveled (VKT) on unpaved roads needs to be ≥ 10,000 VKT/year to trigger the need to include emissions estimates in NPRI reporting. If <10,000 VKT per year, road dust emissions need not be included in the site's emissions. This calculator also requires additional site-specific information such as the number of operating days, road composition and number of precipitation days. Significant site air emissions reported under the GRI [1] are equivalent to those meeting NPRI reporting thresholds and would include contributions from road dust.

On-Site Vehicle Transportation					
Parameter Name	**Parameter Monitoring Criteria ***	**Justification for Monitoring (or Not Monitoring) of Parameter**	**Measured or Estimated**	**Monitoring Frequency & Sample Type**	**Justification for:** 1. **Monitoring Frequency** 2. **Estimation over Measurement**
Greenhouse Gases (GHGs)					

REDACTED

On-Site Vehicle Transportation					
Parameter Name	**Parameter Monitoring Criteria ***	**Justification for Monitoring (or Not Monitoring) of Parameter**	**Measured or Estimated**	**Monitoring Frequency & Sample Type**	**Justification for:** 1. **Monitoring Frequency** 2. **Estimation over Measurement**
Carbon Dioxide Equivalent (CO_2e) ($CO_2 + CH_4 + N_2O$)	h, i, q	Monitored: h: Total CO_2e emissions from all site activities may be reportable under Environment Canada's Greenhouse Gas Reporting Notices [2]. i: Estimated emissions are used for exposure assessment in the site's Environmental Risk Assessment. q: Total CO_2e emissions from all site activities are used for reporting under the Global Reporting Initiative [1]. CO_2e emissions are estimated based on annual fuel used on site (using standard emission factors and estimations where quantities are not available). Estimation is of loading (Tonnes/year) as required by the Federal GHG Notice [2].	Estimate	Annual & N/A	1. Environment Canada's Greenhouse Gas Reporting Notices [2] require reporting annually if reporting threshold is met for site CO_2e emissions. GRI reporting is also annual [1]. 2. Estimation of CO_2e emissions is based on fuel consumption is standard industry practice and acceptable by both the Federal GHG Notice [2] and the GRI reporting guidance [1].
NPRI Part 4 Substances - Criteria Air Contaminants (CACs)					
Nitrogen Oxides (NO_x) & Sulphur Dioxide (SO_2) & Carbon Monoxide (CO) & Volatile Organic Compounds (VOCs)	--	Not Monitored: Fuel use in vehicles would result in airborne NO_x, SO_2, CO and VOCs but these emissions are not reportable under the NPRI Notice, therefore their monitoring is not required for the NPRI or GRI [1], [4].	N/A	N/A	N/A

REDACTED

On-Site Vehicle Transportation					
Parameter Name	**Parameter Monitoring Criteria ***	**Justification for Monitoring (or Not Monitoring) of Parameter**	**Measured or Estimated**	**Monitoring Frequency & Sample Type**	**Justification for:** 1. **Monitoring Frequency** 2. **Estimation over Measurement**
Vehicle Kilometers Travelled on unpaved roads	h	Monitored: h: Tracking of the Vehicle Kilometers Traveled (VKT) on CRL's unpaved roads is required by the NPRI; if determined to be ≥ 10,000 VKT/year, road dust emissions need to be estimated and included in site particulate emission estimates; if <10,000 VKT in given year, road dust emissions need not be included [4].	Estimate	Annual & N/A	1. Environment Canada's *National Pollutant Release Inventory* Notices [4] requires reporting annually if reporting threshold is met for site TPM, PM_{10} and $PM_{2.5}$ emissions. 2. Estimation of VKT on unpaved roads is an acceptable method according to the NPRI Notice [4].
Total Particulate Matter (TPM) & Particulate Matter 10 micron (PM_{10}) & Particulate Matter 2.5 micron ($PM_{2.5}$)	h, i, o, q	Monitored: h: Total TPM, PM_{10} and $PM_{2.5}$ emissions from all site operations may be reportable under Environment Canada's *National Pollutant Release Inventory* Notices [4]. i: Estimated emissions are used for exposure assessment in the site's Environmental Risk Assessment. TPM, PM_{10} and $PM_{2.5}$ from travel on unpaved roads are estimated based on vehicle type, distance travelled on unpaved roads, road conditions (surface type, rain events, dust suppression etc). Estimation is of loading (Tonnes/year) as required by the Federal NPRI Notice [4]. o: The site's road dust emissions typically are >10% of the NPRI reporting threshold and are therefore considered a significant source of these emissions [5] q: Total TPM, PM_{10} and $PM_{2.5}$ emissions from NPRI reporting may be reportable under the Global Reporting Initiative as an "Other Significant Emission" [1].	Estimate	Annual & N/A	1. Environment Canada's National Pollutant Release Inventory Notices [4] require reporting annually if reporting threshold is met for site TPM, PM_{10} and $PM_{2.5}$ emissions. Annual review of significant airborne emissions which were estimated is recommended by CSA N288.5:22 [3]. 2. Estimation of particulate emissions from road dust is standard industry practice and acceptable by the federal NPRI Notice (NPRI provides guidance and a calculator) [4] and the GRI guidance reporting [1].

REDACTED

On-Site Vehicle Transportation					
Parameter Name	**Parameter Monitoring Criteria ***	**Justification for Monitoring (or Not Monitoring) of Parameter**	**Measured or Estimated**	**Monitoring Frequency & Sample Type**	**Justification for:** 1. **Monitoring Frequency** 2. **Estimation over Measurement**

* See Table 15 *Parameter Monitoring Criteria for the Effluent Verification Monitoring Program* (Criteria h-q)

References:

[1] Global Sustainability Standards Board, *Global Reporting Initiative 305: Emissions,* 2016.
[2] Environment Canada, *Greenhouse Gas Reporting,* Annual Notices.
[3] CSA N288.5:22, *Canadian Standards Association, Effluent and Emissions Monitoring Programs at Nuclear Facilities, 2022* February.
[4] Environment Canada, *National Pollutant Release Inventory,* Annual Notices.
[5] *2023 CRL NPRI Release Estimates*. CRL-509212-055-000, 67890210

REDACTED

4.3.3.9 Fire Fighting Training Complex Burning

Table 36: Detailed Design – Fire Fighting Training Complex Burning

Description: This complex completes training exercises which include the burning of wood pallets and straw bales. These burn exercises occur on occasion throughout the warmer seasons of the year and vary from year to year depending on training needs.

Source term & Potential Non-radiological Contaminants: This burning of straw and wood results in airborne emissions of both NPRI Criteria Air Contaminants (NO_x, SO_2, CO, TPM, PM_{10}, $PM_{2.5}$ and VOCs) as well as Greenhouse Gases (CO_2e).

Discharge Characterization: Emissions from this activity are not significant. Recently emissions were <1% of the sites' GHG emissions, and <1% for all NPRI CACS except for CO and VOCs (neither of which meet the NPRI reporting threshold for the site).

Monitoring Strategy: Tracking of the number of straw bales and the ft^3 of wood burned is done through out the calendar year. Estimating emissions using generic emission factors is done annually. Significant site air emissions reported under the GRI are equivalent to those meeting NPRI reporting thresholds and would include contributions from the burning of this wood and straw. Total CO_2e emissions from all site activities are used for reporting under the Global Reporting Initiative [1].

Fire Fighting Training Complex Burning					
Parameter Name	**Parameter Monitoring Criteria ***	**Justification for Monitoring (or Not Monitoring) of Parameter**	**Measured or Estimated**	**Monitoring Frequency & Sample Type**	**Justification for:** 1. **Monitoring Frequency** 2. **Estimation over Measurement**
Greenhouse Gases (GHGs)					
Carbon Dioxide Equivalent (CO_2e) ($CO_2 + CH_4 + N_2O$)	h, i, q	Monitored: h: Total CO_2e emissions from all site activities may be reportable under Environment Canada's Greenhouse Gas Reporting Notices [2]. i: Estimated emissions are used for exposure assessment in the site's Environmental Risk Assessment. q: Total CO_2e emissions from all site activities are used for reporting under the Global Reporting Initiative [1]. CO_2e emissions are estimated based on annual consumption of wood and straw used on site using standard emission factors. Estimation is of loading (Tonnes/year) as required by the Federal GHG Notice [2].	Estimate	Annual & N/A	1. Environment Canada's Greenhouse Gas Reporting Notices [2] require reporting annually if reporting threshold is met for site CO_2e emissions. GRI reporting is also annual [1]. 2. Estimation of CO_2e emissions is based on fuel consumption is standard industry practice and acceptable by both the Federal GHG Notice [2] and the GRI reporting guidance [1].
NPRI Part 4 Substances - Criteria Air Contaminants (CACs)					

REDACTED

Fire Fighting Training Complex Burning					
Parameter Name	**Parameter Monitoring Criteria ***	**Justification for Monitoring (or Not Monitoring) of Parameter**	**Measured or Estimated**	**Monitoring Frequency & Sample Type**	**Justification for:** 1. **Monitoring Frequency** 2. **Estimation over Measurement**
Nitrogen Oxides (NO_x) & Sulphur Dioxide (SO_2) & Carbon Monoxide (CO) & Particulate Matter 10 micron (PM_{10}) & Volatile Organic Carbon (VOC)	h, i, o, q	Monitored: h: Total NO_x, SO_2, CO, PM_{10} and VOC emissions from all site operations may be reportable under Environment Canada's *National Pollutant Release Inventory* Notices [4]. NO_x, SO_2, CO, PM_{10} and VOC emissions are estimated based on the amount of straw and wood burned annually using generic emission factors. Estimation is of loading (Tonnes/year) as required by the Federal NPRI Notice [4]. h: Public reporting is required of site NO_x & SO_2 [6]. i: Estimated emissions are used for exposure assessment in the site's Environmental Risk Assessment. o: VOC emissions have been ≥ 10% of the NPRI reporting threshold (not consistently however as fuel use varies) [7]. q: Total NO_x, SO_2, CO, PM_{10} and VOC emissions from all site activities may be reportable under the Global Reporting Initiative as an "Other Significant Emission" [1].	Estimate	Annual & N/A	1. Environment Canada's *National Pollutant Release Inventory* Notices [4] require reporting annually if reporting threshold is met for site NO_x, SO_2, CO, PM_{10} and VOC emissions. Annual review of significant airborne emissions which were estimated is recommended by CSA N288.5:22 [3]. Annual reporting of Public reporting is required of site NO_x & SO_2 [6]. 2. Estimation of NO_x, SO_2, CO, PM_{10} and VOC emissions are based on fuel consumption is standard industry practice and acceptable by the federal NPRI Notice [4] and the GRI guidance reporting [1].
Total Particulate Matter (TPM) & Particulate Matter 2.5 micron ($PM_{2.5}$)	N/A	Not Monitored: Particulate emissions from the burning of straw/hay and wood are assumed to be 100% PM_{10} in particulate emission estimations [5].	N/A	N/A	N/A
NPRI Part 5 Substances – Speciated Volatile Organic Compounds					

REDACTED

Fire Fighting Training Complex Burning					
Parameter Name	**Parameter Monitoring Criteria ***	**Justification for Monitoring (or Not Monitoring) of Parameter**	**Measured or Estimated**	**Monitoring Frequency & Sample Type**	**Justification for:** 1. **Monitoring Frequency** 2. **Estimation over Measurement**
Speciated Volatile Organic Compounds (VOCs)	h	Monitored: h: Speciate VOCs emissions from all site operations (including burning fuel) may be reportable under Environment Canada's *National Pollutant Release Inventory* Notices [1]. Estimation is of loading (Tonnes/year) as required by the Federal NPRI Notice [1].	Estimate	Annual & N/A	1. Environment Canada's *National Pollutant Release Inventory* Notices [1] require reporting annually if reporting threshold is met for speciated VOC emissions under Part 5. 2. Estimation of VOC emissions released to atmosphere is standard industry practice and acceptable by the federal NPRI Notice [1].

* See Table 15 *Parameter Monitoring Criteria for the Effluent Verification Monitoring Program* (Criteria h-q)

References:

[1] Global Sustainability Standards Board, *Global Reporting Initiative 305: Emissions*, 2016.
[2] Environment Canada, *Greenhouse Gas Reporting,* Annual Notices.
[3] Canadian Standards Association, *Effluent and Emissions Monitoring Programs at Nuclear Facilities*, CSA N288.5-22, 2022 February.
[4] Environment Canada, *National Pollutant Release Inventory,* Annual Notices.
[5] *Unites States Environmental Protection Agency*, AP-42, *Compilation of Air Pollutant Emissions Factors*
[6] *Public Information Program for CNL*, CW-513430-REPT-001. 53749225
[7] *2023 CRL NPRI Release Estimates*. CRL-509212-055-000, 67890210

REDACTED

4.3.3.10 Stationary Equipment

Table 37: Detailed Design – Stationary Equipment

Description: Concrete/Rock/Asphalt Crusher, Shredder, Scalping Screen, Backup for Fire water pumps and Heaters burning diesel fuel to support site operations. This fuel use results in airborne emissions of both NPRI Criteria Air Contaminants as well as Greenhouse Gases.

Source term & Potential Non-radiological Contaminants: Airborne contaminants from the burning of diesel fuel results include CO_2e, NO_x, SO_2, CO, TPM, PM_{10}, $PM_{2.5}$ and VOCs. Note: the airborne particulate emissions from the mechanical action of crushing activities is covered under the Materiel Crushing section.

Discharge Characterization: Recent diesel use in other stationary equipment was approximately 30,000 litres. All releases were ≤5% of their respective site total releases [4].

Monitoring Strategy: Diesel use is tracked throughout year and contaminant emissions are estimated annually using generic emission factors as site-specific are not available. Significant site air emissions reported under the GRI are equivalent to those meeting NPRI reporting thresholds and would include contributions from this diesel use.

Stationary Equipment					
Parameter Name	**Parameter Monitoring Criteria ***	**Justification for Monitoring (or Not Monitoring) of Parameter**	**Measured or Estimated**	**Monitoring Frequency & Sample Type**	**Justification for:** 1. **Monitoring Frequency** 2. **Estimation over Measurement**
Greenhouse Gases (GHGs)					
Carbon Dioxide Equivalent (CO_2e) ($CO_2 + CH_4 + N_2O$)	h, q	Monitored: h: Total CO_2e emissions from all site activities may be reportable under Environment Canada's Greenhouse Gas Reporting Notices [2]. q: Total CO_2e emissions from all site activities are used for reporting under the Global Reporting Initiative [1]. CO_2e emissions are estimated based on annual consumption of diesel fuel used on site (using standard emission factors). Estimation is of loading (Tonnes/year) as required by the Federal GHG Notice [2].	Estimate	Annual & N/A	1. Environment Canada's Greenhouse Gas Reporting Notices [2] require reporting annually if reporting threshold is met for site CO_2e emissions. GRI reporting is also annual [1]. 2. Estimation of CO_2e emissions is based on fuel consumption is standard industry practice and acceptable by both the Federal GHG Notice [2] and the GRI reporting guidance [1].
NPRI Part 1B Substances – Alternative Threshold Substances					

REDACTED

Stationary Equipment					
Parameter Name	**Parameter Monitoring Criteria ***	**Justification for Monitoring (or Not Monitoring) of Parameter**	**Measured or Estimated**	**Monitoring Frequency & Sample Type**	**Justification for:** 1. **Monitoring Frequency** 2. **Estimation over Measurement**
Mercury (Hg)	h, q	Monitored: h: Total Hg emissions from all Site releases may be reportable under Environment Canada's *National Pollutant Release Inventory* Notices [3]. q: Total Hg emissions from all site activities may be reportable under the Global Reporting Initiative as an "Other Significant Emission" [1]. Hg emissions are estimated based on annual consumption of the site's diesel use (using standard emission factors). Estimation is of loading (kg/year) as required by the Federal NPRI Notice [3].	Estimate	Annual & N/A	1. Environment Canada's *National Pollutant Release Inventory* Notices [3] require reporting annually if reporting threshold is met for site Hg emissions. GRI reporting is also annual [1]. 2. Estimation of Hg emissions is based on fuel consumption is standard industry practice and acceptable by the federal Notice [3].
NPRI Part 4 Substances - Criteria Air Contaminants (CACs)					

REDACTED

Stationary Equipment					
Parameter Name	**Parameter Monitoring Criteria ***	**Justification for Monitoring (or Not Monitoring) of Parameter**	**Measured or Estimated**	**Monitoring Frequency & Sample Type**	**Justification for:** 1. **Monitoring Frequency** 2. **Estimation over Measurement**
Nitrogen Oxides (NO_x) & Sulphur Dioxide (SO_2) & Carbon Monoxide (CO) & Total Particulate Matter (TPM) & Particulate Matter 10 micron (PM_{10}) & Particulate Matter 2.5 micron ($PM_{2.5}$) & Volatile Organic Compounds (VOCs)	h, q	Monitored: h: Total NOx, SO_2, CO, TPM, PM_{10}, $PM_{2.5}$ and VOC emissions from all site operations may be reportable under Environment Canada's *National Pollutant Release Inventory* Notices [3]. Total NOx, SO_2, CO, TPM, PM_{10}, $PM_{2.5}$ and VOC emissions are estimated based on annual consumption of the site's diesel use using generic emission factors. Estimation is of loading (Tonnes/year) as required by the Federal NPRI Notice [3]. h: Public reporting is required of site NOx and SO_2 [5]. q: Total NOx, SO_2, CO, TPM, PM_{10}, $PM_{2.5}$ and VOC emissions from all site activities may be reportable under the Global Reporting Initiative as an "Other Significant Emission" [1].	Estimate	Annual & N/A	1. Environment Canada's *National Pollutant Release Inventory* Notices [3] require reporting annually if reporting threshold is met for site Total NOx, SO_2, CO, TPM, PM_{10}, $PM_{2.5}$ and VOC emissions. Annual reporting of Public reporting is required of site NOx and SO_2 [5]. 2. Estimation of Total NOx, SO_2, CO, TPM, PM_{10}, $PM_{2.5}$ and VOC emissions are based on fuel oil consumption is standard industry practice and acceptable by both the federal NPRI Notice [3] and the GRI guidance reporting [1].
NPRI Part 5 Substances – Speciated Volatile Organic Compounds					
Speciated Volatile Organic Compounds (VOCs)	h	Monitored: h: Speciate VOCs emissions from all site operations (including burning fuel) may be reportable under Environment Canada's *National Pollutant Release Inventory* Notices [1]. Estimation is of loading (Tonnes/year) as required by the Federal NPRI Notice [1].	Estimate	Annual & N/A	1. Environment Canada's *National Pollutant Release Inventory* Notices [1] require reporting annually if reporting threshold is met for speciated VOC emissions under Part 5. 2. Estimation of VOC emissions released to atmosphere is standard industry practice and acceptable by the federal NPRI Notice [1].

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Stationary Equipment					
Parameter Name	**Parameter Monitoring Criteria ***	**Justification for Monitoring (or Not Monitoring) of Parameter**	**Measured or Estimated**	**Monitoring Frequency & Sample Type**	**Justification for:** 1. **Monitoring Frequency** 2. **Estimation over Measurement**

* See Table 15 *Parameter Monitoring Criteria for the Effluent Verification Monitoring Program* (Criteria h-q)

References:

[1] Global Sustainability Standards Board, *Global Reporting Initiative 305: Emissions*, 2016.
[2] Environment Canada, *Greenhouse Gas Reporting,* Annual Notices.
[3] Environment Canada, *National Pollutant Release Inventory,* Annual Notices.
[4] *2023 CRL NPRI Release Estimates.* CRL-509212-055-000*,* 67890210
[5] *Public Information Program for CNL*, CW-513430-REPT-001. 53749225

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4.3.3.11 Petroleum Storage Tanks

Table 38: Detailed Design – Petroleum Storage Tanks

Description: Storage Tanks containing products which can emit VOCs, passively release VOCs while the product is in storage. These emissions vary depending on the type of product, amount of product and the specifics of the tank itself (size, design, colour etc.)

Source term & Potential Non-radiological Contaminants: Airborne contaminants from the storage of fuel include insignificant amounts of VOCs.

Discharge Characterization: Emission estimates are not completed annually but instead are carried from year-to-year and is estimated to be <1% of both the site's VOC emissions as well as <1% of the NPRI reporting threshold for VOCs, therefore storage tank emissions is not considered a significant source of any of these emissions.

Monitoring Strategy: Characteristics of actively used petroleum fuel tanks are used to populate the NPRIs storage tanks software which estimates the VOC emissions. Emissions were estimated in the past and determined to be < 0.1% of Site VOC emissions and with VOC emissions as a whole not meeting the NPRI reporting threshold, routine annual emission estimates were not deemed to be required but instead the previous estimate is kept. In the event that the VOCs for the site reach the NPRI reporting threshold, an up-to-date storage tank emission estimate would be calculated. Significant site air emissions reported under the GRI are equivalent to those meeting NPRI reporting thresholds and would include VOCs from storage tanks.

Petroleum Storage Tanks					
Parameter Name	**Parameter Monitoring Criteria ***	**Justification for Monitoring (or Not Monitoring) of Parameter**	**Measured or Estimated**	**Monitoring Frequency & Sample Type**	**Justification for:** 1. **Monitoring Frequency** 2. **Estimation over Measurement**
NPRI Part 4 Substances - Criteria Air Contaminants (CACs)					
Volatile Organic Compounds (VOCs)	h, i, q	Monitored: h: Total VOC emissions from all site operations may be reportable under Environment Canada's *National Pollutant Release Inventory* Notices [2]. i: Estimated emissions are used for exposure assessment in the site's Environmental Risk Assessment. Estimation is of loading (Tonnes/year) as required by the Federal NPRI Notice [2]. q: Total VOC emissions from all site activities may be reportable under the Global Reporting Initiative as an "Other Significant Emission" [1].	Estimate	Annual & N/A	1. Environment Canada's *National Pollutant Release Inventory* Notices [2] require reporting annually if reporting threshold is met for site VOC emissions. 2. Estimation of VOC emissions released to atmosphere is standard industry practice and acceptable by the federal NPRI Notice [2] and the GRI guidance reporting [1].
NPRI Part 5 Substances – Speciated Volatile Organic Compounds					

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Petroleum Storage Tanks					
Parameter Name	**Parameter Monitoring Criteria ***	**Justification for Monitoring (or Not Monitoring) of Parameter**	**Measured or Estimated**	**Monitoring Frequency & Sample Type**	**Justification for:** 1. **Monitoring Frequency** 2. **Estimation over Measurement**
Speciated Volatile Organic Compounds (VOCs)	h	Monitored: h: Speciate VOCs emissions from all site operations (including burning fuel) may be reportable under Environment Canada's *National Pollutant Release Inventory* Notices [1]. Estimation is of loading (Tonnes/year) as required by the Federal NPRI Notice [1].	Estimate	Annual & N/A	1. Environment Canada's *National Pollutant Release Inventory* Notices [1] require reporting annually if reporting threshold is met for speciated VOC emissions under Part 5. 2. Estimation of VOC emissions released to atmosphere is standard industry practice and acceptable by the federal NPRI Notice [1].

* See Table 15 *Parameter Monitoring Criteria for the Effluent Verification Monitoring Program* (Criteria h-q)

References:

[1] Global Sustainability Standards Board, *Global Reporting Initiative 305: Emissions*, 2016.
[2] Environment Canada, *National Pollutant Release Inventory,* Annual Notices.

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4.3.3.12 Construction/Demolition Activities

Table 39: Detailed Design – Construction/Demolition Activities

Description: Various construction/demolition work is completed at the Chalk River site throughout the year. Mitigation measures are in place in order to reduce airborne particulate emissions from these activities however, emissions still occur.

Source term & Potential Non-radiological Contaminants: Airborne contaminants from the construction/demolition activities include particulates (TPM, PM_{10} and $PM_{2.5}$).

Discharge Characterization: Typical emissions of particulates from construction/demolition activities are <1% of the site's particulate emissions and are therefore considered insignificant for CRL.

Monitoring Strategy: TPM from excavation projects is conservatively estimated based on a sampling campaign completed which measured TPM emissions on an average construction day from various construction types and estimating the number of construction days at the CRL site in a given year. Significant site air emissions reported under the GRI are equivalent to those meeting NPRI reporting thresholds and would include particulate contributions from construction/demolition activities.

Construction/Demolition Activities					
Parameter Name	**Parameter Monitoring Criteria ***	**Justification for Monitoring (or Not Monitoring) of Parameter**	**Measured or Estimated**	**Monitoring Frequency & Sample Type**	**Justification for:** 1. **Monitoring Frequency** 2. **Estimation over Measurement**
NPRI Part 4 Substances - Criteria Air Contaminants (CACs)					
Total Particulate Matter (TPM)	h, i, q	Monitored: h: Total TPM emissions from all site operations may be reportable under Environment Canada's *National Pollutant Release Inventory* Notices [1]. i: Estimated emissions are used for exposure assessment in the site's Environmental Risk Assessment. TPM from excavation projects is conservatively estimated based on a sampling campaign completed which measured TPM emissions on an average construction day from various construction types and estimating the number of construction days at the CRL site in a given year. Estimation is of loading (Tonnes/year) as required by the Federal NPRI Notice [1]. q: Total TPM emissions from NPRI reporting may be reportable under the Global Reporting Initiative as an "Other Significant Emission" [2].	Estimate	Annual & N/A	1. Environment Canada's National Pollutant Release Inventory Notices [1] require reporting annually if reporting threshold is met for site TPM emissions. 2. Estimation of particulates from excavation projects is standard industry practice and acceptable by the federal NPRI Notice (NPRI provides guidance and a calculator) [1] and the GRI guidance reporting [2].

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Construction/Demolition Activities					
Parameter Name	**Parameter Monitoring Criteria ***	**Justification for Monitoring (or Not Monitoring) of Parameter**	**Measured or Estimated**	**Monitoring Frequency & Sample Type**	**Justification for:** 1. **Monitoring Frequency** 2. **Estimation over Measurement**
Particulate Matter 10 micron (PM_{10}) & Particulate Matter 2.5 micron ($PM_{2.5}$)	N/A	Not Monitored: PM_{10} and $PM_{2.5}$ are not estimated as a field estimate was not measured. With TPM estimated to be insignificant (<1%) compared to the rest of the CRL's site TPM emissions, we can assume that PM_{10} and $PM_{2.5}$ are insignificant as well as they are only a fraction of TPM emissions. Therefore, the effort to estimate their emissions is not justified.	N/A	N/A	N/A

* See Table 15 *Parameter Monitoring Criteria for the Effluent Verification Monitoring Program* (Criteria h-q)

References:

[1] Environment Canada, *National Pollutant Release Inventory,* Annual Notices.
[2] Global Sustainability Standards Board, *Global Reporting Initiative 305: Emissions*, 2016.

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4.3.3.13 Groundwater Plumes

Table 40: Detailed Design – Groundwater Plumes

Description: VOCs are routinely measured through the groundwater monitoring program in relation to historical waste emplacement activities. These VOCs would be released to atmosphere with the surfacing of this groundwater.

Source term & Potential Non-radiological Contaminants: Historical waste placement have been known to release VOCs into groundwater plumes which in turn are released to the atmosphere when groundwater reaches surface. The type(s) of VOCs would be dependent on the source material generating the groundwater plume.

Discharge Characterization: Total VOCs are estimated to be <1% of the site's VOC emissions and therefore considered an insignificant source of emissions.

Monitoring Strategy: Measurement of releases to the environment through the surfacing of groundwater is not possible, therefore estimation is used based on the concentration found in groundwater which is monitored routinely under the groundwater monitoring program. A one-time estimation was completed for the 2018 CY which determined that the emissions would be negligible compared to other site VOC emissions and the NPRI reporting threshold of 10 tonnes. As a result, this estimation is used annually and will only be redone if there is a reason to be based on concentrations in the groundwater. Significant site air emissions reported under the GRI are equivalent to those meeting NPRI reporting thresholds and would include contributions from groundwater plume releases (albeit negligible).

Groundwater Plumes					
Parameter Name	**Parameter Monitoring Criteria ***	**Justification for Monitoring (or Not Monitoring) of Parameter**	**Measured or Estimated**	**Monitoring Frequency & Sample Type**	**Justification for:** 1. **Monitoring Frequency** 2. **Estimation over Measurement**
NPRI Part 4 Substances - Criteria Air Contaminants (CACs)					
Volatile Organic Compounds (VOCs)	h, q	Monitored: h: Total VOC emissions from all site operations may be reportable under Environment Canada's *National Pollutant Release Inventory* Notices [1]. VOC emissions are estimated based on concentrations found in site groundwater. Estimation is of loading (Tonnes/year) as required by the Federal NPRI Notice [1]. q: Total VOC emissions from all site activities may be reportable under the Global Reporting Initiative as an "Other Significant Emission" [2].	Estimate	Annual & N/A	1. Environment Canada's *National Pollutant Release Inventory* Notices [1] require reporting annually if reporting threshold is met for site VOC emissions. 2. Estimation of VOC emissions released to atmosphere is standard industry practice and acceptable by the federal NPRI Notice [1] and the GRI guidance reporting [2].
NPRI Part 5 Substances – Speciated Volatile Organic Compounds					

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Groundwater Plumes					
Parameter Name	**Parameter Monitoring Criteria ***	**Justification for Monitoring (or Not Monitoring) of Parameter**	**Measured or Estimated**	**Monitoring Frequency & Sample Type**	**Justification for:** 1. **Monitoring Frequency** 2. **Estimation over Measurement**
Speciated Volatile Organic Compounds (VOCs)	h	Monitored: h: Speciate VOCs emissions from all site operations (including groundwater) may be reportable under Environment Canada's *National Pollutant Release Inventory* Notices [1]. VOC emissions to air are estimated based on concentrations found in site groundwater. Estimation is of loading (Tonnes/year) as required by the Federal NPRI Notice [1].	Estimate	Annual & N/A	1. Environment Canada's *National Pollutant Release Inventory* Notices [1] require reporting annually if reporting threshold is met for speciated VOC emissions under Part 5. 2. Estimation of VOC emissions released to atmosphere is standard industry practice and acceptable by the federal NPRI Notice [1].

* See Table 15 *Parameter Monitoring Criteria for the Effluent Verification Monitoring Program* (Criteria h-q)

References:

[1] Environment Canada, *National Pollutant Release Inventory,* Annual Notices.
[2] Global Sustainability Standards Board, *Global Reporting Initiative 305: Emissions*, 2016.

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4.3.3.14 Concrete/ Rock/ Asphalt Crushing

Table 41: Detailed Design – Concrete/ Rock/ Asphalt Crushing

Description: Chalk River has a mobile crusher on site. It crushes concrete, rock and asphalt generated on the CRL site from decommissioning activities in order to reuse the material for construction, repairs and maintenance across the site. It generally runs in campaigns through the warmer seasons.

Source term & Potential Non-radiological Contaminants: Airborne contaminants from crushing activities include particulates (TPM, PM_{10} and $PM_{2.5}$). Note: airborne releases from the fuel used to operate the equipment is covered under the stationary equipment section.

Discharge Characterization: Typical emissions of particulates from crushing activities contribute to <1% of the site's particulate emissions and are therefore considered and insignificant CRL emission.

Monitoring Strategy: Volume (m^3) of material being crushed is tracked throughout the calendar year. Emission estimates are calculated annually using a crushing processing calculator provided by the NPRI. Significant site air emissions reported under the GRI are equivalent to those meeting NPRI reporting thresholds and would include particulate contributions from crushing activities.

Concrete/ Rock/ Asphalt Crushing					
Parameter Name	**Parameter Monitoring Criteria ***	**Justification for Monitoring (or Not Monitoring) of Parameter**	**Measured or Estimated**	**Monitoring Frequency & Sample Type**	**Justification for:** 1. **Monitoring Frequency** 2. **Estimation over Measurement**
NPRI Part 4 Substances - Criteria Air Contaminants (CACs)					
Total Particulate Matter (TPM) & Particulate Matter 10 micron (PM_{10}) & Particulate Matter 2.5 micron ($PM_{2.5}$)	h, q	Monitored: h: Total TPM, PM_{10} and $PM_{2.5}$ emissions from all site operations may be reportable under Environment Canada's *National Pollutant Release Inventory* Notices [2]. TPM, PM_{10} and $PM_{2.5}$ from crushed concrete/rock/ asphalt are estimated based on characteristics of the CRL crusher's process and the volume of material crushed. Estimation is Tonnes/year is required by the Federal NPRI Notice [2]. q: Total TPM, PM_{10} and $PM_{2.5}$ emissions from NPRI reporting may be reportable under the Global Reporting Initiative as an "Other Significant Emission" [1].	Estimate	Annual & N/A	1. Environment Canada's *National Pollutant Release Inventory* Notices [2] require reporting annually if reporting threshold is met for site TPM, PM_{10} and $PM_{2.5}$ emissions. 2. Estimation of particulates from concrete/rock/asphalt crushing is standard industry practice and acceptable by the federal NPRI Notice (NPRI provides guidance and a calculator) [2] and the GRI guidance reporting [1].

* See Table 15 *Parameter Monitoring Criteria for the Effluent Verification Monitoring Program* (Criteria h-q)

References:

[1] Global Sustainability Standards Board, *Global Reporting Initiative 305: Emissions*, 2016.
[2] Environment Canada, *National Pollutant Release Inventory,* Annual Notices.

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4.3.3.15 MR-3 Experimental Loop

Table 42: Detailed Design – MR-3 Experimental Loop

Description: The MR-3 Loop at CRL is a test rig containing a large quantity of the halocarbon R-134a. The experimental equipment is designed with two large holding tanks where R-134a is stored between testing. The loop itself is designed with many access points to take readings throughout the experimental period. There are R-134a detectors located throughout the facility to detect leaks however due to the design of the test loop, there are micro-leaks which occur throughout the system.

Source term & Potential Non-radiological Contaminants: Airborne release of R-134a which is a Greenhouse Gas.

Discharge Characterization: Releases vary due to experiment scheduling however when they do occur, they are typically <1% of the site's CO_2e emissions and are therefore considered an insignificant source of GHG emissions.

Monitoring Strategy: Since the micro-leaks are not detectable with monitors, their presence and quantity is determined through monitoring the inventory of R-134a once it returns to the storage tanks. The schedule for this monitoring is based on the experimentation schedule and when the halocarbon leaves and returns to the storage tanks.

MR-3 Experimental Loop					
Parameter Name	**Parameter Monitoring Criteria ***	**Justification for Monitoring (or Not Monitoring) of Parameter**	**Measured or Estimated**	**Monitoring Frequency & Sample Type**	**Justification for:** 1. **Monitoring Frequency** 2. **Estimation over Measurement**
Greenhouse Gases (GHGs)					
Carbon Dioxide equivalent (CO_2e)	h, q	Monitored: h: Total CO_2e emissions (from R-134a emissions) from all site activities may be reportable under Environment Canada's Greenhouse Gas Reporting Notices (GHGRP) [2]. q: Total CO_2 emissions from R-134a use are used for reporting under the Global Reporting Initiative [1]. Microleaks are estimated based on the inventory of R-134a in storage tank(s). Estimation is of loading (Tonnes/year) as required by the Federal GHG Notice [2].	Estimate	Annual & N/A	1. Environment Canada's Greenhouse Gas Reporting Notices [2] require reporting annually if reporting threshold is met for site CO_2e emissions. GRI reporting is also annual [1]. 2. Estimation of emissions through tracking of inventory is acceptable industry practice for both the Federal GHG Notice [2] and the GRI reporting guidance [1].

* See Table 15 *Parameter Monitoring Criteria for the Effluent Verification Monitoring Program* (Criteria h-q)

References:

[1] Global Sustainability Standards Board, *Global Reporting Initiative 305: Emissions*, 2016.
[2] *Environment Canada, Greenhouse Gas Reporting,* Annual Notices.

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4.3.3.16 High Voltage Tank

Table 43: Detailed Design – High Voltage Tank

Description: The High Voltage Tank is a system which was purchased containing SF_6 (a potent Greenhouse Gas). The sealed system is not expected to have any releases of SF_6 except in an accidental/failure of decommissioning situation.

Source term & Potential Non-radiological Contaminants: Airborne releases of SF_6 could potentially occur during an accident scenario or during decommissioning of system.

Discharge Characterization: Typically there are no releases. It is a relatively new system which was purchased in 2017.

Monitoring Strategy: Monitoring emissions are not possible however volume of gases contained in tank is known therefore any release would be based on tank content volume. Emission factors to use for SF_6 are provided under the GHGRP [2].

Parameter Name	Parameter Monitoring Criteria *	Justification for Monitoring (or Not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification for: 1. Monitoring Frequency 2. Estimation over Measurement
Greenhouse Gases (GHGs)					
Carbon Dioxide equivalent (CO_2e) & Sulphur Hexaflouride (SF_6)	h, q	Monitored: h: Total CO_2e emissions (from SF_6 emissions) from all site activities may be reportable under Environment Canada's Greenhouse Gas Reporting Notices (GHGRP) [2]. q: Total CO_2 emissions from SF_6 use are used for reporting under the Global Reporting Initiative [1]. In the event of a release, emissions are estimated based on the quantity of SF_6 in tank. Estimation is of loading (Tonnes/year) as required by the Federal GHG Notice [2].	Estimate	Annual & N/A	1. Environment Canada's Greenhouse Gas Reporting Notices [2] require reporting annually if reporting threshold is met for site CO_2e emissions. GRI reporting is also annual [1]. 2. Estimation of emissions based on quantity charged into system is acceptable industry practice for both the Federal GHG Notice [2] and the GRI reporting guidance [1].

* See Table 15 *Parameter Monitoring Criteria for the Effluent Verification Monitoring Program* (Criteria h-q)

References:

[1] Global Sustainability Standards Board, *Global Reporting Initiative 305: Emissions*, 2016.
[2] Environment Canada, *Greenhouse Gas Reporting,* Annual Notices.

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4.3.3.17 Dry Ice Use

Table 44: Detailed Design – Dry Ice Use

Description: Dry ice is used across the site for various routine (e.g. laboratory use) and non-routine (decommissioning/repair) applications. Annual site dry ice usage is tracked.

Source term and Potential Non-radiological Contaminants: Airborne CO_2 (Greenhouse Gas) emissions as dry ice is the solid form of CO_2.

Discharge Characterization: Typical dry ice usage is <1% of the overall site GHG emissions and is therefore considered insignificant.

Monitoring Strategy: Fugitive emissions are estimated annually based on product used.

Parameter Name	Parameter Monitoring Criteria *	Justification for Monitoring (or Not Monitoring) of Parameter	Measured or Estimated	Monitoring Frequency & Sample Type	Justification for: 1. Monitoring Frequency 2. Estimation over Measurement
Greenhouse Gases (GHGs)					
Carbon Dioxide (CO_2)	h, i, q	Monitored: h: Total CO_2e emissions from all site activities may be reportable under Environment Canada's Greenhouse Gas Reporting Notices (GHGRP) [2]. i: Estimated emissions are used for exposure assessment in the site's Environmental Risk Assessment. q: Total CO_2 emissions from dry ice use are used for reporting under the Global Reporting Initiative [1]. Emissions are estimated based on the quantity of dry ice used. Estimation is of loading (Tonnes/year) as required by the Federal GHG Notice [2].	Estimate	Annual & N/A	1. Environment Canada's Greenhouse Gas Reporting Notices [2] require reporting annually if reporting threshold is met for site CO_2e emissions. GRI reporting is also annual [1]. 2. Estimation of emissions based on quantity used is standard industry practice and recommended by both the Federal GHG Notice [2] and the GRI reporting guidance [1].

* See Table 15 *Parameter Monitoring Criteria for the Effluent Verification Monitoring Program* (Criteria h-q)

References:

[1] Global Sustainability Standards Board, *Global Reporting Initiative 305: Emissions*, 2016
[2] Environment Canada, *Greenhouse Gas Reporting,* Annual Notices.

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4.3.3.18 Landfill Emissions

Table 45: Detailed Design – Landfill Emissions

Description: There are currently two landfills located on the CRL site: The Bulk Material Landfill and the Inactive Waste Landfill.

The Bulk Material Landfill receives dewatered sewage cake from the onsite Sanitary Sewage Treatment Facility in batched (roll off bins) periodically throughout the year. It was opened in 2011 and has a closure date of 2080 with various additional cells possible for development.

The Inactive Waste Landfill routinely receives non-radioactive waste from CRL operations.

Source term: Airborne contaminants from the decomposition of landfill waste.

Potential Non-radiological Contaminants: Greenhouse Gases (CO_2e): carbon dioxide (CO_2), methane (CH_4) and Nitrous oxide (N_2O)

Discharge Characterization: Recent BML CO_2e emissions were estimated to be <1% of the site's CO_2e emissions and the inactive waste landfill's CO_2e emissions were approximately 5%.

Monitoring Strategy: Contaminant emissions are estimated annually using the LandGEM emission estimation tool recommended by the Greenhouse Gas Reporting Program. Emissions are calculated annually as required under the GHGRP (CO_2e, CH_4) and GRI reporting (CO_2e, CO_2).

Landfill Emissions					
Parameter Name	**Parameter Monitoring Criteria ***	**Justification for Monitoring (or Not Monitoring) of Parameter**	**Measured or Estimated**	**Monitoring Frequency & Sample Type**	**Justification for:** 1. **Monitoring Frequency** 2. **Estimation over Measurement**
Greenhouse Gases (GHGs)					

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Landfill Emissions					
Parameter Name	**Parameter Monitoring Criteria ***	**Justification for Monitoring (or Not Monitoring) of Parameter**	**Measured or Estimated**	**Monitoring Frequency & Sample Type**	**Justification for:** 1. **Monitoring Frequency** 2. **Estimation over Measurement**
Methane (CH_4) & & Carbon Dioxide (CO_2) & Carbon Dioxide Equivalent (CO_2e)	h, i, q	Monitored: h: Total CO_2e emissions from all site activities may be reportable under Environment Canada's Greenhouse Gas Reporting Notices (GHGRP) [2]. Methane is the only landfill emission monitored (converted to CO_2e) as CO_2 emissions are excluded from the National Total (reasoning - assumed that the biomass is produced in a sustainable manner (i.e. Replaced by growing biomass which in turn reabsorbs the same amount of atmospheric carbon as was given off by the combusted material)). i: Estimated emissions are used for exposure assessment in the site's Environmental Risk Assessment. q: Total CO_2e and CO_2 emissions from landfill activities are used for reporting under the Global Reporting Initiative [1]. Emissions are estimated based on the volume and type of waste making up the current landfill as well as the age of the landfill. Estimation is of loading (Tonnes/year) as required by the Federal GHG Notice [2].	Estimate	Annual & N/A	1. Environment Canada's Greenhouse Gas Reporting Notices [2] require reporting annually if reporting threshold is met for site CO_2e emissions. Annual review of significant airborne emissions which were estimated is recommended by CSA N288.5:22 [3]. GRI reporting is also annual [1]. 2. Estimation of emissions using the LandGEM model is standard industry practice and recommended by both the Federal GHG Notice [2] and the GRI reporting guidance [1].
Nitrous Oxide (N_2O)	N/A	Not Monitored: Although landfills do emit Nitrous oxide, these emissions are not reportable under either the GHGRP [2] or the GRI [1]. Reasoning provided by ECCC: N_2O emissions are negligible compared to other GHGs.	N/A	N/A	N/A

* See Table 15 *Parameter Monitoring Criteria for the Effluent Verification Monitoring Program* (Criteria h-q)

References:

[1] Global Sustainability Standards Board, *Global Reporting Initiative 305: Emissions*, 2016

[2] Environment Canada, *Greenhouse Gas Reporting,* Annual Notices**.**

[3] *2023 CRL NPRI Release Estimates*. CRL-509212-055-000, 67890210

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4.3.3.19 Halocarbon Releases

Table 46: Detailed Design - Halocarbon Releases

Description: Site refrigeration systems, air-conditioning systems and fire-extinguishing systems on site contain various halocarbons which are greenhouse gases with varying global warming potentials and can be harmful when released to the environment. Generally speaking these systems can develop leaks where some or all of their contents are released to the environment. Releases are typically detected when the equipment is noticed to not be functioning properly. As the releases are fugitive, in order to determine the quantity released, the amount required to recharge the system is often used. **Source term & Potential Non-radiological Contaminants:** Airborne releases of halocarbons (by type) which are greenhouse gases of varying potency. **Discharge Characterization:** There are typically a handful of releases which are reportable under the Federal Halocarbon Regulations (FHR) annually. **Monitoring Strategy:** Releases of >10kg are reportable under the Federal Halocarbon Regulations, therefore monitoring of releases of greater than 10kg is completed under the EVMP. Note: for operational purposes, the HVAC groups also tracks the smaller releases (<10kg). Monitoring is required continuously as releases ≥ 100kg are reportable within 24hrs of detection under the FHR [1].

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Halocarbon Releases					
Parameter Name	**Parameter Monitoring Criteria ***	**Justification for Monitoring (or Not Monitoring) of Parameter**	**Measured or Estimated**	**Monitoring Frequency & Sample Type**	**Justification for:** 1. **Monitoring Frequency** 2. **Estimation over Measurement**
Halocarbons	h, i, k	Monitored: h: All releases from refrigeration systems, air-conditioning systems and fire-extinguishing systems greater that 10kg are reportable under the *Federal Halocarbon Regulations* (FHR) [1] therefore monitoring of releases and estimating the quantity released is required to determine reportability. h: Public reporting is required for releases of over 100kg [2]. i: Estimated emissions are used for exposure assessment in the site's Environmental Risk Assessment. k: There is an operational need to identify unplanned, reasonably foreseeable upset events as equipment will not function adequately with a loss and losses should be identified and remediated ASAP in order to minimize. Emissions are estimated based on the known quantity in system or, more commonly, the amount needed to recharge system once repaired.	Estimate	Continuous & N/A	1. Continuous monitoring is required as some larger releases are reportable immediately under the *Federal Halocarbon Regulations* (FHR) [1] and to the public [2]. 2. Estimation of emissions based on quantity needed to recharge system or quantity system can hold is standard industry practice.

* See Table 15 *Parameter Monitoring Criteria for the Effluent Verification Monitoring Program* (Criteria h-q)

References:

[1] *The Canada Gazette*, Part II, Volume 137, No. 18, *Federal Halocarbon Regulations*, SOR/DOR/2003-289, P.C. 2003-1203, 2003 August 13.
[2] *Public Information Program for CNL*, CW-513430-REPT-001. 53749225

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5. Additional Monitoring Details

5.1 Sampling and Analysis

There are three groups that perform sampling under the CRL EVMP;

1. The Environmental Monitoring Branch (EMB);
2. The Waste Treatment Centre (WTC); and,
3. Spring B Ground Water Treatment Facility.

There are multiple groups that perform analysis under the CRL EVMP:

1. The Environmental Monitoring Branch (EMB);
2. The Waste Treatment Centre (WTC);
3. Analytical Chemistry Branch (ACB); and,
4. A series of external laboratories.

The *Effluent Verification Monitoring Program Sampling Schedule* [10] identifies the sampling and analysis performed under the EVMP.

Sampling and laboratory analysis procedures are maintained by respective groups that perform these functions. Analysis procedures specifically are listed in Appendix C. External laboratories maintain their own analysis procedures.

5.2 Duration of Monitoring

Monitoring outlined in this monitoring plan is *routine* meaning it is to continue indefinitely unless a change to it or its removal is triggered.

5.3 Field Quality Control Monitoring

In order to ensure that the data collected through the program is valid, the laboratories performing monitoring for the program have strong Quality Assurance/ Quality Control (QA/QC) programs as required by the *EnvP Program Radiological and Non-Radiological Monitoring Services Quality Plan* [**54**]. Note: This QA plan is in line with the requirements of N288.5:22 [6].

In addition to this, field Quality Control (QC) monitoring is in place. This QC monitoring is designed to cover the requirements of both the Non-Radioactive EVMP and the Non-Radioactive Environmental Monitoring Program (EMP) with the frequency set to accommodate both of the programs. MISA requires that sampling take place annually on one effluent stream but recommends that all ATGs be part of the field QC program. The recommended frequencies [1] are outlined in Table 47.

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Table 47: Field QC Frequency Recommended by MISA

Sampling Frequency	Field QC Frequency
Daily	Monthly
Weekly	Quarterly
Monthly	Semi-annual
Quarterly	Semi-annual
Semi-annual	Annual

With the current QC monitoring schedule [10], CRL exceeds the field QC requirements outlined by MISA and strives to conform to the MISA recommendations.

More specifically, the field QC design in place covers each sampling type (grab samples, autosamplers) being taken by each sampling group.

Also, for those samples which are being analysed by more than one laboratory (e.g. ATG 9), QC samples are collected for each of the analytical laboratories.

It should be noted that the field samples collected on a daily, weekly and monthly frequency are taken on the same day as the semi-annual monitoring under the EVMP (i.e. whether frequency is daily, weekly, monthly or semi-annual, all will be taken on the same day as the monitoring sample for that parameter under the Non-Radioactive EVMP).

The type of field QC sampling applicable for each of the ATGs is also prescribed by the *Protocol for the Sampling and Analysis of Industrial/Municipal Waste Water* [1]. These include the following types of samples serving different purposes and are required in different combinations depending on the parameter.

Types and Purposes:

- Duplicate – Precision
- Travelling Blank – Contamination
- Travelling Spiked Blank – Accuracy

6. Continual Improvement of the Non-radioactive EVMP

The majority of processes and requirements for the execution of CRL's Non-Radioactive EVMP can be found in the *Management and Monitoring of Effluents and Emissions* standard [**5** (covering company-wide processes adopted by CRL) and the *CRL's Integrated Environmental Monitoring Framework* [4].

In addition to the information in these two documents, this section covers the information which is specific to the continual improvement of the CRL Non-Radioactive EVMP.

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As outlined in the *CRL's Integrated Environmental Monitoring Framework* [4], many of the required changes for the Non-Radioactive EVMP will be identified during the formal reviews which take place for the program. There are instances, however, where changes to the program need to take place in between these reviews. In either case, changes to the program are formally documented as per the requirement in *Management and Monitoring of Effluents and Emissions* standard [5].

This section describes processes which are followed by the program when changes to the schedule are required (either during routine reviews or between routine reviews).

6.1 Program Optimization

Optimization of the monitoring program can occur at any time and has a goal of making the program more accurate, efficient, and cost-effective. An optimized sampling design tends to show little redundancy while retaining sufficient data to enable accurate and defensible decisions.

Statistical methods should be used to judge whether a monitoring program is optimized and can lead to the need for either an increase or decrease in monitoring locations, parameters and/or events (frequency). These statistical methods can be in the form of exploratory data analysis, meaning a collection of descriptive and graphical statistical techniques, or more formal statistical methods.

6.1.1 Optimization of Parameters

Despite meeting one or more of the "should" Need for Monitoring Criteria – Parameter (Table 15), in instances where the absence of results of concern and/or the absence of results above the detection limit are observed over a period of time, the monitoring of the parameter may be dropped based on the professional judgement of EnvP Staff. For example, a substance with low toxicity with monitoring results consistently falling well below levels of concern. Note: Consideration should always be given to the purpose and history of the monitoring of that parameter at that location.

6.1.2 Optimization of Monitoring Frequency

With a well-established monitoring program such as CRL's Non-Radioactive EVMP, which typically has large amounts of data due to long-term monitoring, *Temporal Optimization* is appropriate to take place throughout the life of the program. This optimization looks to determine if the sampling frequency is appropriate based on the objectives of the program with the principles for this optimization being to:

- Sample more frequently at locations where the apparent changes are more dynamic and associated with the greatest statistical uncertainty, and
- Sample less frequently when the trend is changing little and is statistically more certain (i.e. less variable)

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The technique of Iterative Thinning should be used in such an optimization exercise. Iterative thinning examines whether sampling frequencies can be reduced due to temporal redundancy in the sampling events. This approach identifies redundancy by first estimating a baseline trend using the full data set, after which the trend is repeatedly re-estimated using subsets of the full data to identify the average number of data points needed to accurately reconstruct the baseline. The computations in iterative thinning create a series of 'what if' scenarios estimating the nature of the trend that would have been identified if only some of the existing data had been sampled. The overriding principle in iterative thinning is that if a trend can be accurately reconstructed using fewer sampling events, the optimal sampling frequency should be based on this smaller number.

A further reduction in frequency or elimination of monitoring should be considered where reduced frequency has taken place and the parameter continues to not be of concern in any area of the integrated monitoring program. Again, professional judgement of EnvP staff should be used and consideration given to the purpose and history of the monitoring of that parameter at that location when making this decision.

In the event that anomalous results are observed and the monitoring objectives warrant a higher monitoring frequency, the frequency of monitoring may be increased in order to better determine the variability in the monitoring results. This can be done through a special investigation (outside of the routine monitoring program) or within the routine monitoring program (added to the monitoring schedule) and is based on the professional judgement of program staff.

6.2 Core Parameters for New Effluent Monitoring Locations

Table 48: Core Parameters for CRL Effluents

ATG	Parameter	Effluent Type			
		Process			Storm
		All	Treatment Facilities	OTCW	
Chemical Characteristics					
1	Chemical Oxygen Demand (COD)	√	√		
3	pH	√	√	√	√
4b	Nitrate, Total Filter React	√	√	√	
5a	Dissolved Organic Carbon (DOC)	√	√	√	
5b	Total Organic Carbon (TOC)	√	√	√	
6	Phosphorus, Unfiltered Total	√	√		√

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ATG	Parameter	Effluent Type			
		Process			Storm
		All	Treatment Facilities	OTCW	
7	Conductivity, at 25˚C	√	√	√	√
8	Residue, Particulate (TSS)	√	√	√	√
9	Al, Cu & Zn only			√	√
9	All Metals in ATG 9, except Silver	√	√		
9a	Iron, Unfiltered Total	√	√	√	√
12	Mercury, Unfiltered Total	√	√		
14	Phenolics, Unfiltered React		√	√	
16	Volatile, Halogenated		√		
17	Volatiles, Non-Halogenated		√		
19	Extractables, Neutral		√		
20	Extractables, Acid		√		
23	Extractables, Chlorinated		√		
25	Solvent Extractables	√	√	√	√
30	Chloride				√
31	Total Residual Chlorine	√*	√*		
Physical Characteristics					
--	Temperature			√	
--	Flow	√	√	√	√

Note: ATG – Analytical Test Group

OTCW – Once Through Cooling Water

* TRCl need only be measured in effluent streams which are being treated with chlorine

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7. References

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[20] *Public Information Program for Canadian Nuclear Laboratories*, CW-513430-REPT-001, Rev 8, 2021 January, 54145153

[21] *Canadian Environmental Protection Act* (CEPA), 1999

[22] *Fisheries Act*, 1985

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[27] *Environmental Aspect Assessment Report – Nuclear Fuel Fabrication Facility Building* [redacted] EMS Group 8, NFFF-509210-114-000, 2022 November, 58687485

[28] *Environmental Aspect Assessment Report – Recycle Fuel Fabrication Laboratories*, EMS Group 5, RFFL-509210-114-000, 2023 October, 62737184

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[30] *Environmental Aspect Assessment Report – Nuclear Facility Operations*, EMS Group 4, 9400-509210-114-000, 2024 November, 68288404

[31] *Environmental Aspect Assessment Report – Molydenum-99 Production Facility*, EMS Group 3, MPF-509210-114-000, 2020 September, 52982960

[32] *Environmental Aspect Assessment Report – Tritium Facility Operations*, EMS Group 9, TF-509210-114-000, 2022 October, 58267455

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[51] *Environmental Aspect Assessment Report – Power House and Associated*, EMS Group 29, 4172-509210-114-000, 2023 October, 62893934

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[53] *Levels for CRL's Non-Radioactive Effluents and Emissions*, 900-509200-STD-014, Rev 4.2, 2025 January, 51059932

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Appendix A Effluent Verification Monitoring Program History

Prior to 1988, there was no formal Non-Radioactive Effluent Monitoring Program at CRL.

In 1986, the Ontario Ministry of the Environment (MOE) introduced the "Municipal – Industrial Strategy for Abatement (MISA)" program with the goal of virtual elimination of toxic chemical discharges to Ontario's surface waters. In order to accomplish this, the MOE needed to determine what was being discharged and in what amounts (stream characterization). As a former federal crown corporation, Atomic Energy of Canada (AECL) was not under provincial jurisdiction. Despite this, the company volunteered to participate in the MISA program and provide data to the Ontario MOE and Environment Canada.

The MISA program consists of a series of phases. CRL took part in the first "pre-regulation phase" which was designed to provide information and data for the development of effluent monitoring regulations. This phase consisted of "pre-regulation monitoring" which took place at CRL in the fall of 1988 and involved identifying, in conjunction with the MOE, various locations requiring monitoring as well as which type of monitoring (i.e. stream characterization). Among the types of effluents requiring monitoring are process effluents, once-through-cooling water effluents, combined effluents and storm sewer effluents.

Based on the data collected from this "pre-regulation phase", general regulations for effluent monitoring were released in 1989 and then subsequently, effluent monitoring regulations specific to the Electric Power Generating Sector in 1995. As of 1995, CRL was no longer part of the MISA program development and ceased submission of monitoring results to the Ministry.

Despite no longer being obliged to monitor non-radioactive contaminants formally under the MISA program, CRL has committed to continuing on with the MISA monitoring, albeit at a reduced intensity compared to the "pre-regulation phase", as the basis of a program for good environmental management. The monitoring program has gone through many changes since that time and continues to evolve.

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Appendix B Historical Monitoring Locations Removed from the EVMP

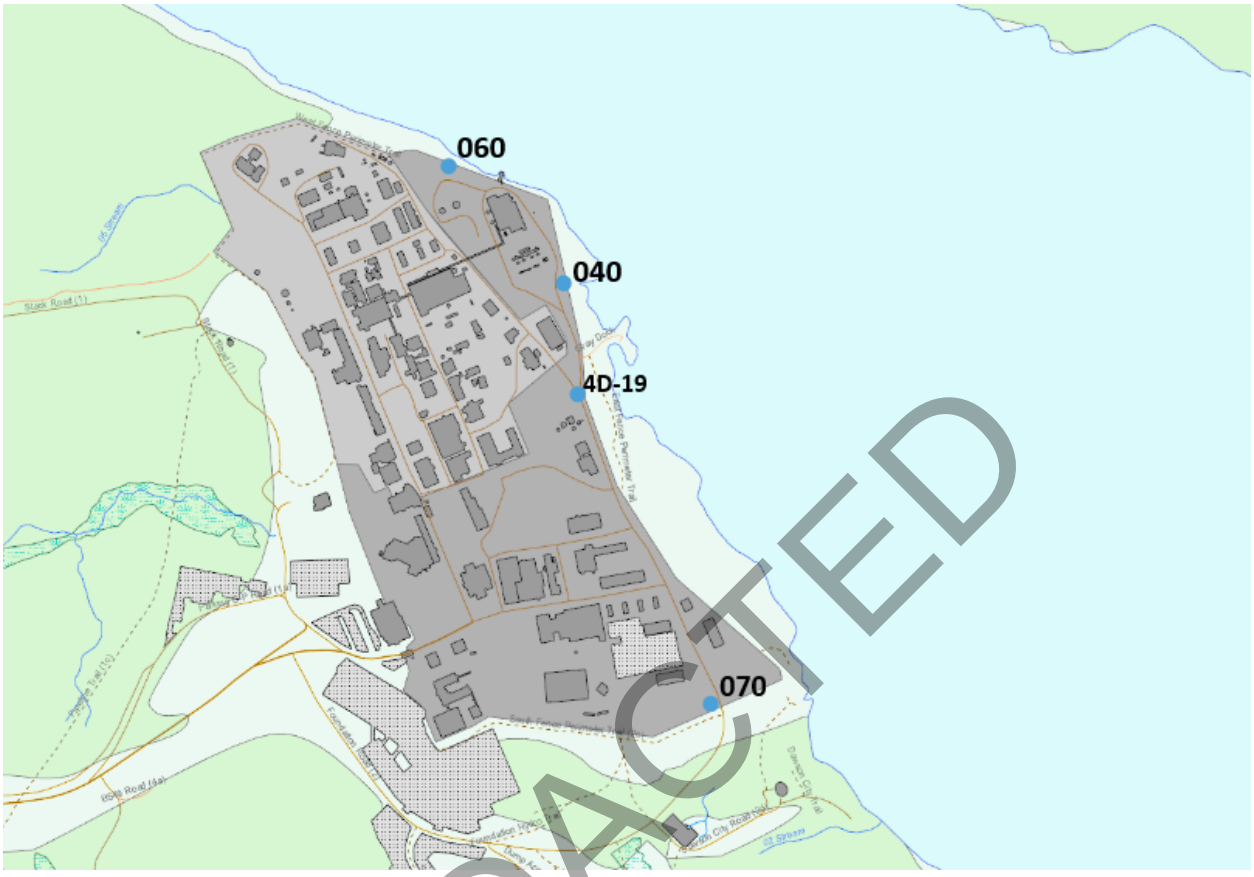


Figure 3: Historical Monitoring Locations Removed from the EVMP

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B.1 [redacted] Storm Outfall

Table 49: Detailed Design - [redacted] Storm Outfall

Description: The monitoring location, storm sewer Manhole [redacted] is situated after all contributions to the effluent but prior to the effluent reaching the environment (Ottawa River).
Source Term: Currently --> Minimal road and roof run-off from the vicinity of [redacted] as well as tile drains around [redacted]
Effluent Treatment: The [redacted] Storm Outfall discharges directly into the Ottawa River with no prior treatment.
History and Reason for Removal from Program:
This monitoring location is located in a truncated portion of the original [redacted] Storm Outfall system that used to collect surface water runoff from a large portion of the Controlled Area as well as cooling water from various facilities. The flow for this storm sewer was heavily dependent on the cooling water and therefore did not significantly fluctuate throughout the calendar year. In 2017, the Storm Water Diversion project diverted 80% of the original flow into the [redacted] Storm Outfall system's collection ponds. The remainder of the water that was not re-routed by this project was subsequently diverted in 2018 with a large portion transferred via underground piping to the Process Outfall such that now (2020), only a very small amount of seepage through degraded portions of the culvert continue to be discharged and monitored by the [redacted] sample location.
This monitoring point was part of the original MISA program where it is classified as a "Storm Sewer"; Routine monitoring began in 1990 and was monitored consistently since then through 2021. Prior to the 2017 diversion, there were minor changes to the parameters and frequency of monitoring.
With the diversion of almost all of the 04 storm collection system to the [redacted] storm collection system, the measurable flows have significantly reduced and/or non-existent with no flow during the semi-annual monitoring campaigns in the 2019, 2020 and 2021 CYs. This monitoring location was removed from the program in 2022.

[redacted] Storm Outfall

ATG	Parameter Name Treatment	Parameter Criteria *	Justification for Monitoring (or not Monitoring) of Parameter	Measurement or Estimation	Monitoring Frequency & Sample Type **	Justification for: 1. Monitoring Frequency & Sample Type 2. Estimation over Measurement
3	pH N/A	N/A	Not Monitored: (was from 1990 - 2022) p: 1990: Core parameter required under MISA specifically for this location [1], [4]. p: 2014 Note: Confirmed to be a required parameter under the *Storm Water Control Study* (Reg 215/95), therefore monitoring was kept [6]. 2022: Removed due to lack of flow [7].	N/A	N/A	1. Frequency: 1990: Monthly (within the few hours following a rain event (>5mm/day) or a thaw, if possible) in efforts to characterize the stream [1]. 1991: Reduced to semi-annual after characterization of effluent was complete [2]. 2022: Removed [7]. 2. N/A

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[redacted] Storm Outfall						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ***	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type ****	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
4b	Nitrates, Total Filter Reactive N/A	N/A	Not Monitored: (was from 1990 - 2014) p: 1990: Core parameter required under MISA specifically for this location [1], [4]. 2014: Removed as not a required monitoring parameter under the *Storm Water Control Study* (Reg 215/95) and very low and seemingly stable concentrations over a number of years, all of which were well below the CWQG [6]	N/A	N/A	1. Frequency: 1990: Monthly (within the few hours following a rain event (>5mm/day) or a thaw, if possible) in efforts to characterize the stream [1]. 1991: Reduced to semi-annual after characterization of effluent was complete [2]. 2014: Removed [4]. 2. N/A
5a	Dissolved Organic Carbon (DOC) N/A	N/A	Not Monitored: (was from 1990 - 2022) p: 1990: Core parameter required under MISA specifically for this location [1]. q: 2014: Although not a required monitoring parameter under the *Storm Water Control Study* (Reg 215/95); and there have been consistent concentrations observed over many years and very similar to levels seen in river water (background) since this effluent consists primarily of cooling water, there is potential of contamination from the use of hydraulic oils, greases, lubricating oils etc. [6] 2022: Removed due to lack of flow [7].	N/A	N/A	1. Frequency: 1990: Monthly (within the few hours following a rain event (>5mm/day) or a thaw, if possible) in efforts to characterize the stream [1]. 1991: Reduced to semi-annual after characterization of effluent was complete [2] 2022: Removed [7]. 2. N/A
5b	Total Organic Carbon (TOC) N/A	N/A	Not Monitored: (was from 1990 - 2022) p: 1990: Core parameter required under MISA specifically for this location [1]. q: 2014 Note: Although not a required monitoring parameter under the *Storm Water Control Study* (Reg 215/95); and there have been consistent concentrations observed over many years and very similar to levels seen in river water (background) since this effluent consists primarily of cooling water, there is potential of contamination from the use of hydraulic oils, greases, lubricating oils etc. [6]. 2022: Removed due to lack of flow [7].	N/A	N/A	1. Frequency: 1990: Monthly (within the few hours following a rain event (>5mm/day) or a thaw, if possible) in efforts to characterize the stream [1]. 1991: Reduced to semi-annual after characterization of effluent was complete [2] 2022: Removed [7]. 2. N/A

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[redacted] Storm Outfall						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ***	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type ****	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
6	Phosphorus, Unfiltered Total N/A	N/A	Not Monitored: (was from 1990 - 2022) p: 1990: Core parameter required under MISA specifically for this location [1], [4]. q: 2014: Although not part of the required monitoring parameters under the *Storm Water Control Study* (Reg 215/95), some variability in the results over the years indicate potential source of contamination, therefore the parameter was kept in routine monitoring program [6]. 2022: Removed due to lack of flow [7].	N/A	N/A	1. Frequency: 1990: Monthly (within the few hours following a rain event (>5mm/day) or a thaw, if possible) in efforts to characterize the stream [1]. 1991: Reduced to semi-annual after characterization of effluent was complete [2]. 2022: Removed [7]. 2. N/A
7	Conductivity, @[redacted] N/A	N/A	Not Monitored: (was from 1990 - present) p: 1990: Core parameter required under MISA specifically for this location [1], [4]. q: 2014: Although not a required monitoring parameter under the *Storm Water Control Study* (Reg 215/95) this parameter was kept under the routine monitoring program as it is a good indicator of water quality and is used to screen for other potential issues with parameters not under the routine monitoring program [6]. 2022: Removed due to lack of flow [7].	N/A	N/A	1. Frequency: 1990: Monthly (within the few hours following a rain event (>5mm/day) or a thaw, if possible) in efforts to characterize the stream [1] 1991: Reduced to semi-annual after characterization of effluent was complete [2]. 2022: Removed [7]. 2. N/A
8	Total Suspended Solids (TSS) N/A	N/A	Not Monitored: (was from 1990 - 2022) p: 1990: Core parameter required under MISA specifically for this location [1], [4]. p: 2014: Confirmed to be a required *Storm Water Control Study* parameter under Reg 215/95; despite being very stable and low for this effluent [6]. 2022: Removed due to lack of flow [7].	N/A	N/A	1. Frequency: 1990: Monthly (within the few hours following a rain event (>5mm/day) or a thaw, if possible) in efforts to characterize the stream [1] 1991: Reduced to semi-annual after characterization of effluent was complete [2]. 2022: Removed [7]. 2. N/A

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[redacted] Storm Outfall						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ***	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type ****	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
9	Aluminium, Unfiltered Total N/A	N/A	Not Monitored: (was from 1990 - 2022) p: 1990: Core parameter required under MISA specifically for this location [1], [4]. q: 2014: Although not part of the required monitoring parameters under the *Storm Water Control Study* (Reg 215/95), there has been relatively high concentrations observed over the past years and Al is known to be high in background concentrations in this area, therefore the parameter was kept in the routine monitoring program [6]. 2022: Removed due to lack of flow [7].	N/A	N/A	1. Frequency: 1990: Monthly (within the few hours following a rain event (>5mm/day) or a thaw, if possible) in efforts to characterize the stream [1]. 1991: Reduced to semi-annual after characterization of effluent was complete [2]. 2022: Removed [7]. 2. N/A
9	Copper, Unfiltered Total N/A	N/A	Not Monitored: (was from 1990 - 2022) p: 1990: Core parameter required under MISA specifically for this location [1], [4]. q: 2014 Note: Although not part of the required monitoring parameters under the *Storm Water Control Study* (Reg 215/95), there are detectable concentrations with variability noted over the past number of years. All resulting concentrations are still well below the CNL Guideline however, due to the potential source in piping and knowing that when the analysis is run for ATG 9, it includes Cu, the parameter was kept in routine monitoring program [6]. 2022: Removed due to lack of flow [7].	N/A	N/A	1. Frequency: 1990: Monthly (within the few hours following a rain event (>5mm/day) or a thaw, if possible) in efforts to characterize the stream [1]. 1991: Reduced to semi-annual after characterization of effluent was complete [2]. 2022: Removed [7]. 2. N/A

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[redacted] Storm Outfall						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ***	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type ****	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
9	Lead, Unfiltered Total N/A	N/A	Not Monitored: (was from 1990 - 2022) p: 1990: Core parameter required under MISA specifically for this location due to the large volumes of lead being used in the Controlled Area for shielding etc [1], [4]. q: 2014: Despite not being a required monitoring parameters under the *Storm Water Control Study* (Reg 215/95) and concentrations observed over many years being at or below the LMDL, since lead is widely used across the site and often stored outdoors in this storm sewer's drainage area and the analysis for other metals in ATG 9 are already being completed, this parameter was kept in the routine monitoring program [6]. 2022: Removed due to lack of flow [7].	N/A	N/A	1. Frequency: 1990: Monthly (within the few hours following a rain event (>5mm/day) or a thaw, if possible) in efforts to characterize the stream [1] 1991: Reduced to semi-annual after characterization of effluent was complete [2]. 2022: Removed [7]. 2. N/A
9	Zinc, Unfiltered Total N/A	N/A	Not Monitored: (was from 1990 - 2022) p: 1990: Core parameter required under MISA specifically for this location [1], [4]. q: 2014: Although not part of the required monitoring parameters under the *Storm Water Control Study* (Reg 215/95) and having very, very minimal detectable concentrations with little variability noted over the past number of years, all well below the CNL Guideline, due to the potential source in piping and knowing that when the analysis is completed for ATG 9, it includes Zn, the parameter was kept in the routine monitoring program [6]. 2022: Removed due to lack of flow [7]	N/A	N/A	1. Frequency: 1990: Monthly (within the few hours following a rain event (>5mm/day) or a thaw, if possible) in efforts to characterize the stream [1]. 1991: Reduced to semi-annual after characterization of effluent was complete [2] 2022: Removed [7]. 2. N/A
9a	Iron, Unfiltered Total N/A	N/A	Not Monitored: (was from 1990 - 2022) p: 1990: Core parameter required under MISA specifically for this location [1], [4]. p: 2014: Confirmed to be a required parameter under the *Storm Water Control Study* (Reg 215/95); despite all results to date being well below the CNL Guideline, routine monitoring continues due to consistently detectable results and known high background concentrations [6]. 2022: Removed due to lack of flow [7].	N/A	N/A	1. Frequency: 1990: Monthly (within the few hours following a rain event (>5mm/day) or a thaw, if possible) in efforts to characterize the stream [1]. 1991: Reduced to semi-annual after characterization of effluent was complete [2]. 2022: Removed [7] 2. N/A

REDACTED

[redacted] Storm Outfall						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ***	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type ****	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
9a	Uranium, Unfiltered Total N/A	N/A	Not Monitored: (was from 2007 - 2022) q: 2007: Added based on SRC comment as EnvP was monitoring this in the radioactive program but not the non-radioactive program [3]. q: 2014: Despite not being a required monitoring parameters under the *Storm Water Control Study* (Reg 215/95) and concentrations observed over many years being fairly consistent and remaining well below the CWQG and PWQG, this parameter is being kept in 04 storm sewer which is the main storm sewer in the Controlled Area which is the most likely source based on use of uranium on site. 2022: Removed due to lack of flow [7].	N/A	N/A	1. Frequency: 2007: Semi-annual to align with all other monitoring at this location [3]. 2022: Removed [7]. 2. N/A
16	Chloroform N/A	N/A	Not Monitored: (was from 1990 - 2016) p: 1990: Monitored at major storm sewers across site which are known to collect cooling water etc. as it is present in cleaning products used across the site and therefore there is a potential for it to enter these storm systems [1], [4]. n, q: 2014: Although not a required parameter for stormwater monitoring under Reg215/95, monitoring of this effluent continues to show consistent levels above the CWQG and it is a known result of site operations, therefore it has been kept in the routine monitoring program [6]. 2016: Removed as all results are well below the ERA Benchmark value [9].	N/A	N/A	1. Frequency: 1990: Monthly (within the few hours following a rain event (>5mm/day) or a thaw, if possible) in efforts to characterize the stream [1]. 1991: Reduced to semi-annual after characterization of effluent was complete [2]. 2016: Removed [9] 2. N/A
25	Solvent Extractables N/A	N/A	Not Monitored: (was from 1990 - 2022) p: 1990: Core parameter required under MISA specifically for this location [1], [4]. p: 2014: Confirmed to be a required parameter under the *Storm Water Control* Study (Reg 215/95). Some variability noted in monitoring results over the years but all well below CNL Guideline; known potential source on site through routine operations therefore kept in routine program [6]. 2022: Removed due to lack of flow [7].	N/A	N/A	1. Frequency: 1990: Monthly (within the few hours following a rain event (>5mm/day) or a thaw, if possible) in efforts to characterize the stream [1]. 1991: Reduced to semi-annual after characterization of effluent was complete [2]. 2022: Removed [7]. 2. N/A

REDACTED

[redacted] Storm Outfall						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ***	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type ****	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
27	Polychlorinated Biphenyls (PCB) N/A	N/A	Not Monitored: (was from 1990 - 1997) p: 1990: Required to be monitored at this location by MISA in efforts to check for contamination resulting from a leak or spill [1]. 1997: Removed from monitoring as all results were ≤ LMDL and there is no known source on site [2]. 2014 Note: Although part of the required monitoring parameters under the *Storm Water Control Study* (Reg 215/95), the parameter is not part of the routine program based on non-detectable previous monitoring results in all major storm sewers on site, including [redacted] storm sewer, and the fact that there is no known or suspected source of spills or leaks on site. Also, being monitored under the GWMP with no contamination noted [5].	N/A	N/A	1. Frequency: 1990: Quarterly as a scan for contamination from leaks or spills [1]. 1997: Removed [5]. 2. N/A
30	Chloride N/A	N/A	Not Monitored: (was from 2007 - 2022) q: 2007: Added to determine road salt effects, if any, on effluent (based on an SRC Comment) [3]. n, q: 2014: Although not a core parameter under Reg215/95 [6] and relatively low concentrations have been observed, it is a known contaminant source currently being used on site, therefore kept in routine monitoring program [4]. 2022: Removed due to lack of flow [7].	N/A	N/A	1. Frequency: 2007: Semi-annual to align with all other monitoring at this location [3]. 2022: Removed [7]. 2. N/A
--	Flow Rate (m^3/day) N/A	N/A	Not Monitored: (was from 1990 – 2022) p: 1990: Core physical characteristic under MISA used to determine loading from the source [1]. p: 2014: Confirmed to be a required parameter under the *Storm Water Control Study* (Reg 215/95) [6] to determine loading from the source [4]. 2022: Removed due to lack of flow [7].	N/A	N/A	1. Frequency: 1990: Monthly (within the few hours following a rain event (>5mm/day) or a thaw, if possible) in efforts to characterize the stream [1]. 1991: Reduced to semi-annual after characterization of effluent was complete [2]. 2022: Removed [7]. 2. N/A

REDACTED

[redacted] Storm Outfall						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ***	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type ****	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
--	Temperature Effluent Maximum N/A	N/A	Not Monitored: (was from 2014 – 2018) q: 2014: Added to monitoring program as the effluent stream is known to be comprised primarily of cooling water [4]. 2018: Removed as there is a major decrease in the flow at this location with re-routing from the stormwater diversion project. Not the same cooling water using this effluent stream anymore [8].	N/A	N/A	1. Frequency: 2014: Semi-annual to align with all other stormwater monitoring. If primarily cooling water, should not vary widely [4]. 2018: Removed [8]. 2. N/A

Notes:
LMDL - Laboratory Method Detection Level; SRC - Safety Review Committee; CWQG - Canadian Water Quality Guideline; MISA - Municipal/Industrial Strategy for Abatement; ATG - Analytical Test Group; GWMP- Groundwater Monitoring Program.
* See Table 15: Parameter Monitoring Criteria for the Effluent Compliance Monitoring Program
** Samples were taken as daily composites using an automatic sampler at 15-minute intervals – not flow proportional (8:30am one day to 8:30am the next day). Note: Automatic sampler was shared with radioactive EVMP.

References:

[1] *MISA Liquid Effluent Monitoring at CRL: Summary of Monitoring Results for the Period 1990 June to 1991 May,* RC-809, 1992 March. 14601444
[2] *Non-Radiological Liquid Effluent Monitoring at CRL: Summary of the Monitoring Results for the Period 1991 May to 1992 December,* RC-1086, 1993 December. 40793178
[3] *SRC Acceptance of the Annual Program Report - Non-Radiological Effluent Monitoring in 2005 at Chalk River Laboratories*, SRCM-62-059, 2006 August.
[4] *Effluent Verification Monitoring Program Sampling Schedule for CRL*, CRL-509200-062-000-0001, Rev 6, 2013 December. 23651723
[5] *Non-Radiological Liquid Effluent Monitoring at CRL: The Results for 1997*, AECL-MISC-397-97, 1998 September. 22869405
[6] *Effluent Monitoring and Effluent Limits - Electric Power Generation Sector,* Ontario Regulation, 215/95
[7] *Effluent Verification Monitoring Program Sampling Schedule for CRL & NPD – Non-Radiological Liquid Effluent*, CRL-509200-062-000-0004, Rev20, 2022 DRAFT.
[8] *Effluent Verification Monitoring Program Sampling Schedule for CRL & NPD,* CRL-509200-062-000-0004, Rev 12, 2018 Dec 14. 42016713
[9] *Effluent Verification Monitoring Program Sampling Schedule for CRL*, CRL-509200-062-000-0004, Rev 7, 2016 August. 22726453

REDACTED

B.2 [redacted] Storm Outfall

Table 50: Detailed Design - [redacted] Storm Outfall

Description: The [redacted] Storm Outfall collection system was a small system extending to a few buildings in the Controlled Area which has since been removed as a result of the effluent being redirected to the [redacted] storm collection system during the storm water diversion project which was completed in 2018.
History: This monitoring location was removed from the EVMP in 2018 however, prior to this diversion and removal, [redacted] storm collected surface runoff from a few roads in the northwest portion of the built-up area as well as some roof and foundation drainage and discharged directly into the Ottawa River without prior treatment.
This monitoring point was not part of the original MISA program. Instead, its effluent was reviewed through a Special Investigation which took place monthly during 2008. As a result of the special investigation monitoring, this monitoring point and a certain set of parameters which were considered significant were added to the routine monitoring program in 2009.

[redacted] Storm Outfall						
ATG	Parameter Name Treatment	Parameter Criteria *	Justification for Monitoring (or not Monitoring) of Parameter	Measurement or Estimation	Monitoring Frequency & Sample Type	Justification for: 1. Monitoring Frequency & Sample Type 2. Estimation over Measurement
3	pH N/A	N/A	Not Monitored: (was in 2008; 2014 - 2018) p: 2008: Core parameter for CRL's storm sewers therefore, special investigation monitoring and found to be comparable to other CRL storm sewers (close to neutral) and within the CNL Guideline acceptable range. As a result, routine monitoring was not implemented [1]. p: 2014: Confirmed to be a required parameter under the *Storm Water Control Study* (Reg 215/95) [3], [5]. 2018: Removed from program as this effluent no longer exists due to the storm water diversion project [6].	N/A	N/A	1. Frequency: 2008: Monthly throughout special investigation [1]. 2009: Removed [7]. 2014: Semi-annual being implemented in alignment with other stormwater monitoring [3]. 2018: Removed [6]. 2. N/A
4b	Nitrates, Total Filter Reactive N/A	N/A	Not Monitored: (was from 2008 - 2014) p: 2008: Core parameter for CRL's storm sewers therefore, special investigation monitoring and found to be relatively high compared to other CRL storm sewers [1]. p: 2009: Added to routine monitoring program with routinely detectable results [7]. 2014: Removed as not a required parameter to be monitored under Reg 215/95 [5], despite being one of the highest effluent concentrations for CRL, this parameter has been seemingly stable since 2009 and well below the CWQG [3].	N/A	N/A	1. Frequency: 2008: Monthly throughout special investigation [1]. 2009: Semi-annual to align with monitoring of other storm outfalls [7]. 2014: Removed [3]. 2. N/A
5a	Dissolved Organic Carbon (DOC) N/A	N/A	Not Monitored: (was in 2008) p: 2008: Core parameter for CRL's storm sewers therefore, special investigation monitoring and found to very low compared to other CRL storm sewers. As a result, routine monitoring was not implemented [1]. 2009: Removed [7]	N/A	N/A	1. Frequency: 2008: Monthly throughout special investigation [1]. 2009: Removed [7]. 2. N/A

REDACTED

[redacted] Storm Outfall						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ***	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
5b	Total Organic Carbon (TOC) N/A	N/A	Not Monitored: (was in 2008) p: 2008: Core parameter for CRL's storm sewers therefore, special investigation monitoring and found to be consistently at or below the LMDL, therefore routine monitoring was not implemented [1]. 2009: Removed [7].	N/A	N/A	1. Frequency: 2008: Monthly throughout special investigation [1]. 2009: Removed [7]. 2. N/A
6	Phosphorus, Unfiltered Total N/A	N/A	Not Monitored: (was in 2008; 2014-2018) p: 2008: Core parameter for CRL's storm sewers therefore, special investigation monitoring with the majority of results found to be comparable to other storm sewers and all results below the CNL Guideline. As a result, routine monitoring was not implemented [1]. q: 2014: Although not part of the required monitoring parameters under the *Storm Water Control Study* (Reg 215/95) [5], a potential source of contamination existed in activities on site which included the use of soaps and some variability was evident in the monitoring results, therefore the parameter was included in routine monitoring program [3]. 2018: Removed from program as this effluent no longer exists due to the storm water diversion project [6].	N/A	N/A	1. Frequency: 2008: Monthly throughout special investigation [1]. 2009; Removed [7]. 2014: Semi-annual being implemented in alignment with other stormwater monitoring [3]. 2018: Removed [6]. 2. N/A
7	Conductivity, @ [redacted] N/A	N/A	Not Monitored: (was from 2008 – 2018) p: 2008: Core parameter for CRL's storm sewers therefore, special investigation monitoring and found to be very high compared to other CRL storm sewers [1]. p: 2009: Added to routine monitoring program with routinely detectable results [7]. q: 2014: Although not a required monitoring parameter under the *Storm Water Control Study* (Reg 215/95) [5] this parameter was kept under the routine monitoring program as it is a good indicator of water quality and is used to screen for other potential issues with parameters not under the routine monitoring program. Levels in this storm sewer also tend to be elevated [3]. 2018: Removed from program as this effluent no longer exists due to the storm water diversion project [6].	N/A	N/A	1. Frequency: 2008: Monthly throughout special investigation [1]. 2009: Semi-annual to align with monitoring of other storm outfalls [7]. 2018: Removed [6]. 2. N/A

REDACTED

[redacted] Storm Outfall						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ***	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
8	Total Suspended Solids (TSS) N/A	N/A	Not Monitored: (was in 2008; 2014 - 2018) p: 2008: Core parameter for CRL's storm sewers therefore, special investigation monitoring and found to not exceed the CNL Guideline, therefore it was not added to the routine monitoring program [1]. n, q: 2014: Confirmed to be a required parameter under the *Storm Water Control Study* (Reg 215/95) [5]. Also, there were 2 months during the 2008 investigation where TSS exceeded the monthly CNL Guideline [3]. 2018: Removed from program as this effluent no longer exists due to the storm water diversion project [6].	N/A	N/A	1. Frequency: 2008: Monthly throughout special investigation [1] 2009: Removed [7]. 2014: Semi-annual being implemented in alignment with other stormwater monitoring [3]. 2018: Removed [6]. 2. N/A
9	Aluminium, Unfiltered Total N/A	N/A	Not Monitored: (was from 2008 – 2018) p: 2008: Core parameter for CRL's storm sewers therefore, special investigation monitoring and found results to be both highly variable and to exceed PWQG [1]. p: 2009: Added to routine monitoring program with routinely detectable results [7]. q: 2014: Although not part of the required monitoring parameters under the *Storm Water Control Study* (Reg 215/95) [5], there is a lot of variability noted over the past few years therefore the parameter was kept in the routine monitoring program. Also, the potential source in piping is known. 2018: Removed from program as this effluent no longer exists due to the storm water diversion project [6].	N/A	N/A	1. Frequency: 2008: Monthly throughout special investigation [1]. 2009: Semi-annual to align with monitoring of other storm outfalls [7]. 2018: Removed [6]. 2. N/A
9	Copper, Unfiltered Total N/A	N/A	Not Monitored: (was in 2008; 2014-2018) p: 2008: Core parameter for CRL's storm sewers therefore, special investigation monitoring and although found to be similar to other storm sewers, all measurements were found to be seemingly stable and well below the CNL Guideline. As a result, routine monitoring was not implemented [1]. q: 2014: Despite copper not being a core parameter under the *Storm Water Control Study* (Reg 215/95) [5], since it is already being analysed for with the rest of ATG9, it is being kept at this monitoring location [3] 2018: Removed from program as this effluent no longer exists due to the storm water diversion project [6].	N/A	N/A	1. Frequency: 2008: Monthly throughout special investigation [1]. 2009: Removed [7]. 2014: Semi-annual being implemented in alignment with other stormwater monitoring [3]. 2018: Removed [6]. 2. N/A

REDACTED

[redacted] Storm Outfall						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ***	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
9	Lead, Unfiltered Total N/A	N/A	Not Monitored: (was in 2008; 2014-2018) p: 2008: Core parameter for monitoring of CRL's storm sewers therefore it was monitored during a special investigation which observed all concentrations to be ≤ LMDL; therefore this parameter was not added to the routine monitoring program [1]. q: 2014: Despite lead not being a core parameter under the *Storm Water Control Study* (Reg 215/95) [5], since it is already being analysed for with the rest of ATG9, it is being kept at this monitoring location [3]. 2018: Removed from program as this effluent no longer exists due to the storm water diversion project [6].	N/A	N/A	1. Frequency: 2008: Monthly throughout special investigation [1]. 2009: Removed [7] 2014: Semi-annual being implemented in alignment with other stormwater monitoring [3]. 2018: Removed [6]. 2. N/A
9	Zinc, Unfiltered Total N/A	N/A	Not Monitored: (was in 2008; 2014-2018) p: 2008: Core parameter for monitoring of CRL's storm sewers therefore it was monitored during a special investigation which observed detectable concentrations with some variability. All results were below the CNL Guideline; therefore this parameter was not added to the routine monitoring program [1]. q: 2014: Despite zinc not being a core parameter under the *Storm Water Control Study* (Reg 215/95) [5], there was some variability noted during the special investigation and since zinc is already being analysed for with the rest of ATG9, it is being kept at this monitoring location [3]. 2018: Removed from program as this effluent no longer exists due to the storm water diversion project [6].	N/A	N/A	1. Frequency: 2008: Monthly throughout special investigation [1]. 2009: Removed [7]. 2014: Semi-annual being implemented in alignment with other stormwater monitoring [3]. 2018: Removed [6]. 2. N/A
9a	Iron, Unfiltered Total N/A	N/A	Not Monitored: (was from 2008 – 2018) n, p: 2008: Core parameter for CRL's storm sewers therefore, special investigation monitoring and found concentrations to be highly variable and to exceed the CNL Guideline [1]. p: 2009: Added to routine monitoring program with routinely detectable results [7]. n, p: 2014: Confirmed to be a required parameter under the *Storm Water Control Study* (Reg 215/95) [5]; highly variable and known to exceed CNL Guidelines. 2018: Removed from program as this effluent no longer exists due to the storm water diversion project [6].	N/A	N/A	1. Frequency: 2008: Monthly throughout special investigation [1]. 2009: Semi-annual to align with monitoring of other storm outfalls [7]. 2018: Removed [6]. 2. N/A
16	Chloroform N/A	N/A	Not Monitored: (was in 2008) 2008: Special Investigation monitoring and found most concentrations to be <LMDL with no detected concentrations above the CWQG, confirming that there are no sources entering this system, therefore this parameter was not added to the routine monitoring program [1].	N/A	N/A	1. Frequency: 2008: Monthly throughout special investigation [1]. 2009: Removed [7]. 2. N/A

REDACTED

[redacted] Storm Outfall						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ***	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
25	Solvent Extractables N/A	N/A	Not Monitored: (was from 2008 – 2018) p: 2008: Core parameter for CRL's storm sewers therefore, special investigation monitoring and although found to be similar to other storm sewers, all measurements were well below the CNL Guideline. As a result, routine monitoring was not implemented [1]. p: 2014: Confirmed to be a required parameter under the *Storm Water Control Study* (Reg 215/95) [5]. Some variability noted in special investigation monitoring and identified potential source on site [3]. 2018: Removed from program as this effluent no longer exists due to the storm water diversion project [6].	N/A	N/A	1. Frequency: 2008: Monthly throughout special investigation [1]. 2009: Removed [7]. 2014: Semi-annual being implemented in alignment with other stormwater monitoring [3]. 2018: Removed [6]. 2. N/A
27	Polychlorinated Biphenyls (PCB) N/A	N/A	Not Monitored: As a result of being a required monitoring parameter in Reg 215/95 [5] for storm sewers, monitoring of the site's largest storm sewers took place with no contamination found. There is no suspected or known source on site, therefore not added to the routine monitoring program. Also, being monitored under the GWMP with no contamination noted [4].	N/A	N/A	N/A
30	Chloride N/A	N/A	Not Monitored: (was from 2008 – 2018) n, q: 2008: Special Investigation monitoring and found to be relatively high compared to other CRL storm sewers and above CWQG at times and a based on SRC comment therefore it was added to the routine monitoring program [1] [2]. 2014 Note: This is not a required parameter under the *Storm Water Control Study* (Reg 215/95) [5]. 2018: Removed from program as this effluent no longer exists due to the storm water diversion project [6].	N/A	N/A	1. Frequency: 2008: Monthly throughout special investigation [1]. 2009: Semi-annual to align with monitoring of other storm outfalls [7]. 2018: Removed [6]. 2. N/A
--	Flow Rate (m^3/day) N/A	N/A	Not Monitored: (was in 2008; 2014 – 2018) p: 2008: Monitored for presence/absence only during the Special Investigation [1]. p: 2014: Confirmed to be a required parameter under the *Storm Water Control Study* (Reg 215/95) [5] to determine loading from the source [3]. 2018: Removed from program as this effluent no longer exists due to the storm water diversion project [6].	N/A	N/A	1. Frequency: 2008: Monthly throughout special investigation [1]. 2009 Removed [7]. 2014: Semi-annual being implemented in alignment with other stormwater monitoring [3]. 2018: Removed [6]. 2. N/A

REDACTED

[redacted] Storm Outfall						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ***	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**

Notes: CRL - Chalk River Laboratory; CWQG - Canadian Water Quality Guideline; MISA - Municipal/Industrial Strategy for Abatement; ATG - Analytical Test Group; GWMP – Groundwater Monitoring Program.

* See Table 15: Parameter Monitoring Criteria for the Effluent Compliance Monitoring Program

References:

[1] *Response to Letter on Licence Condition* 7.15, EnvP-09-113, EnvP-ACNO-09-0017-L, 2009 August. 22443369
[2] *SRC Acceptance of the Annual Program Report - Non-Radiological Effluent Monitoring in 2005 at Chalk River Laboratories,* SRCM-62-059, 2006 August.
[3] *Effluent Verification Monitoring Program Sampling Schedule for CRL*, CRL-509200-062-000-0001, Rev 6, 2013 December. 23651723
[4] *Non-Radiological Liquid Effluent Monitoring at CRL: The Results for* 1997, AECL-MISC-397-97, 1998 September. 22869405
[5] *Ontario Regulation 215/95, Effluent Monitoring and Effluent Limits - Electric Power Generation Sector*.
[6] *Effluent Verification Monitoring Program Sampling Schedule for CRL & NPD*, CRL-509200-062-000-0004, Rev 12, 2018 Dec 14. 42016713
[7] *Non Radiological Monitoring Schedule for CRL*, CRL-509200-062-000-0001, 2009 March. 23657179

REDACTED

B.3 [redacted] Storm Outfall

Table 51: Detailed Design - [redacted] Storm Outfall

Description: The [redacted] Monitoring point was removed as the station no longer exists due to the stormsewer redirection project which was completed in 2018.
History: Prior to this redirection/removal, the [redacted] Storm Outfall collection system was a series of storm sewers extending through the Supervised Area. It collected surface runoff from roads in the south portion of the built-up area as well as cooling water, building roof and foundation drainage.
The [redacted] Storm Outfall was a piped system which opened up into an open ditch prior to combining with [redacted] Stream and then discharged directly into the Ottawa River. There was no treatment of this outfall.
Note: [redacted] Stream is considered an environmental monitoring point and is therefore not covered by the *CRL Environmental Monitoring Plan* (CRL-509200-PLA-007) and was part of the original MISA program. As with all other streams which were part of the original MISA program, [redacted] underwent a thorough characterization. The [redacted] monitoring point was not part of the original MISA program but was instead implemented in 2010 after some elevated results were noted in [redacted] Stream of which the source was not known Implementing [redacted] allowed for (1) the determination of whether any contaminants of concern seen at [redacted] Monitoring Point were coming from the attached storm sewer system or [redacted] Stream; and (2) identification of any site discharges of concern which may have been masked once [redacted] storm sewer combines with [redacted] stream.
Since [redacted] Stream is downgradient from the inactive landfill, it has very thorough monitoring in terms of the number of parameters under the program. The same extensive list of parameters (much more than any other storm sewer) was implemented at [redacted] Storm Outfall as well in order that a direct comparison could be made.

[redacted] Storm Outfall						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ***	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
1	Chemical Oxygen Demand (COD) N/A	N/A	Not Monitored: (was from 2011 - 2018) q: 2011: Added to align monitoring with MOE guidelines for landfills [5]. Note: The same parameter was also added to [redacted] Outfall so the two sets of results can be compared and the contaminant source location narrowed (i.e. from storm sewer system or from [redacted] Stream (leachate from the landfill)) [3]. Note: Parameter is not required under the *Storm Water Control Study* (Reg 215/95) [6]. 2018: Removed as station no longer exists due to the stormsewer redirection project [9].	N/A	N/A	1. Frequency: 2011: Semi-annual to align with all other storm outfall monitoring [3]. 2018: Removed [9]. N/A
1a	Biological Oxygen Demand (BOD) N/A	N/A	Not Monitored: (was from 2011 - 2016) q: 2011: Added to align monitoring with MOE guidelines for landfills [5]. Note: The same parameter was also added to [redacted] Outfall so the two sets of results can be compared and the contaminant source location narrowed (i.e. from storm sewer system or from [redacted] Outfall (leachate from the landfill)) [3]. Note: Parameter is not required under the *Storm Water Control Study* (Reg 215/95) [6]. 2016: Removed as all results are below detect [10].	N/A	N/A	1. Frequency: 2011: Semi-annual to align with all other storm outfall monitoring [3]. 2016: Removed [10]. 2. N/A
3	pH N/A	N/A	Not Monitored: (was from 2010 - 2018) p: 2010: Core parameter required under MISA for all storm outfall monitoring [1]. Note: Confirmed to also be required by the MOE guidelines for landfills [5] and under the *Storm Water Control Study* (Reg 215/95) [6]. 2018: Removed as station no longer exists due to the stormsewer redirection project [9].	N/A	N/A	1. Frequency: 2010: Semi-annual to align with all other storm outfall monitoring [1]. 2018: Removed [9]. 2. N/A

REDACTED

[redacted] Storm Outfall						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ***	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
4a	Total Kjedahl Nitrogen N/A	N/A	Not Monitored: (was from 2011 - 2018) q: 2011: Added to align monitoring with MOE guidelines for landfills [5]. NOTE: The same parameter was also added to [redacted] Outfall so the two sets of results can be compared and the contaminant source location narrowed (i.e. from storm sewer system or from [redacted] Outfall (leachate from the landfill)) [3]. Note: Parameter is not required under the *Storm Water Control Study* (Reg 215/95) [6]. 2018: Removed as station no longer exists due to the stormsewer redirection project [9].	N/A	N/A	1. Frequency: 2011: Semi-annual to align with all other storm outfall monitoring [3]. 2018: Removed [9]. 2. N/A
4b	Nitrates, Total Filter Reactive N/A	N/A	Not Monitored: (was from 2010 - 2018) q: 2010: Core parameter required under MISA for all storm outfall monitoring [1]. Note: Confirmed to also be required by the MOE guidelines for landfills [5] despite not being a required parameter under the *Storm Water Control Study* (Reg 215/95) [6]. 2018: Removed as station no longer exists due to the stormsewer redirection project [9].	N/A	N/A	1. Frequency: 2010: Semi-annual to align with all other storm outfall monitoring [1]. 2018: Removed [9]. 2. N/A
5a	Dissolved Organic Carbon (DOC) N/A	N/A	Not Monitored: (was from 2010 - 2014) p: 2010: Core parameter required under MISA for all storm outfall monitoring [1]. 2014: Removed as not a required monitoring parameter under the *Storm Water Control Study* (Reg 215/95) [6] nor under the MOE guidelines for landfills [5] and results have shown very low and stable concentrations since 2010 which were well below the background (River water) [7], [8].	N/A	N/A	1. Frequency: 2010: Semi-annual to align with all other storm outfall monitoring [1]. 2014: Removed [8]. 2. N/A
5b	Total Organic Carbon (TOC) N/A	N/A	Not Monitored: (was from 2010 - 2014) p: 2010: Core parameter required under MISA for all storm outfall monitoring [1]. 2014: Removed as not a required monitoring parameter under the *Storm Water Control Study* (Reg 215/95) [6] nor under the MOE guidelines for landfills [5] and consistent concentrations have been observed since 2010 which were well below the background (River water) [7], [8].	N/A	N/A	1. Frequency: 2010: Semi-annual to align with all other storm outfall monitoring [1]. 2014: Removed [8]. 2. N/A
6	Phosphorus, Unfiltered Total N/A	N/A	Not Monitored: (was from 2010 - 2018) p: 2010: Core parameter required under MISA for all storm outfall monitoring [1] Note: Confirmed to also be required by the MOE guidelines for landfills [5] despite not being a required parameter under the *Storm Water Control Study* (Reg 215/95) [6]. Also, there is a potential source from phosphorus containing substances used on site. 2018: Removed as station no longer exists due to the stormsewer redirection project [9].	N/A	N/A	1. Frequency: 2010: Semi-annual to align with all other storm outfall monitoring [1]. 2018: Removed [9]. 2. N/A
7	Conductivity, @ [redacted] N/A	N/A	Not Monitored: (was from 2010 - 2018) p: 2010: Core parameter required under MISA for all storm outfall monitoring [1]. Note: Confirmed to also be required by the MOE guidelines for landfills [5] despite not being a required parameter under the *Storm Water Control Study* (Reg 215/95) [6]. Also, it is a good indicator of water quality and is used to screen for other potential issues with parameters not under the routine monitoring program. 2018: Removed as station no longer exists due to the stormsewer redirection project [9].	N/A	N/A	1. Frequency: 2010: Semi-annual to align with all other storm outfall monitoring [1]. 2018: Removed [9]. 2. N/A

REDACTED

[redacted] Storm Outfall						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ***	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
8a	Dissolved Solids, Total (TDS) N/A	N/A	Not Monitored: (was from 2011 - 2018) q: 2011: Added to align monitoring with MOE guidelines for landfills. Note: The same parameter was also added to [redacted] Outfall so the two sets of results can be compared and the contaminant source location narrowed (i.e. from storm sewer system or from [redacted] Outfall (leachate from the landfill)) [3]. Note: Parameter is not required under the *Storm Water Control Study* (Reg 215/95) [6]. 2018: Removed as station no longer exists due to the stormsewer redirection project [9].	N/A	N/A	1. Frequency: 2011: Semi-annual to align with all other storm outfall monitoring [3]. 2018: Removed [9]. 2. N/A
8	Total Suspended Solids (TSS) N/A	N/A	Not Monitored: (was from 2010 - 2018) p: 2010: Core parameter required under MISA for all storm outfall monitoring [1]. Confirmed to also be required by the MOE guidelines for landfills [5] as well as a required parameter under the *Storm Water Control Study* (Reg 215/95) [6]. 2018: Removed as station no longer exists due to the stormsewer redirection project [9].	N/A	N/A	1. Frequency: 2010: Semi-annual to align with all other storm outfall monitoring [1]. 2018: Removed [9]. 2. N/A
9	Aluminium, Unfiltered Total N/A	N/A	Not Monitored: (was from 2010 - 2018) p, q: 2010: Core parameter required under MISA for all storm outfall monitoring [1]. Note: Although not part of the required monitoring parameters under the *Storm Water Control Study* (Reg 215/95) [6], there has been relatively high concentrations observed over the past years with a large degree of variability and Al is known to be high in background concentrations in this area, therefore the parameter was kept in the routine monitoring program. 2018: Removed as station no longer exists due to the stormsewer redirection project [9].	N/A	N/A	1. Frequency: 2010: Semi-annual to align with all other storm outfall monitoring [1]. 2018: Removed [9]. 2. N/A
9	Boron, Unfiltered Total & Cadmium, Unfiltered Total & Chromium, Unfiltered Total N/A	N/A	Not Monitored: (was from 2011 - 2018) q: 2011: Added to align monitoring with MOE guidelines for landfills [5]. Note: The same parameter was also added to 010 Outfall so the two sets of results can be compared and the contaminant source location narrowed (i.e. from storm sewer system or from 010 stream (leachate from the landfill)) [3]. Note: Parameter is not required under the *Storm Water Control Study* (Reg 215/95) [6]. 2018: Removed as station no longer exists due to the stormsewer redirection project [9].	N/A	N/A	1. Frequency: 2011: Semi-annual to align with all other storm outfall monitoring [3]. 2018: Removed [9]. 2. N/A
9	Copper, Unfiltered Total N/A	N/A	Not Monitored: (was from 2010 - 2018) p: 2010: Core parameter required under MISA for all storm outfall monitoring [1]. Note: Confirmed to also be required by the MOE guidelines for landfills [5] despite not being a required parameter under the *Storm Water Control Study* (Reg 215/95) [6]. Also, there is a potential source from piping. 2018: Removed as station no longer exists due to the stormsewer redirection project [9].	N/A	N/A	1. Frequency: 2010: Semi-annual to align with all other storm outfall monitoring [1]. 2018: Removed [9]. 2. N/A

REDACTED

[redacted] Storm Outfall						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ***	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
9	Lead, Unfiltered Total N/A	N/A	Not Monitored: (was from 2010 - 2018) 2010: Core parameter required under MISA for CRL's entire storm outfall monitoring [1] Note: Confirmed to also be required by the MOE guidelines for landfills [5] despite not being a required parameter under the *Storm Water Control Study* (Reg 215/95) [6]. Also, there is a potential source from lead use on site and observations have shown detectable levels, albeit very low. 2018: Removed as station no longer exists due to the stormsewer redirection project [9].	N/A	N/A	1. Frequency: 2010: Semi-annual to align with all other storm outfall monitoring [1]. 2018: Removed [9]. 2. N/A
9	Zinc, Unfiltered Total N/A	N/A	Not Monitored: (was from 2010 - 2018) p: 2010: Core parameter required under MISA for CRL's entire storm outfall monitoring therefore added to this monitoring location [1]. Note: Confirmed to also be required by the MOE guidelines for landfills [5] despite not being a required parameter under the *Storm Water Control Study* (Reg 215/95) [6]. Also, there is a potential source from piping. 2018: Removed as station no longer exists due to the stormsewer redirection project [9].	N/A	N/A	1. Frequency: 2010: Semi-annual to align with all other storm outfall monitoring [1]. 2018: Removed [9]. 2. N/A
9a	Iron, Unfiltered Total N/A	N/A	Not Monitored: (was from 2011 - 2018) n, p: 2010: Core parameter required under MISA for all storm outfall monitoring [1]. Note: Confirmed to be a requirement under both the MOE guidelines for landfills [5] and the *Storm Water Control Study* (Reg 215/95) [6]. Also, this parameter has been known to exceed the CNL Guideline for this effluent. 2018: Removed as station no longer exists due to the stormsewer redirection project [9].	N/A	N/A	1. Frequency: 2011: Semi-annual to align with all other storm outfall monitoring [3]. 2018: Removed [9]. 2. N/A
10	Arsenic, unfiltered Total N/A	N/A	Not Monitored: (was from 2011 - 2016) q: 2011: Added to align monitoring with MOE guidelines for landfills [5]. NOTE: The same parameter was also added to [redacted] Outfall so the two sets of results can be compared and the contaminant source location narrowed (i.e. from storm sewer system or from [redacted] Outfall (leachate from the landfill)) [3]. Note: Parameter is not required under the *Storm Water Control Study* (Reg 215/95) [6]. 2016: Removed as all results are below detect [10].	N/A	N/A	1. Frequency: 2011: Semi-annual to align with all other storm outfall monitoring [3]. 2016: Removed [10]. 2. N/A
12	Mercury, Unfiltered Total N/A	N/A	Not Monitored: (was from 2011 - 2018) q: 2011: Added to align monitoring with MOE guidelines for landfills [5]. NOTE: The same parameter was also added to [redacted] Outfall so the two sets of results can be compared and the contaminant source location narrowed (i.e. from storm sewer system or from [redacted] Outfall (leachate from the landfill)) [3]. Note: Parameter is not required under the *Storm Water Control Study* (Reg 215/95) [6]. 2018: Removed as station no longer exists due to the stormsewer redirection project [9].	N/A	N/A	1. Frequency: 2011: Semi-annual to align with all other storm outfall monitoring [3] 2018: Removed [9]. 2. N/A

REDACTED

[redacted] Storm Outfall						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ***	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
14	Phenolics, Unfiltered React N/A	N/A	Not Monitored: (was from 2011 - 2018) q: 2011: Added to align monitoring with MOE guidelines for landfills [5]. Note: The same parameter was also added to [redacted] Outfall so the two sets of results can be compared and the contaminant source location narrowed (i.e. from storm sewer system or from [redacted] Stream (leachate from the landfill)) [3]. Note: Parameter is not required under the *Storm Water Control Study* (Reg 215/95) [6]. 2018: Removed as station no longer exists due to the stormsewer redirection project [9].	N/A	N/A	1. Frequency: 2011: Semi-annual to align with all other storm outfall monitoring [3]. 2018: Removed [9]. 2. N/A
16	Chloroform N/A	N/A	Not Monitored: (was from 2010-2017) q: 2010: Core parameter required under MISA for major storm outfall monitoring [1]. Note: Confirmed to not be a requirement under either the *Storm Water Control Study* (Reg215/95) [6] or the MOE guidelines for landfills [5] and to date, detectable results have been just above the LMDL and all were well below the CWQG. 2017: Removed as all results continue to be very low and none above CWQG [11].	N/A	N/A	1. Frequency: 2010: Semi-annual to align with all other storm outfall monitoring [1]. 2017: Removed [11]. 2. N/A
25	Solvent Extractables N/A	N/A	Not Monitored: (was from 2010 - 2018) n, p: 2010: Core parameter required under MISA for all storm outfall monitoring [1]. Note: Confirmed to be a required parameter for the *Storm Water Control Study* under Reg 215/95 [6] and not under the MOE guidelines for landfills [5]. Although monitoring results to date have at or just above the LMDL, routine operations continue to be a known potential source on site, therefore monitoring has been kept in the routine monitoring program. 2018: Removed as station no longer exists due to the stormsewer redirection project [9].	N/A	N/A	1. Frequency: 2010: Semi-annual to align with all other storm outfall monitoring [1]. 2018: Removed [9]. 2. N/A
27	Polychlorinated Biphenyls (PCB) N/A	N/A	Not Monitored: Although part of the required monitoring parameters under the *Storm Water Control* Study (Reg 215/95) [6], the parameter is not part of the routine program based on non-detectable previous monitoring results at the major CRL storm sewers and the fact that there is no known or suspected source on site. Also, being monitored under the GWMP with no contamination noted.	N/A	N/A	N/A
29	Barium N/A	N/A	Not Monitored: (was from 2011 - 2018) q: 2011: Added to align monitoring with MOE guidelines for landfills [5]. Note: The same parameter was also added to [redacted] Outfall so the two sets of results can be compared and the contaminant source location narrowed (i.e. from storm sewer system or from [redacted] Outfall (leachate from the landfill)) [3]. Note: Parameter is not required under the *Storm Water Control Study* (Reg 215/95) [6]. 2018: Removed as station no longer exists due to the stormsewer redirection project [9].	N/A	N/A	1. Frequency: 2011: Semi-annual to align with all other storm outfall monitoring [3]. 2018: Removed [9]. 2. N/A

REDACTED

[redacted] Storm Outfall						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ***	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
30	Chloride N/A	N/A	Not Monitored: (was from 2010 - 2018) n, q: 2010: Added to determine road salt effects, if any, on effluent (based on SRC comment) [2]. Note: Confirmed to be a requirement under MOE guidelines for landfills [5] but not under Reg215/95 [6]. Concentrations are easily detectable and known source is from site operations and relatively low concentrations have been observed to date, it is a known contaminant source currently being used on site. 2018: Removed as station no longer exists due to the stormsewer redirection project [9].	N/A	N/A	1. Frequency: 2010: Semi-annual to align with all other storm outfall monitoring [1] 2018: Removed [9]. 2. N/A
30	Sulphates N/A	N/A	Not Monitored: (was from 2011 - 2018) q: 2011: Added to align monitoring with MOE guidelines for landfills [5]. Note: The same parameter was also added to [redacted] Outfall so the two sets of results can be compared and the contaminant source location narrowed (i.e. from storm sewer system or from [redacted] Stream (leachate from the landfill)) [3]. Note: Parameter is not required under the *Storm Water Control Study* (Reg 215/95) [6]. 2018: Removed as station no longer exists due to the stormsewer redirection project [9].	N/A	N/A	1. Frequency: 2011: Semi-annual to align with all other storm outfall monitoring [3]. 2018: Removed [9]. 2. N/A
--	Flow Rate (m^3/day) N/A	N/A	Not Monitored: (was from 2010- 2018) p: 2010: Core physical characteristic under MISA used to determine loading from the source [1]. Note: Confirmed to be a required parameter under the *Storm Water Control Study* under Reg 215/95 [6] and the MOE guidelines for landfills [5] to determine loading from the source. 2018: Removed as station no longer exists due to the stormsewer redirection project [9].	N/A	N/A	2. Frequency: 2011: Semi-annual to align with all other storm outfall monitoring [3]. 2018: Removed [9]. 2. N/A
--	Temperature Effluent Maximum N/A	N/A	Not Monitored: (was from 2011 - 2018) q: 2011: Added to align monitoring with MOE guidelines for landfills [5]. NOTE: The same parameter was also added to [redacted] Outfall so the two sets of results can be compared and the contaminant source location narrowed (i.e. from storm sewer system or from [redacted] Stream (leachate from the landfill)) [3]. Note: Parameter is not required under the *Storm Water Control Study* (Reg 215/95) [6]. 2018: Removed as station no longer exists due to the stormsewer redirection project [9].	N/A	N/A	1. Frequency: 2011: Semi-annual to align with all other storm outfall monitoring [3]. 2018: Removed [9]. 2. N/A
-	Alkalinity N/A	N/A	Not Monitored: (was from 2011 - 2018) q: 2011: Added to align monitoring with MOE guidelines for landfills [5] Note: The same parameter was also added to [redacted] Outfall so the two sets of results can be compared and the contaminant source location narrowed (i.e. from storm sewer system or from [redacted] stream (leachate from the landfill) [3]. Note: Parameter is not required under the *Storm Water Control Study* (Reg 215/95) [6]. 2018: Removed as station no longer exists due to the stormsewer redirection project [9].	N/A	N/A	1. Frequency: 2011: Semi-annual to align with all other storm outfall monitoring [3]. 2018: Removed [9]. 2. N/A

REDACTED

[redacted] Storm Outfall						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ***	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
-	Dissolved Oxygen N/A	N/A	Not Monitored: (was from 2011 - 2018) q: 2011: Added to align monitoring with MOE guidelines for landfills [5]. Note: The same parameter was also added to [redacted] Outfall so the two sets of results can be compared and the contaminant source location narrowed (i.e. from storm sewer system or from [redacted] Stream (leachate from the landfill)) [3]. Note: Parameter is not required under the *Storm Water Control Study* (Reg 215/95) [6]. 2018: Removed as station no longer exists due to the stormsewer redirection project [9].	N/A	N/A	1. Frequency: 2011: Semi-annual to align with all other storm outfall monitoring [3]. 2018: Removed [9]. 2. N/A
--	Hardness N/A	N/A	Not Monitored: (was from 2012 - 2018) q: 2012: Added as guidelines for various metals are dependent on the effluent hardness [4]. Note: This parameter is not required under the *Storm Water Control Study* (Reg 215/95) [6] or the MOE guidelines for landfills [5]. 2018: Removed as station no longer exists due to the stormsewer redirection project [9].	N/A	N/A	1. Frequency: 2012: Semi-annual to align with all other storm outfall monitoring [4]. 2018: Removed [9]. 2. N/A

Notes:
LMDL - Laboratory Method Detection Level; SRC - Safety Review Committee; CRL - Chalk River Laboratory; CWQG - Canadian Water Quality Guideline; MISA - Municipal/Industrial Strategy for Abatement; ATG - Analytical Test Group; MOE - Ministry of Environment; GWMP – Groundwater Monitoring Program.
* See Table 15: Parameter Monitoring Criteria for the Effluent Compliance Monitoring Program

References:

[1] *Non-Radiological Monitoring Schedule for CRL*, CRL-509200-062-000-0001, Rev 2, 2010 March. 23657126
[2] *SRC Acceptance of the Annual Program Report - Non-Radiological Effluent Monitoring in 2005 at Chalk River Laboratories*, SRCM-62-059, 2006 August.
[3] *Non-Radiological Monitoring Schedule for CRL*, CRL-509200-062-000-0001, Rev 3, 2011 January. 23657098
[4] *Non-Radiological Monitoring Schedule for CRL*, CRL-509200-062-000-0001, Rev 4, 2012 January. 23651789
[5] *Ministry of the Environment, Landfill Standards: A Guideline on the Regulator and Approval requirements for New and Expanding Landfilling Sites*, 2012 January.
[6] Ontario Regulation 215/95, *Effluent Monitoring and Effluent Limits - Electric Power Generation Sector*.
[7] *CRL Annual Safety Review for* 2012, CRL-00583-ASR-2012, 2013 April. 22322206
[8] *Effluent Verification Monitoring Program Sampling Schedule for CRL*, CRL-509200-062-000-0001, Rev 6, 2013 December. 23651723
[9] *Effluent Verification Monitoring Program Sampling Schedule for CRL & NPD*, CRL-509200-062-000-0004, Rev 12, 2018 Dec 14. 42016713
[10] *Effluent Verification Monitoring Program Sampling Schedule for CRL*, CRL-509200-062-000-0004, Rev 5, 2016 January.
[11] *Effluent Verification Monitoring Program Sampling Schedule for CRL*, CRL-509200-062-000-0004, Rev 7, 2016 August. 22726453

REDACTED

B.4 [redacted] Storm Outfall

Table 52: Detailed Design - [redacted] Storm Outfall

Description: In 2018, the effluent was redirected during the site stormwater redirection project and was instead incorporated into the [redacted] Stormwater collection system so the [redacted] effluent to the River no longer exists.
History: Prior to this redirection/removal, Manhole [redacted] was the last manhole of a storm sewer collection system prior to discharging to the Ottawa River. The collection system was located in the Controlled Area with a series of branches in the vicinity of the Sanitary Sewage Treatment Facility. It collected surface runoff from a few roads in the northeast portion of the built-up area as well as some roof drainage from the Sanitary Sewage Treatment Facility building itself.
There was no prior treatment of this stormwater before it is discharged to the River. This monitoring point was not part of the original MISA program. Instead, its effluent was reviewed through a Special Investigation which took place monthly during 2008. As a result of the special investigation monitoring, this monitoring point and a certain set of parameters were considered significant and were therefore added to the routine monitoring program in 2009. A review of this location's monitoring took place in 2013 resulting in further changes to the program for 2014.
The monitoring of this location was removed from the program in 2016 due to issues with accessing the sampling location [4].

Manhole [redacted] Storm Outfall						
ATG	Parameter Name Treatment	Parameter Criteria *	Justification for Monitoring (or not Monitoring) of Parameter	Measurement or Estimation	Monitoring Frequency & Sample Type	Justification for: 1. Monitoring Frequency & Sample Type 2. Estimation over Measurement
3	pH N/A	N/A	Not Monitored: (was in 2008; 2014 -2016) p: 2008: Core parameter for CRL's storm sewers therefore, special investigation monitoring and found to be comparable to other CRL storm sewers (close to neutral) and within the CNL Guideline acceptable range. As a result, routine monitoring was not implemented [1]. p: 2014: As a result of the review of the effluent monitoring program, core parameters under Reg 215/95 [6] were added for routine monitoring [3]. 2016: Removed from the program due to issues with accessing the sampling location [4].	N/A	N/A	1. Frequency: 2008: Monthly for characterization purposes [1]. 2009: Removed [2]. 2014: Semi-annual to align with all other stormwater monitoring [3]. 2016: Removed [4]. 2. N/A
4b	Nitrates, Total Filter Reactive N/A	N/A	Not Monitored: (was from 2008 - 2014) p: 2008: Core parameter for CRL's storm sewers therefore, special investigation monitoring and found to be relatively high compared to other CRL storm sewers [1]. p: 2009: Added to the routine monitoring program [2]. 2014: Removed as not a required monitoring parameter under the *Storm Water Control Study* (Reg 215/95) [6]; seemingly stable concentrations over a number of years which although is one of the highest effluent concentrations of CRL effluent, is still well below limits [3].	N/A	N/A	1. Frequency: 2008: Monthly for characterization purposes [1]. 2009: Semi-annual to align with all other stormwater monitoring [2]. 2014: Removed [3]. 2. N/A

REDACTED

Manhole [redacted] Storm Outfall						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ***	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
5a	Dissolved Organic Carbon (DOC) N/A	N/A	Not Monitored: (was in 2008) 2008: Core parameter for CRL's storm sewers therefore, special investigation monitoring. All results were found to be low compared to other site storm sewers. As a result, routine monitoring was not implemented [1]	N/A	N/A	1. Frequency: 2008: Monthly for characterization purposes [1]. 2009: Removed [2]. 2. N/A
5b	Total Organic Carbon (TOC) N/A	N/A	Not Monitored: (was in 2008) 2008: Core parameter for CRL's storm sewers therefore, special investigation monitoring. All results were found to be low compared to other site storm sewers. As a result, routine monitoring was not implemented [1]	N/A	N/A	1. Frequency: 2008: Monthly for characterization purposes [1]. 2009: Removed [2]. 2. N/A
6	Phosphorus, Unfiltered Total N/A	N/A	Not Monitored: (was in 2008; 2014 – 2016) p: 2008: Core parameter for CRL's storm sewers therefore, special investigation monitoring and although the results were found to be comparable to other storm sewers, all results were well below the CNL Guideline and as a result, routine monitoring was not implemented [1]. n, q: 2014: Although not part of the required monitoring parameters under the *Storm Water Control Study* (Reg 215/95) [6], there is a potential source of contamination from site operations, therefore the parameter was added to the routine monitoring program [3]. 2016: Removed from the program due to issues with accessing the sampling location [4].	N/A	N/A	1. Frequency: 2008: Monthly for characterization purposes [1]. 2009: Removed [2]. 2014: Semi-annual to align with all other stormwater monitoring [3] 2016: Removed [4]. 2. N/A
7	Conductivity, @ [redacted] N/A	N/A	Not Monitored: (was in 2008 – 2016) p: 2008: Core parameter for CRL's storm sewers therefore, special investigation monitoring and found to be relatively high compared to other CRL storm sewers. As a result, routine monitoring was implemented [1]. q: 2014: Although not a required monitoring parameter under the *Storm Water Control Study* (Reg 215/95) [6] this parameter was kept under the routine monitoring program as it is a good indicator of water quality and is used to screen for other potential issues with parameters not under the routine monitoring program. Levels in this storm sewer also tend to be elevated [3]. 2016: Removed from the program due to issues with accessing the sampling location [4].	N/A	N/A	1. Frequency: 2008: Monthly for characterization purposes [1] 2009: Semi-annual to align with all other site stormwater monitoring [2]. 2016: Removed [4]. 2. N/A

REDACTED

Manhole [redacted] Storm Outfall						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ***	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
8	Total Suspended Solids (TSS) N/A	N/A	Not Monitored: (was in 2008; 2014 – 2016) p: 2008: Core parameter for CRL's storm sewers therefore monitored under a special investigation. Most results were both lower than other storm sewers and all were below the daily CNL Guideline and as a result, routine monitoring was not implemented [1]. n, p: 2014: Confirmed to be a required parameter under the *Storm Water Control Study* (Reg 215/95) [6], variability in Special Investigation monitoring was noted and known potential site source, therefore routine monitoring commenced [3]. 2016: Removed from the program due to issues with accessing the sampling location [4].	N/A	N/A	1. Frequency: 2008: Monthly for characterization purposes [1]. 2009: Removed [2]. 2014: Semi-annual to align with all other stormwater monitoring [3]. 2016: Removed [4]. 2. N/A
9	Aluminium, Unfiltered Total N/A	N/A	Not Monitored: (was in 2008; 2014 – 2016) p: 2008: Special investigation monitoring and observed some very high results were present but the majority were less than the LMDL, therefore not added to the routine monitoring program [1]. q: 2014: Although not part of the required monitoring parameters under the *Storm Water Control Study* (Reg 215/95) [6], the variability noted during the special investigation and the known potential source in the systems piping meant that monitoring of the parameter was once again commenced [3]. 2016: Removed from the program due to issues with accessing the sampling location [4].	N/A	N/A	1. Frequency: 2008: Monthly for characterization purposes [1]. 2009: Removed [2]. 2014: Semi-annual to align with all other stormwater monitoring [3]. 2016: Removed [4]. 2. N/A
9	Copper, Unfiltered Total N/A	N/A	Not Monitored: (was in 2008; 2014 – 2016) p: 2008: Core parameter for CRL's storm sewers therefore, special investigation monitoring and although found to be similar to other storm sewers, all measurements were found to be fairly stable and all were well below the CNL Guideline. As a result, routine monitoring was not implemented [1]. q: 2014: Despite copper not being a core parameter under the *Storm Water Control Study* (Reg 215/95) [6], since it is already being analysed for with the rest of ATG9, it is being kept at this monitoring location [3]. 2016: Removed from the program due to issues with accessing the sampling location [4].	N/A	N/A	1. Frequency: 2008: Monthly for characterization purposes [1]. 2009: Removed [2]. 2014: Semi-annual to align with all other stormwater monitoring [3]. 2016: Removed [4]. 2. N/A

REDACTED

Manhole [redacted] Storm Outfall						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ***	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
9	Lead, Unfiltered Total N/A	N/A	Not Monitored: (was in 2008; 2014 – 2016) p: 2008: Core parameter for CRL's storm sewers therefore, special investigation monitoring; all results were at or below LMDL, therefore the parameter was not added to the routine monitoring program [1]. q: 2014: Despite lead not being a core parameter under the *Storm Water Control Study* (Reg 215/95) [6], since it is already being analysed for with the rest of ATG9, it is being kept at this monitoring location [3]. 2016: Removed from the program due to issues with accessing the sampling location [4]	N/A	N/A	1. Frequency: 2008: Monthly for characterization purposes [1] 2009: Removed [2]. 2014: Semi-annual to align with all other stormwater monitoring [3]. 2016: Removed [4]. 2. N/A
9	Zinc, Unfiltered Total N/A	N/A	Not Monitored: (was in 2008; 2014 – 2016) p: 2008: Core parameter for CRL's storm sewers therefore, special investigation monitoring; most results were similar to other storm sewers and all were well below the CNL Guideline, therefore the parameter was not added to the routine monitoring program [1]. q: 2014: Although not part of the required monitoring parameters under the *Storm Water Control Study* (Reg 215/95) [6], there was a degree of variability noted during the special investigation and despite all of the concentrations being well below the CNL Guideline, due to the potential source in piping and knowing that when the analysis is run for Al, it is also run for Zn, the parameter was added to the routine monitoring program [3]. 2016: Removed from the program due to issues with accessing the sampling location [4].	N/A	N/A	1. Frequency: 2008: Monthly for characterization purposes [1] 2009: Removed [2]. 2014: Semi-annual to align with all other stormwater monitoring [3]. 2016: Removed [4]. 2. N/A
9a	Iron, Unfiltered Total N/A	N/A	Not Monitored: (was in 2008; 2014 – 2016) p: 2008: Core parameter for CRL's storm sewers and therefore monitored under the special investigation. Most of the results were relatively low however there were a few anomalous high results. Overall the average was well below the CNL Guideline and therefore this parameter was not added to the routine monitoring program [1]. n, p: 2014: Confirmed to be a required parameter under the *Storm Water Control Study* (Reg 215/95) [6]; special investigation showed variability in concentrations with some results exceeding the CNL Guideline and known to be high in background on site, therefore added to routine monitoring [3]. 2016: Removed from the program due to issues with accessing the sampling location [4].	N/A	N/A	1. Frequency: 2008: Monthly for characterization purposes [1]. 2009: Removed [2]. 2014: Semi-annual to align with all other stormwater monitoring [3]. 2016: Removed [4]. 2. N/A

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Manhole [redacted] Storm Outfall						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ***	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
16	Chloroform N/A	N/A	Not Monitored: (was in 2008) q: 2008: Monitored at major storm sewers across site which are known to collect cooling water etc. As is present in cleaning products in use across the site and therefore there is a potential for it to enter storm drains at CRL. All results were just above the LMDL and well below the CWQG therefore this parameter was determined to not be of concern and was not added to the routine monitoring program [1]	N/A	N/A	1. Frequency: 2008: Monthly for characterization purposes [1]. 2009: Removed [2]. 2. N/A
25	Solvent Extractables N/A	N/A	Not Monitored: (was in 2008; 2014 – 2016) p: 2008: Core parameter for CRL's storm sewers therefore, special investigation monitoring and although found to be similar to other storm sewers, all measurements were well below the CNL Guideline. As a result, routine monitoring was not implemented [1]. n, p: 2014: Confirmed to be a required parameter under the *Storm Water Control Study* (Reg 215/95) [6]. Some variability noted in monitoring results during the special investigation with one result exceeding the CNL Guideline; also known potential source on site through routine operations therefore added to routine program [3]. 2016: Removed from the program due to issues with accessing the sampling location [4].	N/A	N/A	1. Frequency: 2008: Monthly for characterization purposes [1]. 2009: Removed [2]. 2014: Semi-annual to align with all other stormwater monitoring [3]. 2016: Removed [4]. 2. N/A
27	Polychlorinated Biphenyls (PCB) N/A	N/A	Not Monitored: As a result of being a required monitoring parameter in Reg 215/95 [6] for storm sewers, monitoring of the site's largest storm sewers took place with no contamination found. There is no suspected or known source on site; therefore this parameter was not added to the routine monitoring program. Also, being monitored under the GWMP with no contamination noted [5]	N/A	N/A	N/A
30	Chloride N/A	N/A	Not Monitored: (was in 2008 – 2016) n, q: 2008: A core parameter for CRL's storm sewers identified by the Safety Review Committee (SRC) and monitored through a special investigation and found to be very high compared to other CRL storm sewers. As a result, chloride was added to the routine monitoring program [1], [7]. q: 2014: Although not a core parameter under Reg215/95 [6], it is a known contaminant source currently being used on site and known to present in fairly high concentrations in this effluent [3]. 2016: Removed from the program due to issues with accessing the sampling location [4].	N/A	N/A	1. Frequency: 2008: Monthly for characterization purposes [1] 2009: Semi-annual to align with other stormwater monitoring under the non-radioactive monitoring program [2]. 2016: Removed [4]. 2. N/A

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Manhole [redacted] Storm Outfall						
ATG	**Parameter Name** **Treatment**	**Parameter Criteria ***	**Justification for Monitoring (or not Monitoring) of Parameter**	**Measurement or Estimation**	**Monitoring Frequency & Sample Type**	**Justification for:** **1. Monitoring Frequency & Sample Type** **2. Estimation over Measurement**
--	Flow Rate N/A	N/A	Not Monitored: (was in 2008) p: 2008: Monitored for presence/absence only during the Special Investigation [1] as catch basin in asphalted into the ground at this location and an actual flow was not able to be obtained.	N/A	N/A	1. Frequency: 2008: Monthly for presence/absence only [1]. 2. N/A

Notes: LMDL - Laboratory Method Detection Level; SRC - Safety Review Committee; CRL - Chalk River Laboratory; CWQG - Canadian Water Quality Guideline; MISA - Municipal/Industrial Strategy for Abatement; ATG - Analytical Test Group; GWMP – Groundwater Monitoring Program.
* See Table 15: Parameter Monitoring Criteria for the Effluent Compliance Monitoring Program

References:

[1] *Response to Letter on Licence Condition 7.15*, EnvP-09-113, EnvP-ACNO-09-0017-L, 2009 August. 22443369
[2] *Non Radiological Monitoring Schedule for CRL*, CRL-509200-062-000-0001, 2009 March. 23657179
[3] *Effluent Verification Monitoring Program Sampling Schedule for CRL*, CRL-509200-062-000-0001, Rev 6, 2013 December. 23651723
[4] *Effluent Verification Monitoring Program Sampling Schedule for CRL*, CRL-509200-062-000-0004, Rev 3, 2015 December. 22730333
[5] *Non-Radiological Liquid Effluent Monitoring at CRL: The Results for 1997*, AECL-MISC-397-97, 1998 September. 22869405
[6] Ontario Regulation 215/95, *Effluent Monitoring and Effluent Limits - Electric Power Generation Sector.*
[7] *SRC Acceptance of the Annual Program Report - Non-Radiological Effluent Monitoring in 2005 at Chalk River Laboratories*, SRCM-62-059, 2006 August.

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Appendix C Analytical Methods

ATG	Parameter Name	Units	MISA Recommended Method	Lab(s)	Method Description/ Method Reference	Lab Procedure
1	Chemical Oxygen Demand	mg/L	Colorimetry	BV Labs	SM 24 5220 D m	CAM SOP-00416
1a	Biological Oxygen Demand	mg/L	Oxygen electrode or Winkler Method	BV Labs	Electrode - SM 24 5210B m	CAM SOP-00427
1b	Carbonaceous Biological Oxygen Demand	mg/L	Oxygen electrode or Winkler Method	BV Labs	Electrode - SM 24 5210B m	CAM-SOP-00427
3	pH	-	pH electrode or on-line analyzer	EMB	pH electrode - electrometric	153-121266-TEP-017
				ACB	pH electrode – electrometric	148-127610-PRO-030
4a	Ammonium, Total Filter Reactive	mg/L of (N)	Colorimetry	BV Labs	Colorimetry (US GS I-2522-90)	CAM-SOP-00441
--	Un-ionized ammonia	mg/L	--	BV Labs	PWQO	PWQO
4b	Nitrates, Total Filter Reactive	mg/L (N)	Colorimetry or Ion Chromatography	EMB	Ion Chromatography	153-121266-TEP-021
5a	Dissolved Organic Carbon	mg/L (C)	Digestion followed by Colorimetry	EMB	Ultraviolet/persulfate digestion	153-121266-TEP-020
5b	Total Organic Carbon	mg/L (C)	Digestion followed by Colorimetry	EMB	Ultraviolet/persulfate digestion	153-121266-TEP-020
6	Phosphorus, Unfiltered Total	mg/L (P)	Colorimetry or Inductively Coupled Plasma	ACB	Colorimetry	148-127610-PRO-002506
7	Conductivity, at [redacted]	us/cm	On-line analyser or conductivity probe and meter	EMB	Conductivity probe and meter	153-121266-TEP-017
				ACB	Conductivity probe and meter	148-127610-PRO-030
8	Residue, Particulate (TSS)	mg/L	Gravimetry	ACB	Gravimetry – Modified Version of SM 2540D	148-127610-PRO-003794
8	Volatile Suspended Solids (VSS)	mg/L	Gravimetry	ACB	Gravimetry – Modified Version of SM 2540E	148-127610-PRO-003794

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ATG	Parameter Name	Units	MISA Recommended Method	Lab(s)	Method Description/ Method Reference	Lab Procedure
9	Aluminium, Unfiltered Total	µg/L	Inductively Coupled Plasma	ACB	Inductively Coupled Plasma-Mass Spectrometer (ICP-MS)	148-127610-PRO-064
				BV Lab	Inductively Coupled Plasma-Atomic Emission Spectrometer (ICP-MS)	CAM SOP-00447
9	Boron, Unfiltered Total	µg/L		ACB	Inductively Coupled Plasma-Mass Spectrometer (ICP-MS)	148-127610-PRO-064
				BV Lab	Inductively Coupled Plasma-Atomic Emission Spectrometer (ICP-MS)	CAM SOP-00447
9	Cadmium, Unfiltered Total	µg/L		ACB	Inductively Coupled Plasma-Mass Spectrometer (ICP-MS)	148-127610- PRO-064
				BV Lab	Inductively Coupled Plasma-Atomic Emission Spectrometer (ICP-MS)	CAM SOP-00447
9	Chromium, Unfiltered Total	µg/L		ACB	Inductively Coupled Plasma-Atomic Emission Spectrometer (ICP-MS)	148-127610- PRO-064
				BV Lab	Inductively Coupled Plasma-Atomic Emission Spectrometer (ICP-MS)	CAM SOP-00447
9	Copper, Unfiltered Total	µg/L		ACB	Inductively Coupled Plasma-Atomic Emission Spectrometer (ICP-MS)	148-127610- PRO-064
				BV Lab	Inductively Coupled Plasma-Atomic Emission Spectrometer (ICP-MS)	CAM SOP-00447
9	Lead, Unfiltered Total	µg/L		ACB	Inductively Coupled Plasma-Atomic Emission Spectrometer (ICP-MS)	148-127610- PRO-064
				BV Lab	Inductively Coupled Plasma-Atomic Emission Spectrometer (ICP-MS)	CAM SOP-00447

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ATG	Parameter Name	Units	MISA Recommended Method	Lab(s)	Method Description/ Method Reference	Lab Procedure
9	Lithium, Unfiltered Total	µg/L		ACB	Inductively Coupled Plasma-Atomic Emission Spectrometer (ICP-MS)	148-127610- PRO-064
				BV Lab	Inductively Coupled Plasma-Atomic Emission Spectrometer (ICP-MS)	CAM SOP-00447
9	Nickel, Unfiltered Total	µg/L		ACB	Inductively Coupled Plasma-Atomic Emission Spectrometer (ICP-MS)	148-127610- PRO-064
				BV Lab	Inductively Coupled Plasma-Atomic Emission Spectrometer (ICP-MS)	CAM SOP-00447
9	Silver, Unfiltered Total	µg/L		ACB	Inductively Coupled Plasma-Atomic Emission Spectrometer (ICP-MS)	148-127610- PRO-064
				BV Lab	Inductively Coupled Plasma-Atomic Emission Spectrometer (ICP-MS)	CAM SOP-00447
9	Strontium, Unfiltered Total	µg/L		ACB	Inductively Coupled Plasma-Atomic Emission Spectrometer (ICP-MS)	148-127610- PRO-064
				BV Lab	Inductively Coupled Plasma-Atomic Emission Spectrometer (ICP-MS)	CAM SOP-00447
9	Vanadium, Unfiltered Total	µg/L		ACB	Inductively Coupled Plasma-Atomic Emission Spectrometer (ICP-MS)	148-127610- PRO-064
				BV Lab	Inductively Coupled Plasma-Atomic Emission Spectrometer (ICP-MS)	CAM SOP-00447
9	Zinc, Unfiltered Total	µg/L		ACB	Inductively Coupled Plasma-Atomic Emission Spectrometer (ICP-MS)	148-127610- PRO-064
				BV Lab	Inductively Coupled Plasma-Atomic Emission Spectrometer (ICP-MS)	CAM SOP-00447

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ATG	Parameter Name	Units	MISA Recommended Method	Lab(s)	Method Description/ Method Reference	Lab Procedure
9a	Iron, Unfiltered Total	µg/L	Inductively Coupled Plasma	ACB	Inductively Coupled Plasma-Atomic Emission Spectrometer (ICP-AES)	148-127610- PRO-064
				BV Lab	Inductively Coupled Plasma-Atomic Emission Spectrometer (ICP-MS)	CAM SOP-00447
9a	Uranium, Unfiltered Total	µg/L	Inductively Coupled Plasma	ACB	Inductively Coupled Plasma-Mass Spectrometer (ICP-MS)	148-127610- PRO-064
				BV Lab	Inductively Coupled Plasma-Atomic Emission Spectrometer (ICP-MS)	CAM SOP-00447
10	Selenium, Unfiltered Total	µg/L	Inductively Coupled Plasma	ACB	Inductively Coupled Plasma-Atomic Emission Spectrometer (ICP-MS)	148-127610-PRO-064
				BV Lab	Inductively Coupled Plasma-Atomic Emission Spectrometer (ICP-MS)	CAM SOP-00447
12	Mercury, Unfiltered Total	µg/L	Cold Vapour with AA, ICP or Fluorescence	ACB	Cold Vapour Atomic Fluorescence (CV-AAS)	148-127610-PRO-002879
14	Phenolics, Unfiltered React	µg/L phenol	Colorimetry	ACB	Colorimetry	148-127610-PRO-000236
16	Volatiles, Halogenated	µg/L	Gas Chromatography/Mass Spectrometry	BV Labs	Gas Chromatography/Mass Spectrometry (EPA 8260 modified)	CAM SOP 0226
				ACB	Gas Chromatography/Mass Spectrometry EPA 8260	148-127610-PRO-025
17	Volatiles, Non-Halogenated	µg/L	Gas Chromatography/Mass Spectrometry	BV Labs	Gas Chromatography/Mass Spectrometry (EPA 8260 modified)	CAM SOP 0226
				ACB	Gas Chromatography/Mass Spectrometry EPA 8260	148-127610-PRO-025

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ATG	Parameter Name	Units	MISA Recommended Method	Lab(s)	Method Description/ Method Reference	Lab Procedure
19	Extractables, Neutral	µg/L	Gas Chromatography/Mass Spectrometry	BV Labs	Gas Chromatography/Mass Spectrometry (Based on EPA 8270 m)	CAM SOP 00301
				ACB	Gas Chromatography/Mass Spectrometry EPA 8270E	148-127610-PRO-024
25	Solvent Extractables	mg/L	Gravimetry	ACB	Extraction/ Gravimetry	148-127610-PRO-028
30	Chloride	mg/L	Ion Chromatography	EMB	Ion Chromatography	153-121266-TEP-021
30	Sulphates	mg/L	Ion Chromatography	EMB	Ion Chromatography	153-121266-TEP-021
35	E. coli	Counts/100 ml	Membrane filtration	BV Labs	Membrane Filtration - MOE LSB E3371	CAM SOP-00552

ACB – Analytical Chemistry Branch at CRL, ON.
ATG – Analytical Test Group
BV Labs – Bureau Veritas Laboratories, Mississauga, ON
EPA – U.S. Environmental Protection Agency
EMB – Environmental Monitoring Branch at CRL, ON.
MOE – Ministry of Environment
PWQO – Provincial Water Quality Objectives

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Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

CRL Radioactive Effluent and Emissions Verification Monitoring Plan

CRL-509200-PLA-004

Revision 2.1

REDACTED

Approved by: George Dolinar — 2025/03/31

Director, Corporate Environmen — Date

Effective Date: 2025/03/31
Expiry Date: 2030/03/31

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Revision History

Rev. No.	Date	Details of Rev.	Authored By	Reviewed By	Approved By
2.1	2025/03/31	Issued as Approved for Use	L. Ogilvie A. Mantifel	C. De Waele	G. Dolinar
2.1D1	2025/03/07	Issued for "Review and Comment" Minor Changes: • New template/format • Updated to reflect changes to monitoring since Rev 2 was issued • Removed airborne monitoring locations where exhaust fans were permanently shut off • Added multiple airborne monitoring locations including (but not limited to) at various facility undergoing decommissioning, and Decontamination Center. • Added upstream liquid monitoring location at SBT. • Alignment of document with CRL Radioactive Effluent/Emissions Verification Monitoring Plan CRL-509200-PLA-003	L. Ogilvie A. Mantifel	K. Lambert C. De Waele L. Howat	
2	2022/03/31	Issued as "Approved for Use". Not effective until 2022 May 13.	C. De Waele	G. Dolinar	G. Dolinar
2D1	2022/03/14	Issued for "Review and Comment" Minor Changes • New template/format Major Changes • Updated to reflect changes to monitoring since Rev 1 was issued • Removed airborne monitoring locations where exhaust fans were permanently shut off • Removed Storm Outfall monitoring locations: [redacted] • Added Storm Outfall [redacted]	C. De Waele	K. Lambert C. Matasich	

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Rev. No.	Date	Details of Rev.	Authored By	Reviewed By	Approved By
		monitoring location Added multiple airborne monitoring locations including (but not limited to) WMAs, [redacted] New Tritium Facility, MPF TRM R&T, facilities undergoing decommissioning, some S&T laboratories, etc.			
1	2014/12/22	Issued as “Approved for Use”.	C. De Waele	C. Gallagher	G. Dolinar
1D1	2014/12/17	Issued for Review and Comment. Minor changes made to reflect updated EER, i.e., the 2013 ERA (ENVP-509220-REPT-001).	C. De Waele	C. Gallagher	
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1. Purpose and Scope

The purpose of this monitoring plan is to document the decision for the need of a Radioactive Effluent/Emisions Verification Monitoring Program (EVMP) for the Chalk River Laboratories (CRL) site. It also provides justification for the individual monitoring activities that are part of this EVMP.

The decision for the need of an EVMP and the individual monitoring activities was made in such a way as to comply with:

- Conditions in the *CRL Operating Licence* [1] *and Licence Conditions Handbook* [2];
- *Chalk River Laboratories Environmental Monitoring Program Framework* [3];
- *Management and Monitoring of Effluents and Emissions* [4];
- CSA N288.5:22 [5];
- Other applicable regulations and standards; and
- CNL policies.

Common elements among all of the CRL monitoring components such as auditing and training are not included in this specific plan but instead are in *Chalk River Laboratories Integrated Environmental Monitoring Program Framework* [3].

This plan addresses only radioactive airborne emissions and waterborne effluent verification monitoring. It does not address:

- Effluent/Emission Verification Monitoring of non-radioactive contaminants or physical stressors: These are covered in a separate site-specific document, *CRL Non-radioactive Effluent and Emissions Verification Monitoring Plan* [6];
- Environmental Monitoring: There are a number of contaminated groundwater plumes emanating from certain waste management areas that are (or could) surface to above-ground waters. The need to monitor these surface waters and the airborne fugitive emissions from contaminated surface waters is assessed in the *CRL Environmental Monitoring Plan* [7]. Note that a subset of these surface waters discharge directly to the Ottawa River and these are considered 'waterborne effluent' and as such are assessed within this document;
- Groundwater Monitoring: The monitoring of controlled and uncontrolled releases to the ground are conducted under the site's Groundwater Protection Program. The need to monitor these releases is assessed in the *CRL Groundwater Protection and Monitoring Plans 2020* [8]; and
- Operational Control Monitoring (OCM): This is covered in facility-specific documentation.

This document is primarily intended for use by groups or laboratories which are directly involved in the CRL's Radioactive EVMP.

Note that the EVMP is dynamic in nature and is continually evolving. As a result, this plan is current as of its issuance but does not necessarily completely reflect the program after this date. The most current monitoring schedule should always be consulted [9].

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2. Definitions

2.1 Terms

Term definitions are found in the Environmental *Protection Program Description Document* [10] and *Management and Monitoring of Effluents and Emissions* [4].

2.2 Acronyms

AHJ	Authority having Jurisdiction
ARF	Airborne Release Fraction
ARR	Airborne Release Rate
B	Building
BVS	Building Ventilation System (in reference to NRU)
CECEUD	Combined Electrolysis Catalytic Exchange Upgrading/Detritiation (Test Facility)
CNSC	Canadian Nuclear Safety Commission
CRL	Chalk River Laboratories
DOE	(United States) Department of Energy
DRL	Derived Release Limit
EA	Environmental Assessment
EFS	Emergency Filtration System (in reference to NRU)
EMP	Environmental Monitoring Program
ERA	Environmental Risk Assessment
EVMP	Effluent/Emission Verification Monitoring Program
FA	Facility Authorization
FMC	Fuels and Materials Cells
FPS	Fuel Packaging & Storage
GA	Gross Alpha (particulates)
GB	Gross Beta (particulates)
HEPA	High-Efficiency Particulate Air (filter)
HTO	Tritium Oxide
LCVC	Liquid Confinement Ventilation Confinement (in reference to NRU)
LLRW	Low Level Radioactive Waste
MAGS	Modular Above Ground Storage
MAPLE	Multipurpose Applied Physics Lattice Experiment (reactor)
MPER	Maximum Probable Emission Rate
MPF	Molybdenum-99 Production Facility
NFFF	Nuclear Fuel Fabrication Facility
NPF	New Processing Facility
NRU	National Research Universal (reactor)
NRX	National Research Experimental (reactor)
OE	Operating Envelope
OCM	Operational Control Monitoring

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OCMP	Operational Control Monitoring Program
RFFL	Recycle Fuel Fabrication Facilities
RLP	Radioisotope Laboratory Protocol
RSSA	Recoverable Surface Storage Area
RVS	Reactor Ventilation System (in reference to NRU)
SAR	Safety Analysis Report
SMAGS	Shielded Modular Above Ground Storage
UC	Universal Cells
WHB	Waste Handling Building
WMA	Waste Management Area
WRC	Waste Reception Centre
WTC	Waste Treatment Centre

3. Monitoring Assessment Overview

3.1 Two Sets of Monitoring Criteria

There are two sets of monitoring criteria as outlined in *Management and Monitoring of Effluents and Emissions* [4]. One set is used to determine whether or not a site-wide EVMP is required. If it is determined that a site-wide EVMP is required, the second set of monitoring criteria is used to determine which effluent and emission streams to monitor and what contaminants to monitor for.

3.2 Need for a Site Wide Radioactive Effluent/Emission Verification Monitoring Program

The criteria used to determine whether there was a need for CRL to establish a Radioactive EVMP as outlined in the EnvP Program procedure, *Management and Monitoring of Effluents and Emissions* [5] are duplicated in Table 1 below. An EVMP is needed if one or more of the criteria is met. As indicated in Table 1, more than one criterion is met, thus necessitating the establishment of a Radioactive EVMP.

Table 1: Need for a Radioactive EVMP at CRL

Criteria for Establishing an EVMP [4]	Criteria Met at CRL? (Yes/No & Justification)
(shall) An EVMP for monitoring of non-radioactive emissions for the CRL site shall be established if:	
(a) An Authority Having Jurisdiction (AHJ) requires it;	Yes. 1. The *CRL Operating Licence* [1] requires CNL to implement and maintain an environmental protection program. As part of this program, CNL is required to "control, monitor, and record releases of hazardous substances such that the releases do not exceed the reference levels (limits) specified in Table 9-1" [2]. The Licence also requires that the "dose to the critical group due to the sum of all radioactive releases in any period of

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Criteria for Establishing an EVMP [4]	Criteria Met at CRL? (Yes/No & Justification)
(shall) An EVMP for monitoring of non-radioactive emissions for the CRL site shall be established if:	
	12 consecutive months shall not exceed 0.3 mSv" [2]. 2. Furthermore, CNL is required to prepare and submit to the Canadian Nuclear Safety Commission (CNSC) a written report that covers the results of effluent verification monitoring for nuclear substances at the CRL site [2]. 3. Lastly, per the *Public Information and Disclosure* REGDOC-3.2.1 [11] CNL is also required to develop and implement a public information program that includes a disclosure protocol. As outlined in *Public Information Program for CNL* [12] this needs to include environmental performance reports and results from monitoring programs on CNL's external website.
(b) The results of an Environmental Risk Assessment (ERA) indicate potential concern;	No. The results of the Environmental Risk Assessment (ERA) for the CRL site indicate for example that the concentration of radioactive contaminants (primarily Sr-90) in localized regions of the Perch Lake basin exceed benchmark values [13]. The source of this contamination originates in the Waste Management Areas (WMAs). The impact of radiological contamination on the groundwater, surface water, and biota is assessed by the Groundwater Monitoring Program and the Environmental Monitoring Program. The impact is not predominantly a result of airborne emissions or direct waterborne effluents to the Ottawa River[1]. A small area of groundwater discharge in the Ottawa River nearshore zone near the Controlled Area is affected by known groundwater contaminant plumes from NRU and NRX. Sr-90 was identified in the 2024 ERA [13] as a contaminant of potential concern in the groundwater discharge, based on maximum undiluted concentrations and the benthic invertebrate receptor. However, the area of groundwater discharge in the nearshore zone near the CRL site is very small and Sr-90 would be rapidly diluted as the groundwater discharge immediately mixes with Ottawa River water, such that the ERA concludes no adverse effects are expected from Sr-90 at the benthic invertebrate community level.
(c) There is a need for having the capability of identifying an unplanned release;	Yes. Although the CRL site has extensive OCM programs managed by the various facilities, the EVMP parallels a

[1] Airborne emission deposition is another contributor but because deemed very low, it is not considered.

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Criteria for Establishing an EVMP [4]	Criteria Met at CRL? (Yes/No & Justification)
(shall) An EVMP for monitoring of non-radioactive emissions for the CRL site shall be established if:	
	defense-in-depth approach by providing a redundant and independent means of identifying unplanned releases.
(d) The EVMP would support a radiation dose assessment […]	Yes. An annual assessment of public dose resulting from CRL operations is performed as part of the integrated Environmental Monitoring Program (EMP). The results of the EVMP serve in part to support this public dose assessment by providing an independently calculated dose assessment for comparison. Additionally, the results of the EVMP also inform updates to the site's ERA.

3.3 Systematic Planning Process

As determined in Section 3.2, a site-wide Radioactive EVMP is required for the CRL. Throughout this document, a systematic planning process is used, as per the guidance of the CSA N288.5:22 Standard [5], to determine the breadth and scope of the EVMP. The results of this process is a determination of which emission and/or effluent streams to monitor, what contaminants to monitor for, which monitoring strategy to use, and any performance or acceptance criteria to be applied to the collected data. As defined in the CSA N288.5:22 Standard [5], this systematic planning process consists of five steps:

STEP 1: Define the objectives of the CRL Radioactive EVMP (Section 3.4).

STEP 2: Identify the information required to meet the defined objectives (Section 3.4).

STEP 3: Determine how the data collected will be used to achieve the defined objectives (Section 3.4).

STEP 4: Specify performance and acceptance criteria (Section 3.5).

STEP 5: Develop the detailed design of the EVMP that will be implemented to obtain the required data (Section 4 (airborne) and Section 5 (liquid)).

The same systematic planning process is also applied when making changes to the EVMP.

3.4 Effluent/Emission Verification Monitoring Program Objectives and How They Are Met

This Section covers the first three steps of the Systematic Planning Process:

Step 1: Define the objectives of the CRL Radioactive EVMP;

Step 2: Identify the information required to meet the defined objectives; and,

Step 3: Determine how the data collected will be used to achieve the defined objectives.

Table 2 outlines both the primary and secondary objectives of the CRL Radioactive EVMP which were established in the procedure *CRL's Integrated Environmental Monitoring Program*

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Framework [3]. The primary being those objectives that "shall be considered" under the program according to the CSA N288.5:22 Standard [5] and the secondary are those which could be included. Table 2 provides an explanation for any objectives listed in the Standard that are not part of the CRL Radioactive EVMP.

Defining the information required to meet each CRL Radioactive EVMP objective is a useful pre-cursor step to deciding on the detailed design of the CRL Radioactive EVMP (Table 2). It is clear that knowledge of contaminant concentrations and/or contaminant loadings to the environment from significant airborne emission and waterborne effluent streams constitutes a large part of the information required to meet CRL Radioactive EVMP objectives.

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Table 2: Information to be Collected and How the Data will be used to Achieve the CRL Radioactive EVMP Objectives

EVMP Monitoring Objective [3]	Details on Objective (Explanation)	Information Required to Meet Objective	How Collected Data will be used to Achieve Objective
Primary Monitoring Objectives ("licencees shall consider")			
(a) To demonstrate compliance with regulatory release limits and any other regulatory requirements (e.g., Action Levels) concerning the release of nuclear/hazardous substances from the source	An objective of the CRL Radioactive EVMP is to demonstrate compliance with:		
	CNSC issued Operating *Licence Condition Handbook* [2]		
	The site's Derived Release Limits (DRLs), which are used to ensure that the dose to public as a result of operation of the site is below the Nuclear Safety and Control Act public dose limit of 1 mSv/year [14].	For each airborne emission and waterborne effluent stream, need to calculate a loading to the environment that can be compared to the applicable DRL(s). Hence need routine knowledge of: • Radiological contaminant concentrations • Flow rates or ventilation exhaust rates to the environment	*Are the total airborne and waterborne releases less than the most applicable or most restrictive airborne and waterborne DRLs, respectively?* Calculate a site total %DRL by summing individual contaminant loadings from airborne emission and waterborne effluent streams.
	The requirement to maintain the dose to the critical group due to the sum of all radioactive releases in any period of 12 consecutive months under 0.3 mSv.	Need knowledge of radioactive releases from operating and non-operating nuclear facilities on-site at CRL.	*Does the estimated dose to public from the sum of airborne and waterborne releases, remain below the dose constraint of 0.3 mSv in any period of 12 consecutive months?* Compare the sum of all contaminant loadings (as a %DRL) from airborne emission and waterborne effluent streams to the dose constraint of 0.3 mSv for all periods of 12 consecutive months.
	The licensee shall implement and maintain an environmental protection program, which includes a set of Action Levels in compliance with CSA N288.8 [15].	Need knowledge of radiological emissions and effluent monitoring results (contaminant concentration and flow to calculate loadings).	*Do any site effluents or emissions exceed Action Levels?* Routinely compare radiological EVMP results against program's Action Levels.

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EVMP Monitoring Objective [3]	Details on Objective (Explanation)	Information Required to Meet Objective	How Collected Data will be used to Achieve Objective
	Public Information and Disclosure *REGDOC-3.2.1* [12] [16]		
	To improve the level of understanding by the public of information about proposed or licensed nuclear facilities and activities, licensees are required to develop and implement a public information program that includes a disclosure protocol.	As outlined in Public Information Program for CNL, [12] need knowledge of: • Annual airborne emissions and liquid effluent levels emitted from the CRL site. • Radioactive spills occurring at the CRL site.	Collect and maintain results of routine airborne emissions and liquid effluents, as well as spills and report through CNL's external website, as required.
(b) To demonstrate adherence to internal levels set on release amounts (Administrative Levels) for purposes of effluent and emissions control.	Internal Administrative Levels are set for specific contaminants in specific emission or effluent streams. CRL's EVMP data is routinely compared to these internal limits, as appropriate.	Need knowledge of radiological emission and effluent monitoring results (contaminant concentration and flow to calculate loadings).	*Do any site releases exceed internally set Administrative Levels?* Routinely compare radiological EVMP results against established Administrative Levels.
(c) To confirm the adequacy of controls on releases from the source.	Although the CRL site has process monitoring managed by the various facilities, the EVMP parallels a defense-in-depth approach by providing a redundant and independent means of identifying unplanned releases.	A change in an airborne emission or waterborne effluent contaminant loading to the environment over time could be indicative of a change in the level of control on emissions/effluents. Hence to meet this objective, need routine knowledge of radiological emission and effluent monitoring results (concentrations and flow to calculate loadings) and an understanding of what 'normal' emissions/effluent loadings are for a given airborne emission or waterborne effluent stream.	*Are there any abnormally high releases in any of the significant emission or effluent streams?* Routinely trend monitoring results for the various radiological emissions and effluent streams. Any upward trend, if not coincident with planned work, may suggest a need for increased control.
(d) To provide an indication of unusual or unforeseen conditions that might require corrective action or additional monitoring.	Routine monitoring of site emissions and effluents allows for the identification of unusual conditions and the implementation of	Need knowledge of radiological emissions and effluent monitoring results and an understanding of	*For abnormally high releases in any significant airborne emission or waterborne effluent stream, is a corrective action or additional*

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EVMP Monitoring Objective [3]	Details on Objective (Explanation)	Information Required to Meet Objective	How Collected Data will be used to Achieve Objective
	corrective action and/or additional monitoring, if required.	what 'normal' releases for a given emission/effluent stream are. Results include: • Contaminant concentrations at waterborne final discharge points (or points representative of final discharge) • Waterborne flow rates at final discharge points (or discharge volumes) • Contaminant concentrations at airborne release points to the atmosphere, post abatement (if applicable) • Ventilation exhaust rates at airborne release points to the atmosphere For example, in order to obtain an indication of an issue arising with the Powerhouse Discharge (PPD), one needs knowledge of typical contaminant concentrations in the PPD effluent and flow.	*monitoring needed?* Investigate source of abnormal monitoring results and raise remedial or corrective actions or put in additional monitoring, as required.
(e) To provide data to assess the level of risk on human health and safety, and the potential biological effects in the environment of the nuclear/hazardous substances of concern released from the facility.	The CRL Radiological EVMP serves to support the periodic update of the site's Environmental Risk Assessment which includes a Human Health Risk Assessment (HHRA) (human exposure assessment) and an Ecological Risk Assessment (EcoRA) (non-human biota exposure assessment).	For each airborne emission and waterborne effluent stream the following is required: • Collect radiological contaminant concentrations and air emission exhaust rates or liquid effluent flows; or • Perform estimations based on operational information; and	*Are CRL's radiological releases of concern to the environment?* Compare emission/effluent results to ecological benchmark values making sure to take into consideration dilution factors for each effluent stream. *Are CRL's radiological releases of*

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EVMP Monitoring Objective [3]	Details on Objective (Explanation)	Information Required to Meet Objective	How Collected Data will be used to Achieve Objective
		• Understand the dilution factors for each CRL effluent stream; and, • Relevant ecological benchmark values applicable to CRL. If recommendations are made by the ERA to gather more monitoring results for a given effluent/emission or parameter, this should be done prior to the update of the next ERA.	*concern to public health and safety?* Compare emission/effluent results to the Derived Release Limits calculated for the CRL site to determine the resulting dose to an off-site member of the public.
(f) To confirm predictions in environmental assessments.	CRL site's Environmental Risk Assessment [13]	Only general information is required to meet this objective, i.e., knowledge of contaminant concentrations at final discharge points is sufficient in order to confirm predictions. If recommendations are made by the ERA to gather more monitoring results for a given effluent/emission or parameter, this should be done prior to the update of the next ERA.	Collect and maintain results of any compliance monitoring performed for inclusion in the next revision of the site's ERA.
Secondary Monitoring Objectives:			
(a) To provide data for trend analysis.	Radiological emissions and effluent data collected through the CRL EVMP are trended routinely.	For each airborne emission and waterborne effluent stream, need: • knowledge of what 'normal' emissions/effluent are for a given effluent stream; • to collect radiological contaminant concentrations and effluent flows/ventilation exhaust rates; or • to perform release estimations based on operational	*Are there any trends being observed in releases in any of the site's emission or effluent streams?* Routinely trend monitoring results for the various emission and effluent streams and determine whether or not results are as anticipated. Any concerning trend, if not coincident with planned work, may suggest a need for increased control and should be investigated.

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EVMP Monitoring Objective [3]	Details on Objective (Explanation)	Information Required to Meet Objective	How Collected Data will be used to Achieve Objective
		information.	
(b) To provide assurance to employees and the public on the effectiveness of effluent and emissions control.	Radiological release data collected through the CRL EVMP are posted on CNL's external website. As well, non-radiological releases which are considered of public interest, including some routine effluent releases as well as reportable events or spills are reported as required.	Need knowledge of: • Site's routine radiological airborne emissions and waterborne effluents; and • Any reportable events associated with radiological emissions/effluent and spills to ground.	For CNL employees only: Collect monitoring data and maintain within a site-wide database which is accessible to all CNL employees (Environmental Data Management System "EDMS") For CNL employees and the public: Collect, maintain and report results of the radiological monitoring program on the external website as: • An executive summary of the EMP Annual Compliance Monitoring Report (which contains a summary of EVMP results); and • Quarterly Effluent Verification Monitoring Program performance updates.
(c) To provide data which, when combined with the results of environmental monitoring and modelling can be used to test or refine the models of the environment used in the ERA or dose/exposure assessments.	Although not routinely done, depending on the needs of ERA risk assessors, the data collected through the CRL EVMP could be used to refine or test standard models.	Only general information is required to meet this objective, i.e., knowledge of contaminant concentrations at final discharge points is useful.	Collect and maintain results of any emission/effluent monitoring performed for possible consideration in models used in the ERA.
(d) To provide baseline data and capability for monitoring and assessment in emergency conditions.	The data collected through the routine air emission and liquid effluent monitoring program data can be used as a baseline. As well, routine and non-routine samples can be taken at existing	For each airborne emission and waterborne effluent stream, need to collect radiological contaminant concentrations and effluent flows/ventilation exhaust rates.	*In an emergency situation, can any of the routine sampling we complete serve as a baseline and evidence of the extent of the event?* If the routine monitoring can serve as

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EVMP Monitoring Objective [3]	Details on Objective (Explanation)	Information Required to Meet Objective	How Collected Data will be used to Achieve Objective
	emission/effluent monitoring locations during an event to serve to assess the magnitude/extent of releases from of the event.		both baseline and evidence of an emergency condition, compare the pre-event results to the post-event result to aid in the determination of the extent of the event.
(e) Other business purposes (e.g. demonstrating due diligence, meeting a stakeholder commitment, etc.)	An example of monitoring for due diligence – some upstream airborne emissions and waterborne effluent locations are monitored despite the downstream final discharge location to the environment also being monitored.	For the dominant upstream effluent or emission stream, collect data for almost all contaminants that could be expected regardless of significance.	Collect and maintain results of emission and effluent monitoring performed and trend as needed.

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3.5 Quality Assurance and Quality Control

In order to ensure that the data collected through the program is valid, the monitoring performing laboratories have strong Quality Assurance / Quality Control (QA/QC) programs as required by the *EnvP Program Radiological and Non-Radiological Monitoring Service Quality Assurance Plan* [17]. These laboratories utilize QC tools such as blanks, spiked blanks, and replicate and duplicate samples to address precision, accuracy, sensitivity, and to detect errors in the data. Laboratory QC programs are described in laboratory specific sampling and analysis procedures. Field QC is defined in the *Effluent Verification Monitoring Program Sampling Schedule for CRL, NPD & DP* [9] and this monitoring plan.

Field QC for the EVMP is described in Section 3.5.1. The data generated by the EVMP is subject to performance and acceptance criteria, which are outlined in Section 3.5.2.

3.5.1 Field Quality Control

Field quality control includes requirements for collection of adequate samples to ensure data quality objectives can be met. This field quality control monitoring is designed to cover the requirements of both the Radioactive EVMP and the Radioactive EMP with the frequency set to accommodate both of the programs. The target is that 90% of samples scheduled to be collected are obtained with the results meeting the acceptance criteria provided in Section 3.5.2.2.

Samples and measurements are to be collected at the frequency specified in the monitoring schedule. Where sampling and/or analysis is not completed, the reason for not collecting the information should be documented. It is recognized that not all samples may be collected as effluent streams may have very low flows at the time of sampling and collected samples may become contaminated or lost.

To assess field performance the following control samples are collected for waterborne effluent samples (the number of field quality controls samples make up approximately 10% of all samples collected):

- Field duplicate samples to determine precision;
- Travelling blank samples to determine contamination events; and
- Travelling spiked samples or spiked samples may be used to determine recovery rates (accuracy), if necessary.

For airborne emissions, a sample station functionality check is performed every normal working day (Monday to Friday, excluding statutory holidays and extenuating circumstances), and at least weekly during shut-downs. This ensures that the sample station is operating correctly and that the sample draw (flow into the sample stations) are maintained within the set bounds.

3.5.2 Performance and Acceptance Criteria

In order to ensure that the data collected as part of the EVMP is adequate for its intended purpose, the data is subject to performance and acceptance criteria.

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3.5.2.1 Performance Criteria

3.5.2.1.1 Measurement Sensitivity Levels

It is important to ensure that each radiological analysis performed in the laboratory can yield a result that enables the EVMP to meet its objectives (see Section 3.4). In essence, this obligates the program to ensure that the contaminant concentration results obtained from the monitoring program can be compared to the most stringent of any applicable regulatory discharge concentration limits.

Table 3 and Table 4 provide the programs current Detection Levels (L_D) for each monitored parameter. The program's L_D's, when translated to loadings using typical flow rates, are all well below the emission/effluent limits therefore ensuring that the monitoring results can be used to demonstrate compliance with these limits.

Table 3: Laboratory Detection Levels (L_D) Associated with Analysis of Parameters in Waterborne Effluent Included in the CRL EVMP

Parameter	L_D Range (Bq/L)	Parameter	L_D Range (Bq/L)
Ac-228	0.0115 - 0.14	K-40	0.0543 - 0.689
Ag-108m	0.00235 - 0.0297	Mn-54	0.00327 - 0.227
Ag-110m	0.00303 - 0.554	Mo-99	0.0755 - 15.4
Am-241	0.00429 - 0.0645	Nb-94	0.00269 - 0.0305
Ba-133	0.00306 - 0.0407	Nb-95	0.00458 - 2.27
Ba-140	0.0336 - 52.1	Pa-233	0.0117 - 20.2
Be-7	0.0263 - 2.94	Pb-212	0.00454 - 0.0581
Bi-212	0.0224 - 0.243	Pb-214	0.00595 - 0.0696
Bi-214	0.00486 - 0.0659	Ra-226	0.00486 - 0.0659
Ce-141	0.00585 - 4.13	Ru-103	0.00418 - 1.19
Ce-144	0.0134 - 1.03	Ru-106	0.0256 - 1.32
Co-57	0.00157 - 0.143	Sb-124	0.00402 - 0.226
Co-60	0.00328 0.0423	Sb-125	0.00743 - 0.121
Cr-51	0.0426 - 73.2	Sc-46	0.00372 - 0.109
Cs-134	0.00272 - 0.0545	Se-75	0.00301 - 5.5
Cs-137	0.0026 - 0.0322	Sr-90	0.00191 - 0.528
Eu-152	0.00428 - 0.0593	Ta-182	0.0038 - 10.2
Eu-154	0.00305 - 0.042	Tc-99m	0.0755 - 15.4
Eu-155	0.00353 - 0.0559	Th-228	0.0871 - 1.33
Fe-59	0.00769 - 1.66	Th-234	0.0208 - 0.27
Gross Alpha	5.08E-05 - 0.162	Tl-208	0.00256 - 0.0321
Gross Beta	0.000608 - 0.885	U-235	0.00311 - 0.0431
HTO	0.01285 - 325	U-238	0.028 - 0.427
Hf-175	0.00363 - 0.137	Zn-65	0.00682 - 1.03
Hf-181	0.00469 - 0.91	Zr-95	0.00663 - 0.344

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Table 4: Laboratory Detection Levels (L_D) Associated with Analysis of Parameters in Airborne Emissions Included in the CRL EVMP

Parameter	L_D Range (Bq/week)
Gross Alpha	1.1 – 560
Gross Beta	15.8 – 6290
HTO	2.27E+07 – 3.09E+07
HT	1.15E+06 – 1.18E+08
I-125	36.7 – 1.71E+04
I-131	196 – 9.14E+04

3.5.2.2 Acceptance Criteria

3.5.2.2.1 Quality Verification Measurements

The data acceptance criteria in place for field sample quality control are listed in Table 5.

Table 5: Field sample quality control acceptance criteria

Field QC Sample	Quality Control Test	Test Acceptance Criteria
Travelling Blank	Contamination	Results below 3 x Minimum Detectable Activity (MDA)
Travelling Spiked Blank (if necessary)	Accuracy	Recovery (Determined Values/Expected *100) between 50-150%
Duplicate**	Precision	Relative Percent Difference ≤ 50%

** If the result is ≤ 3 x's MDA, the QC assessment is voided on the basis of low-level result

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3.5.2.2.2 Sample Unavailability

Sample unavailability for the radioactive EVMP could be the result of a number of circumstances; for example sampling according to the monitoring schedule was missed, the collected sample was contaminated or lost, an automatic sampler failure, etc. Acceptance Criteria for such events are shared company-wide and therefore are outlined in *Management and Monitoring of Effluents and Emissions* [4] along with steps which need be taken to compensate for the missed data.

3.6 Detailed Design by Effluent or Emission Stream

In the remaining sections of this document, airborne emission streams (Section 4) and liquid effluent streams (Section 5) are evaluated against the second set of monitoring criteria to determine which effluent and emission streams to monitor and for what contaminants to monitor for.

Airborne emission streams stemming from the nuclear and support facilities listed in the Controlled List *Site Licences, Certificates, Permits, Building/Facility Contacts & Licence*

Representatives [18] that is referenced in the *CRL Operating Licence* [1], be they fugitive emission streams or designed emission streams are assessed:

- Section 0 addresses Class I Nuclear Facilities;
- Section 4.5 addresses Class II Nuclear Facilities;
- Section 4.6 addresses Nuclear Facilities in Extended Shutdown State;
- Section 4.7 addresses Permanently Shut Down Facilities;
- Section 4.8 addresses Nuclear Facilities Undergoing Decommissioning Activities;
- Section 4.9 addresses Radioisotope Laboratories;
- Section 4.10 addresses Support Facilities; and
- Section 4.11 addresses Other Facilities that Handle or Have Handled Nuclear Materials.

Waterborne effluent streams originating from the nuclear and support facilities listed above and the rest of the site, are assessed collectively against the monitoring criteria in Section 5, through a discussion of the various final discharge points from the site.

The applicability of emission/effluent stream and contaminant monitoring criteria to CRL's Radioactive EVMP (airborne emissions and waterborne effluents) are identified in Table 6. Reasons for not citing some of the monitoring criteria in the assessment sections that follow are provided.

For each emission/effluent stream designated as requiring monitoring, the parameter monitoring criteria are used to help determine and justify which parameters require compliance monitoring and which do not. Exactly how these criteria are linked to the program objectives is detailed in *CRL's Integrated Environmental Monitoring Program Framework* [3]. Parameters include radiological contaminants only. The detailed design tables also identify and justify the required monitoring frequencies.

In addition to the detailed design tables found in Section 4 and Section 5, the reader should always reference the current revision of the *Effluent Verification Monitoring Program Sampling Schedule for CRL, NPD & DP* [9] for the most current monitoring that is in place under the EVMP.

Detailed design tables in Appendix C provide similar justification for liquid effluent streams which were at one time but are no longer part of the EVMP. Detailed design tables in Section 4 provide similar justification for air emissions streams which were at one time but are no longer part of the EVMP, these are identified with grey shading.

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Table 6: Applicability of the Monitoring Criteria to the Radioactive Effluent/Emission Verification Monitoring Program

Monitoring Criteria		Applicability	Reason for Not Citing in Assessment Sections
Effluent Stream			
(a)	(shall) If monitoring of the effluent or emission stream is required to demonstrate compliance with an AHJ then that effluent or emission stream shall be monitored.	Applicable	—
(b)	(shall) In the case of effluent or emission streams not subject to Derived Release Limits (DRL), if the total Maximum Probable Emission Rate (MPER) for an effluent or emission stream may exceed 1% of the applicable limits specified by the CNSC, then that effluent or emission stream shall be monitored.	Not Applicable	All effluent and emission streams at the CRL site are subject to Derived Release Limits (DRLs) [19] such that criterion (b) is not applicable.
(c)	(should) If the total MPER for an effluent or emission stream exceeds 0.0005 mSv per year to a member of an off-site critical group, then that effluent or emission stream should be monitored. Normal emission rates, instead of MPER, may be used if the effluent or emission stream has an OCMP in place. Note: The dose as a result of MPER emissions/effluents may be expressed as a fraction of the applicable Derived Release Limit (DRL) times the annual dose limit from which the DRL was derived.	Applicable	—
(d)	(should) If the effluent or emission stream has potential to contribute to biological effects (as determined in an ERA or equivalent risk assessment), based on its constituent radioactive or non-radioactive contaminants, then that effluent or emission stream should be monitored.	Applicable	The *CRL Environmental Risk Assessment (ERA)* [13] does not identify any airborne radioactive contaminants in emissions or waterborne radioactive contaminants in effluents generated by CRL with a potential to contribute to biological effects. This criterion is only applicable to a small area of groundwater discharge in the Ottawa River nearshore zone near the Controlled Area that is affected by known groundwater contaminant plumes from NRU and NRX. Sr-90 was identified in the 2024 ERA [13] as a contaminant of potential concern in the groundwater discharge, based on maximum undiluted concentrations and the benthic invertebrate receptor. However, the area of groundwater discharge in the nearshore zone near the CRL site is very small and Sr-90 would be rapidly diluted as the groundwater discharge immediately mixes with Ottawa River water,

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Monitoring Criteria		Applicability	Reason for Not Citing in Assessment Sections
			such that the ERA concludes no adverse effects are expected from Sr-90 at the benthic invertebrate community level. Monitoring of the groundwater discharges continues to be performed in order to ensure availability of data for future updates of the ERA.
(e)	(should) If the effluent or emission stream contributes significantly to the dose/exposure for a receptor that has been identified as needing a dose/exposure assessment in an ERA or equivalent risk assessment, then that effluent or emission stream should be monitored. Note: An effluent or emission stream that contributes more than 10% of the relevant dose/exposure for the identified receptor can be considered to make a significant contribution.	Not Applicable	The *CRL ERA* [13] identifies certain non-human receptors potentially affected by radioactive contaminants generated by CRL operations. However, contaminants generally originate from WMAs and receptors are localized such that these effects are assessed by the Groundwater Monitoring Program and the Environmental Monitoring Program; airborne effluents originating from CRL or waterborne effluents discharged directly to the river are not a significant contributor.
(f)	(should) If monitoring of the effluent stream is triggered under the *Municipal/Industrial Strategy for Abatement (MISA) Program* [20], then that effluent stream should be monitored.	Not Applicable	This document covers radioactive contaminants only whereas criterion (f) is applicable to non-radioactive contaminants only.
(g)	(should) In addition to the effluent and emission streams mentioned above, locations with similar environmental conditions but without potential for facility-related effects (i.e., representative of natural background) should be included in the EVMP as reference.	Not Applicable	It is conservatively assumed that any radioactive contaminants detected in effluent and emission streams are present due to CRL operations such that no effluent or emission streams representative of natural background are monitored on site.
Contaminant			
(h)	(shall) If effluent or emission monitoring of a contaminant, physical stressor or acute lethality toxicity is explicitly specified by an AHJ, then that contaminant or physical stressor shall be monitored.	Applicable	—

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Monitoring Criteria		Applicability	Reason for Not Citing in Assessment Sections
(i)	(shall) If the results of an ERA or equivalent risk assessment indicate potential concern with the release of a contaminant, or with a physical stressor, then that contaminant or physical stressor shall be monitored.	Applicable	The *CRL Environmental Risk Assessment (ERA)* [13] does not identify any airborne radioactive contaminants generated by CRL with a potential to contribute to biological effects. In terms of waterborne radioactive contaminants generated by CRL with a potential to contribute to biological effects, the CRL ERA identifies some (primarily Sr-90) in localized regions of the Perch Lake basin. However, the source of this contamination originates in the WMAs. The impact of radiological contamination on the groundwater, surface water, and biota is assessed by the Groundwater Monitoring Program and the Environmental Monitoring Program. The impact is not a result of direct waterborne effluents to the Ottawa River. This criterion is only applicable to a small area of groundwater discharge in the Ottawa River nearshore zone near the Controlled Area that is affected by known groundwater contaminant plumes from NRU and NRX. Sr-90 was identified in the 2024 ERA [13] as a contaminant of potential concern in the groundwater discharge, based on maximum undiluted concentrations and the benthic invertebrate receptor. However, the area of groundwater discharge in the nearshore zone near the CRL site is very small and Sr-90 would be rapidly diluted as the groundwater discharge immediately mixes with Ottawa River water, such that the ERA concludes no adverse effects are expected from Sr-90 at the benthic invertebrate community level. Monitoring of the groundwater discharges continues to be performed in order to ensure availability of data for future updates of the ERA.
(j)	(shall) If effluent or emission monitoring of a contaminant supports a radiation dose assessment or assessment of potential exposure, then that contaminant shall be monitored.	Applicable	Note that an annual human (public) radiation dose assessment is done for the CRL site, based on effluent and emissions monitoring results. Criterion (j) is not specifically triggered for gross alpha radioactivity or radioiodine radioactivity in effluents or emissions because these contribute very little to the site total dose calculation (<10%) compared to for example, tritium or gross beta radioactivity. However, note that if monitoring for certain contaminants is being performed, regardless of the reason, the monitoring results are included in the annual radiation dose assessment.
(k)	(shall) If there is an operational need to identify an unplanned or uncontrolled effluent or emission (reasonably foreseeable upset event) of a contaminant into the environment, then that contaminant shall be monitored.	Applicable	—

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Monitoring Criteria		Applicability	Reason for Not Citing in Assessment Sections
(l)	(should) If the site-wide MPER for a radioactive contaminant exceeds 0.0001 mSv per year to a member of an off-site critical group, then that radioactive contaminant should be monitored. 70% Rule: The choice of effluent or emission streams to monitor for this particular radioactive contaminant should be such that at least 70% of site releases of that radioactive contaminant are monitored. If this is not possible, then the need for monitoring for that radioactive contaminant should be assessed by an Environmental Specialist or equivalent based on professional judgment. Note: The dose as a result of MPER effluents/emissions may be expressed as a fraction of the applicable DRL times the annual dose limit from which the DRL was derived.	Applicable	—
(m)	(should) In the case of a waterborne effluent stream, and when no ERA (or equivalent risk assessment) exists that can provide more specific guidance on the parameter(s) to be monitored, if annual average contaminant concentrations at a point of discharge from CNL site property or to a permanent surface water body on site may exceed *Guidelines for Canadian Drinking Water Quality* [21] (or equivalent) for a radioactive contaminant, then that contaminant should be monitored.	Not Applicable	The CRL site does have an ERA to provide guidance on parameters to be monitored based on a risk assessment.
(n)	(should) If a contaminant is likely to approach or has the potential to exceed regulatory release limits or internal release limits, then that contaminant should be monitored.	Applicable	
(o)	(should) If a non-radioactive contaminant is a reportable substance under the National Pollutant Release Inventory (NPRI) [22] and is released in an effluent or emission stream at greater than 10% of the mass or concentration threshold for that contaminant, then it should be monitored.	Not Applicable	This document covers radioactive contaminants only whereas criterion (o) is applicable to non-radioactive contaminants only.

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Monitoring Criteria		Applicability	Reason for Not Citing in Assessment Sections
(p)	(should) If effluent monitoring of a non-radioactive contaminant is triggered under the MISA Protocol [20], then that contaminant should be monitored.	Not Applicable	This document covers radioactive contaminants only whereas criterion (p) is applicable to non-radioactive contaminants only.
(q)	(should) If monitoring is required for other business reasons (e.g., stakeholder concerns, due diligence, etc.).	Applicable	

4. Detailed Design for Airborne Emissions

4.1 Need for Monitoring and Parameters

The assessment of the various airborne emission streams on the CRL site is documented in detail in Sections 0 to 4.11. The methodology used to assess these streams is also documented within these sections. The categorization of these emission streams, and organization into Sections 0 to 4.11, reflects the list of nuclear and support facilities outlined in the Controlled List *Site Licences, Certificates, Permits, Building/Facility Contacts & Licence Representatives* [18] that is referenced in the CRL Operating Licence [1]. Where monitoring is deemed required, knowledge of the potential source term is used to determine the parameters that warrant monitoring. Analysis is predominantly on gross parameters as opposed to specific radionuclides (i.e., gross alpha radioactivity and gross beta radioactivity); this ensures a broad coverage of potential radionuclides present in the stream. In some cases, depending on source term, specific radionuclides are analysed for separately (e.g., tritium oxide or elemental tritium, and some radioiodines). For those airborne emissions streams that are expected to contain relatively higher levels of activity for beta-gamma emitting radioactive contaminants, a periodic gamma spectrometry analysis is also performed allowing for speciation of contaminants. These periodic speciation activities serve to confirm the gross analyses and also serve as an investigation tool in the case of an observed rise in gross analysis results.

Maps identifying the monitoring locations for the EVMP on the CRL site can be found in Appendix A.

4.2 Sample Collection and Analysis Frequency

Where airborne emissions monitoring is deemed required per the assessments detailed in Sections 0 to 4.11, sampling is performed at a continuous frequency (a continuous draw of the emissions stream), and sample collection is weekly for subsequent weekly laboratory analysis. Whereas monitoring by measurement is generally preferred over estimation, in a few cases estimations are the means of monitoring and this is outlined in the assessments.

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4.3 Flow and Velocity Profile

Emission flow rates are determined for each monitoring location in order to calculate contaminant emission loadings. These flow rates are constant as they are determined by the individual exhaust fans' design flow rates and the fans are run continuously.

4.4 Class I Nuclear Facilities

4.4.1 Methodology

All airborne emissions streams stemming from Class I Nuclear Facilities on the CRL site, be they fugitive emission streams or designed emission streams are assessed against the emission stream and contaminant monitoring criteria outlined in Table 1 of *Management and Monitoring of Effluents and Emissions* [4].

The Maximum Probable Emissions Rate (MPER) is defined in *Management and Monitoring of Effluents and Emissions* [4] as the sum of the impact of a worst-case event (i.e., event leading to the largest emission rate) and the normal emission rate of the stream and quoted for a normal monitoring period. It is calculated for each identified emission route using the following equation:

$$MPER = E_A + E_N = m\Delta t + E_N$$

where, E_A = emission during abnormal event (Bq/event), where all events that could occur with a frequency equal to or greater than once in thirty years is considered in the analysis; E_N = emission during normal operations (Bq/week for airborne emission, Bq/month for waterborne effluent), determined as 1 standard deviation above the average of a minimum of three years' of representative emissions; m = emission rate (Bq/s); and Δt = emission duration (s/event). In the case where three years of operational performance is not available, the emission during normal operations can be determined based on less than three years' of operational performance if this history is deemed representative of future emissions, or on best estimates/predictions based on professional experience and judgement.

To allow for an assessment against criterion (c), MPERs for each emission stream were calculated. The calculation method varies depending on whether or not radioactivity in the emission is expected, and on the type of input data available:

<u>Emission Streams Expected to Contain Minimal or No Radioactive Contaminants:</u>

For emission streams expected to contain minimal or no radioactive contaminants, justification for not monitoring is based on:

- The lack of a source term;
- The designated radiological safety zoning of the vented area(s) contributing to those emission streams. In general terms:
    - A zone 1 area is expected to be free from contamination;
    - A zone 2 area is normally free of contamination but may be subject to cross-contamination from higher zones;

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  - A zone 3 area is expected to generate loose surface contamination for short periods of time; and
- Ambient air pressure differentials within the facility affording contamination control. *Nuclear Facility Ventilation System Design* [23] requires that "the contamination control zone depressions shall be progressively greater in the direction of increasing airborne contamination potential" providing assurance for example that a zone 1 area remains a zone 1.

Radiological Areas and Zones [24] describes radiological safety zones 1, 2, and 3 classification based on levels of removable surface contamination (zones 4 and 5 are also defined but not relevant here since the effluent streams stemming from these areas are normally monitored). According to Cember [25], one can reasonably apply a resuspension factor of 10^{-6} to loose surface contamination in order to estimate ambient air concentrations:

"The quantitative relationship between the concentration of loose surface contamination and consequent atmospheric concentration above the contaminated surface due to stirring up the surface is called the *resuspension factor*, f_r, and is defined by:

$$f_r = \frac{\text{atmospheric concentration,Bq/m3}}{\text{surface concentration Bq/m2}}$$

Experimental investigation of the resuspension of loose surface contamination shows that the resuspension factor varies from about 10^{-4} to 10^{-8}, depending on the conditions under which the studies were conducted. A value of 10^{-6} is reasonable for the purpose of estimating the [inhalation] hazard from surface contamination".

By multiplying the maximum removable surface contamination levels [24] by Cember's 10^{-6} resuspension factor, one can derive the maximum ambient air concentrations of various radionuclides (or emitter types) that can be expected within each radiological safety zone. These maximum ambient air concentrations are shown in Table 7 below for radiological safety zones 1, 2, and 3.

Table 7: Radiological Safety Zones – Resuspension of Surface Contamination

Radionuclide	**Removable Surface Contamination (Bq/m^2) [24]**		**Ambient Air Concentration (Bq/m^3) Derived from Multiplication by a 10^{-6} (m^{-1}) Resuspension Factor [25]**	
	Zones 1 & 2	**Zone 3**	**Zones 1 & 2**	**Zone 3**
α emitters	$< 0.01 \times 10^4$	$\leq 0.01 \times 10^5$	$< 0.01 \times 10^{-2}$	$\leq 0.01 \times 10^{-1}$
U-nat, depleted U, LEU	$< 0.2 \times 10^4$	$\leq 0.2 \times 10^5$	$< 0.2 \times 10^{-2}$	$\leq 0.2 \times 10^{-1}$
Sr-90, radioiodines	$< 0.05 \times 10^4$	$\leq 0.05 \times 10^5$	$< 0.05 \times 10^{-2}$	$\leq 0.05 \times 10^{-1}$
β-γ emitters	$< 0.2 \times 10^4$	$\leq 0.2 \times 10^5$	$< 0.2 \times 10^{-2}$	$\leq 0.2 \times 10^{-1}$

These maximum ambient air concentrations from Table 7 above were used to derive conservative MPERs for emission streams that are expected to contain minimal or no

radioactive contaminants. The MPERs were calculated by multiplying zone-specific maximum ambient air concentrations from Table 7 (Bq/m^3) by exhaust fan rates (m^3/s), yielding release rates (e.g., Bq/s). The release rates could then be converted to an equivalent dose to public in units of mSv by applying the appropriate DRL. This provides a conservative estimate of emissions because the starting point of the calculation is a maximum level of removable surface contamination present within the exhausted area(s). Appendix A lists the various Class I Nuclear Facility effluent streams for which emission rates were estimated using contamination zoning designations.

Note that the Radiation Protection Program periodically confirms zoning designations within buildings by empirical surface checks as per *Radiation and Contamination Workplace Monitoring Routines* [26].

Emission Streams Expected to Contain Radioactive Contaminants:

For all emission streams that are expected to contain radioactive contaminants based on the described source term, an MPER was calculated to allow for comparison to criterion (c) by one or a combination of the following methods:

Possible event scenarios were pulled from respective facility Safety Analysis Reports (SARs). Most of these reports identify both a frequency and severity for each event as per the categories in the tables below. Note that the risk acceptance criteria used in the various SARs may differ slightly from what is shown in these tables depending on the date of issuance of the SAR or the type of facility (S&T vs. others). For MPER calculations, and as per the MPER definition, events with a frequency rating of 0.03/a or greater were considered. All severity categories were considered, even "Negligible" defined at < 0.2 mSv, unless severity was further quantified in the report as less than 0.0005 mSv in which case criterion (c) is not triggered. Note that for most of these events, all safety and mitigating systems are assumed to perform at their minimum standards unless the combination of an initiating event and failure of mitigating system is within design basis, i.e., probability of occurrence > 10^{-6}/a. The term 'bounding events' is used in SARs and adopted herein to mean those postulated events within design-basis (i.e., probability of occurrence > 10^{-6}/a) with the highest Frequency times (x) Severity ratings (or highest Risk).

Frequency Category		Event/year
F0	Extremely Rare	<0.0001 to 0.000001
F1	Rare	<0.03 to 0.0001
F2	Occasional	0.3 to 0.03
F3	Frequent	> 0.3

Severity Category		Dose to Public (mSv)
S0	Negligible	up to 0.1
S1	Low	0.1 to 0.5
S2	Moderate	0.5 to 20
S3	High	> 20

- For cases when no postulated events have been identified at frequencies greater than 0.03/a, the MPER calculation is an estimate of routine emissions. If the emission stream is currently monitored, then the monitoring results are used in the MPER calculation. If

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the emission stream is not currently monitored, an estimate is calculated in various ways. Appendix C provides details on the method and the calculations used to estimate airborne emissions from all unmonitored tanks that are part of the WTC Associated Facilities. Other estimations performed as part of this assessment are detailed in the assessment tables in Section 4.4.2.

If the air emissions stream is filtered by a HEPA filter and/or charcoal adsorber, as per the requirements of *Nuclear Facility Ventilation System Design* [23] or the original facility design requirements, then in most cases, this emissions stream is deemed to require monitoring for the relevant contaminants, i.e., particulates and radioiodines, respectively. This monitoring then conservatively serves as a redundant but independent verification of filtration operation ('redundant' because some facilities have OCM programs involving the use of a pressure differential gauge to monitor resistance to air flow, and by Radiation Protection Program requirements, HEPA filters and charcoal adsorbers are to be tested either annually, semi-annually, or quarterly).

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4.4.2 Assessment Tables

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4.4.2.2 Recycle Fuel Fabrication Laboratories (RFFL)

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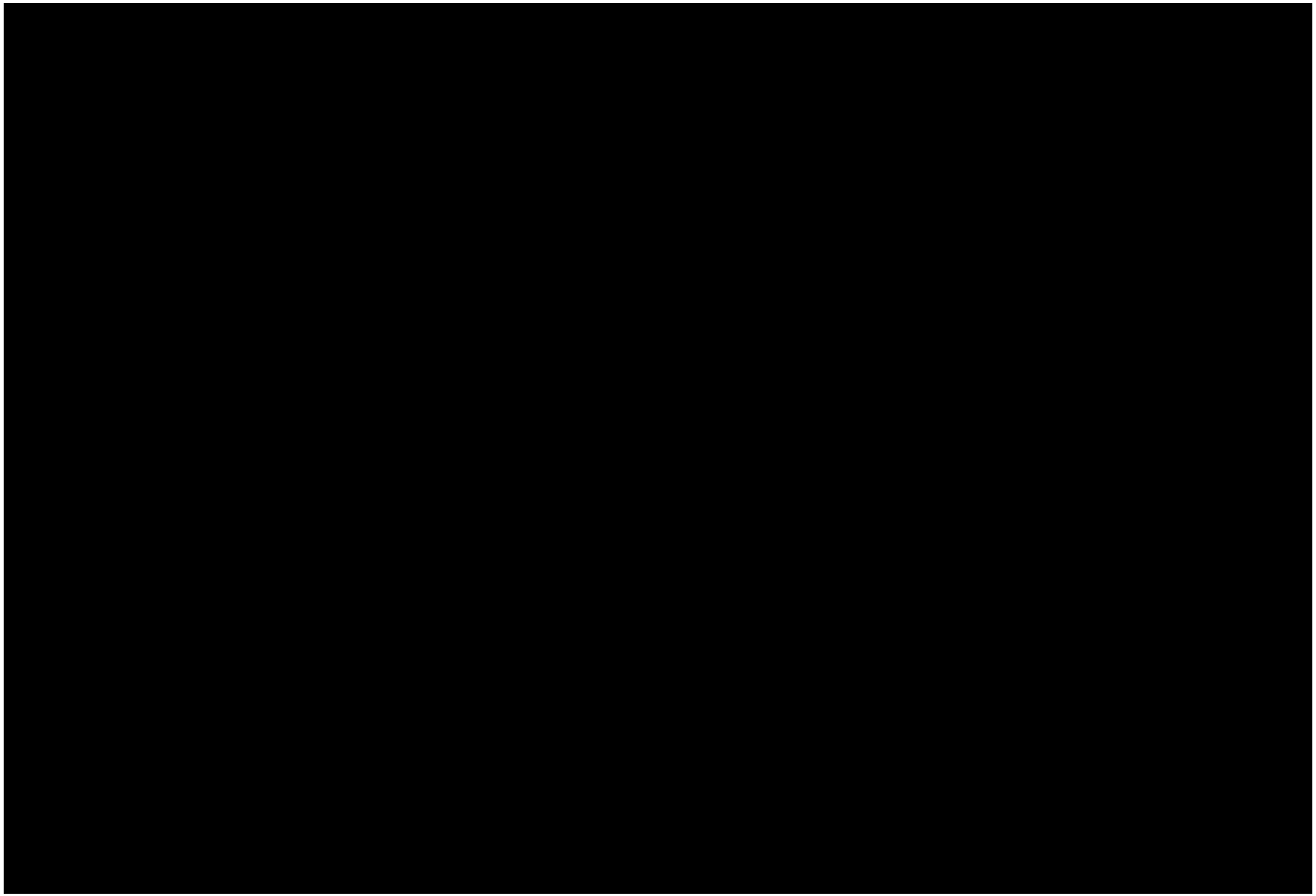
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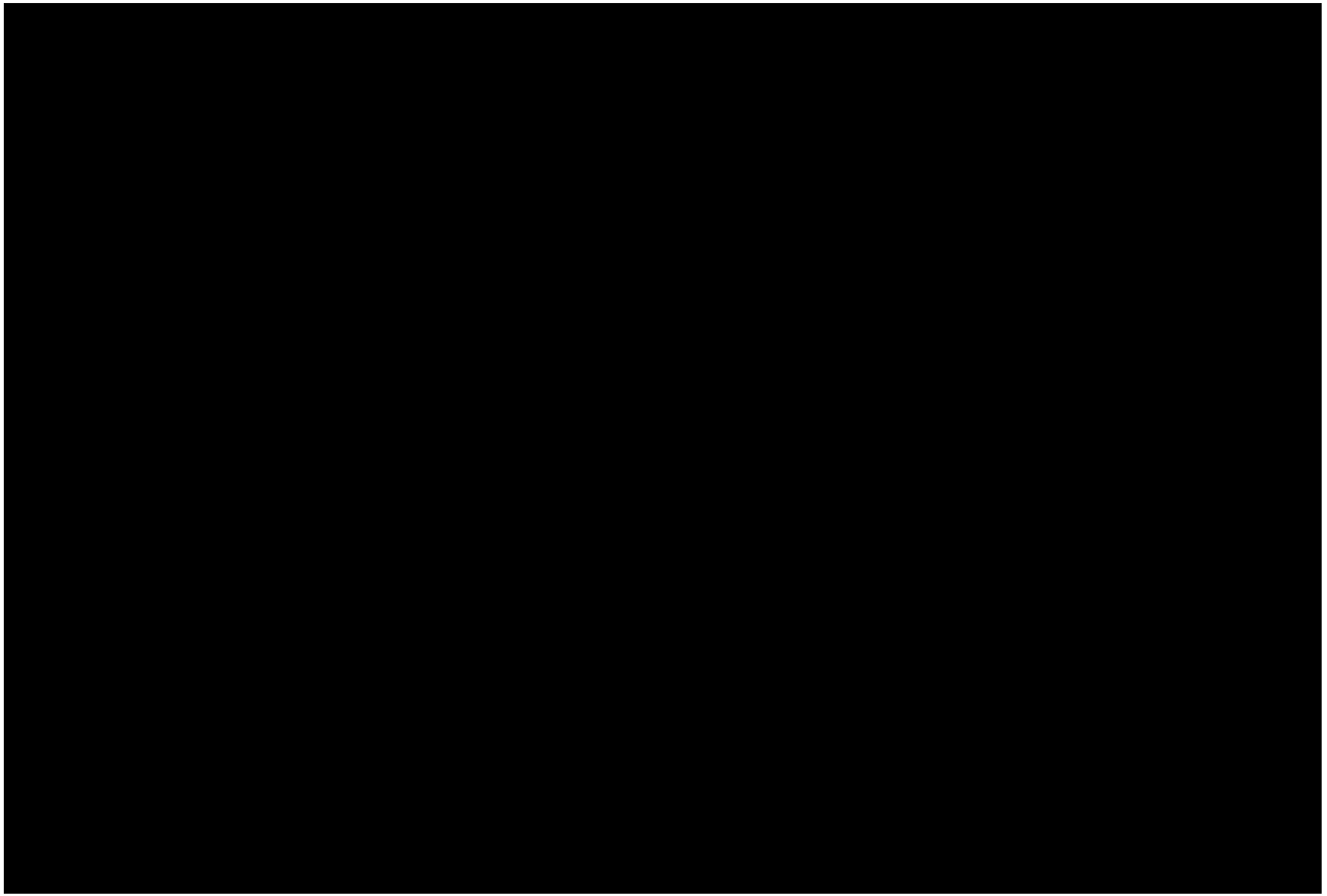
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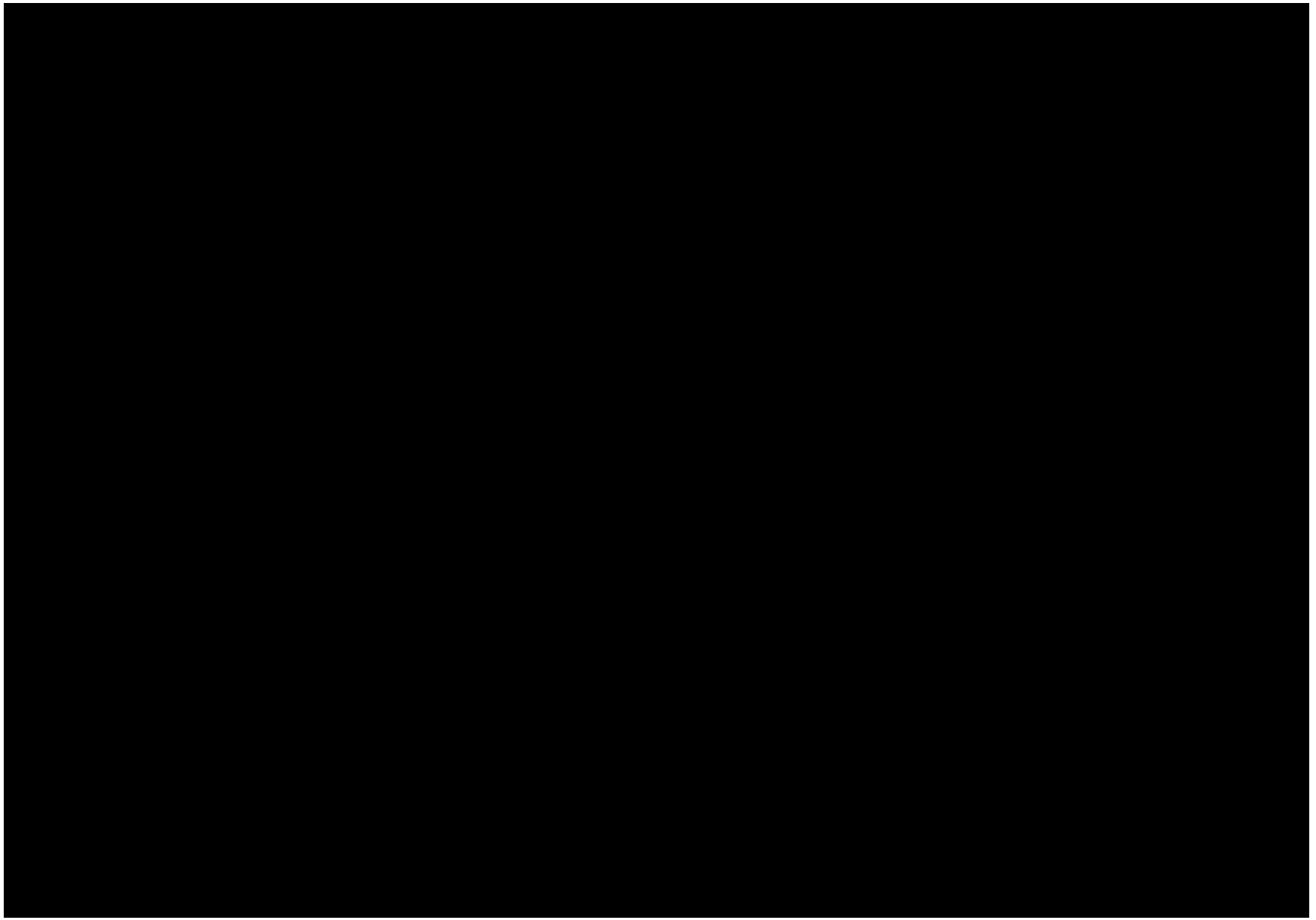
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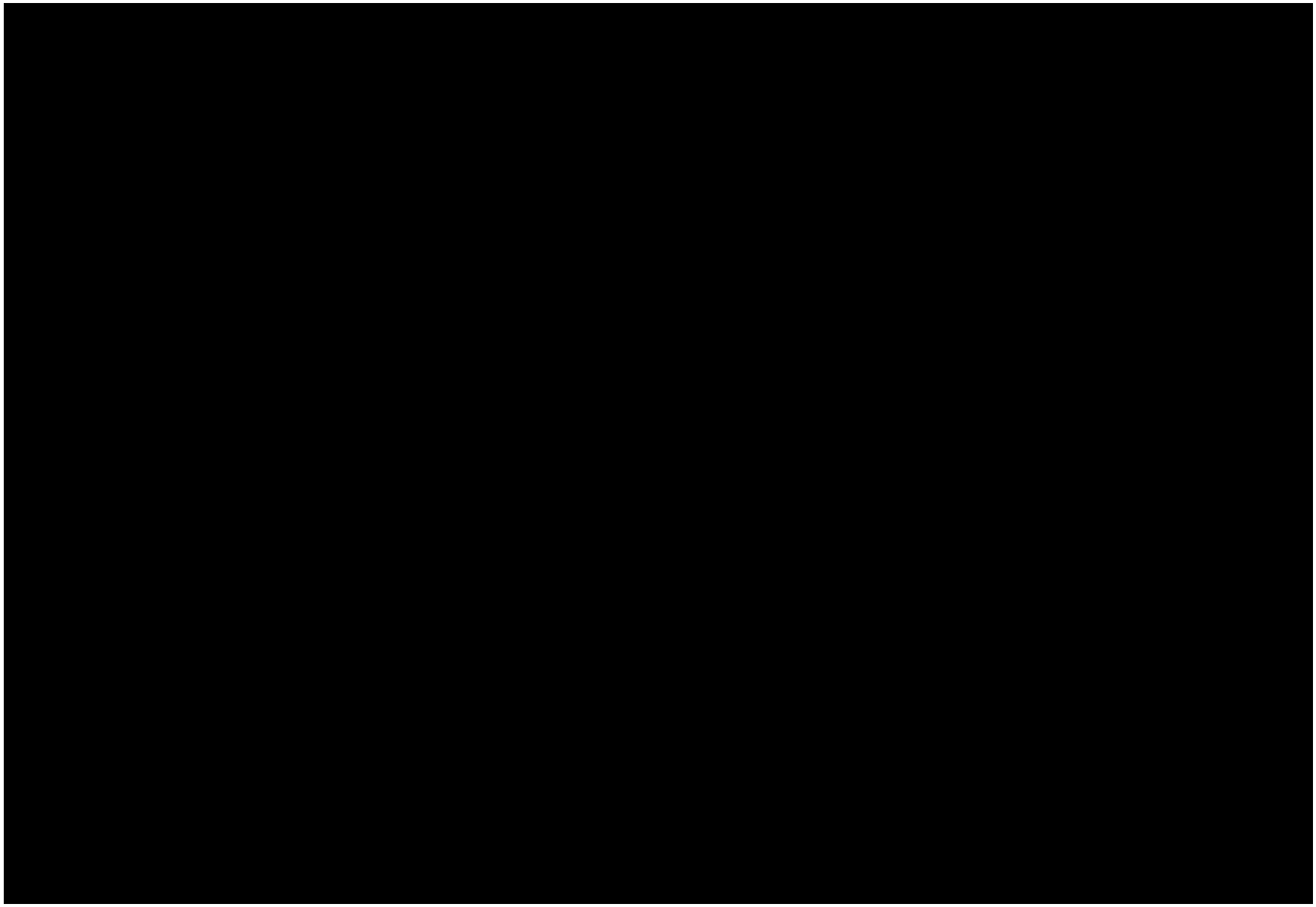


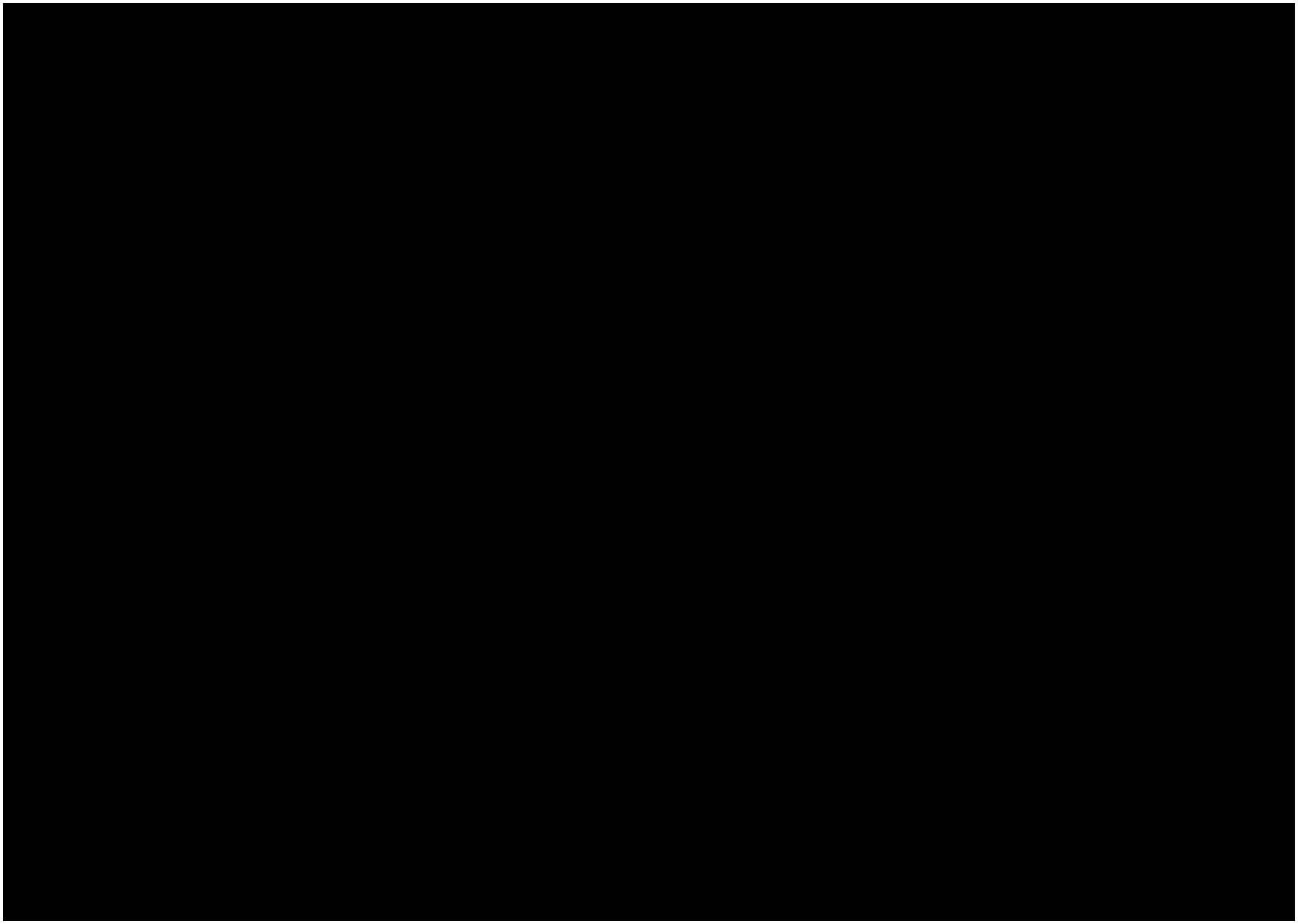
4.4.2.4 Universal Cells (UC)

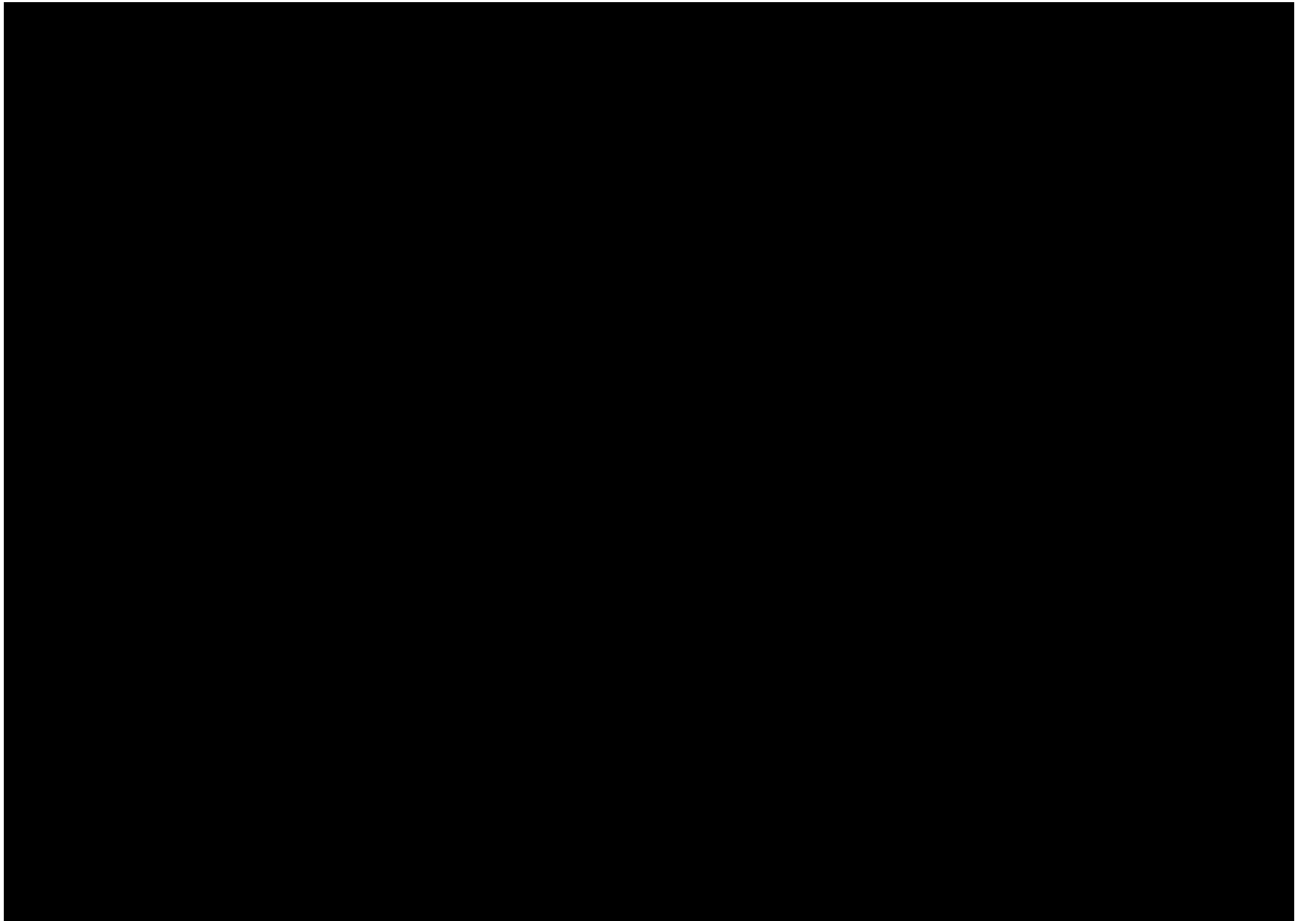
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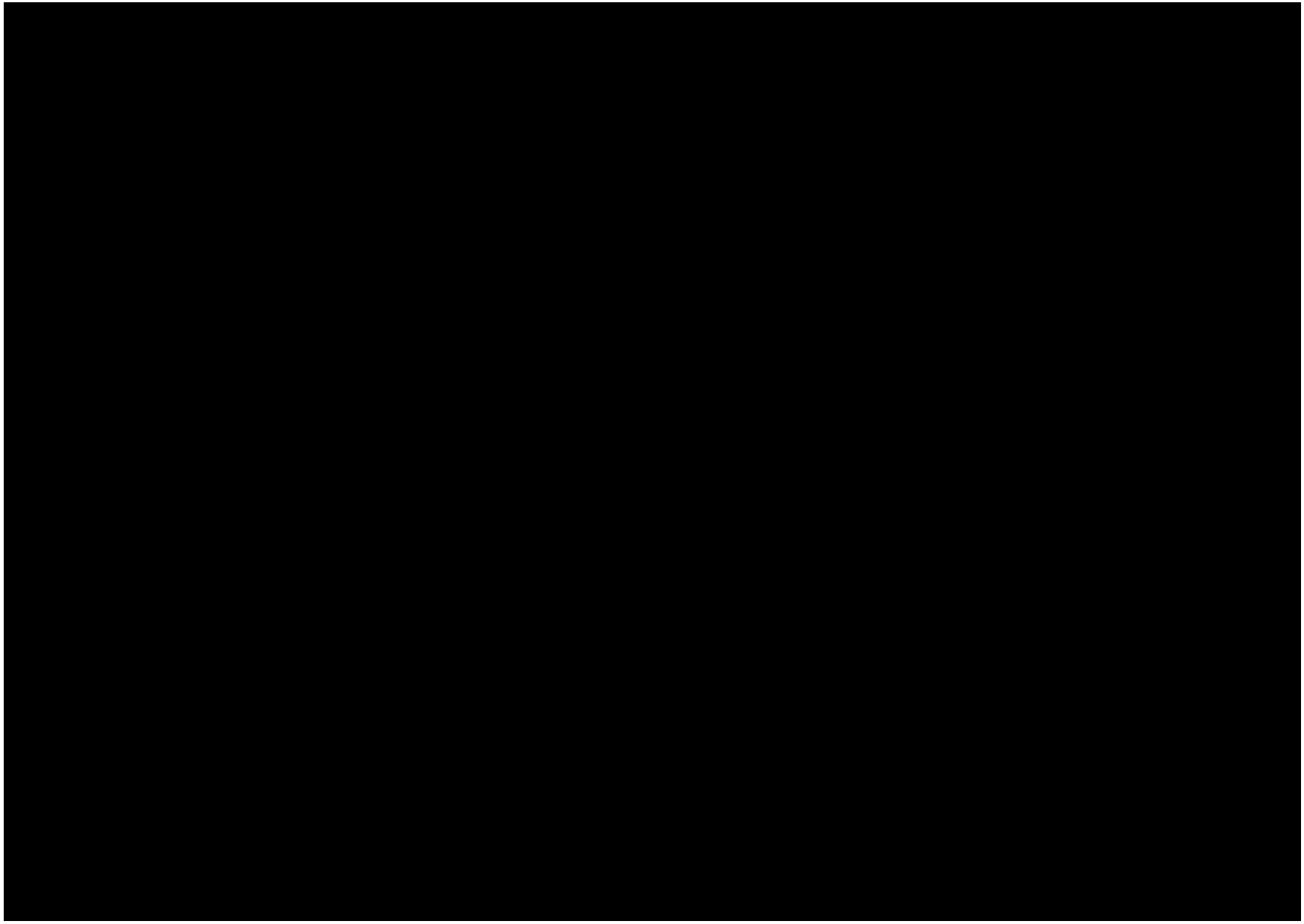




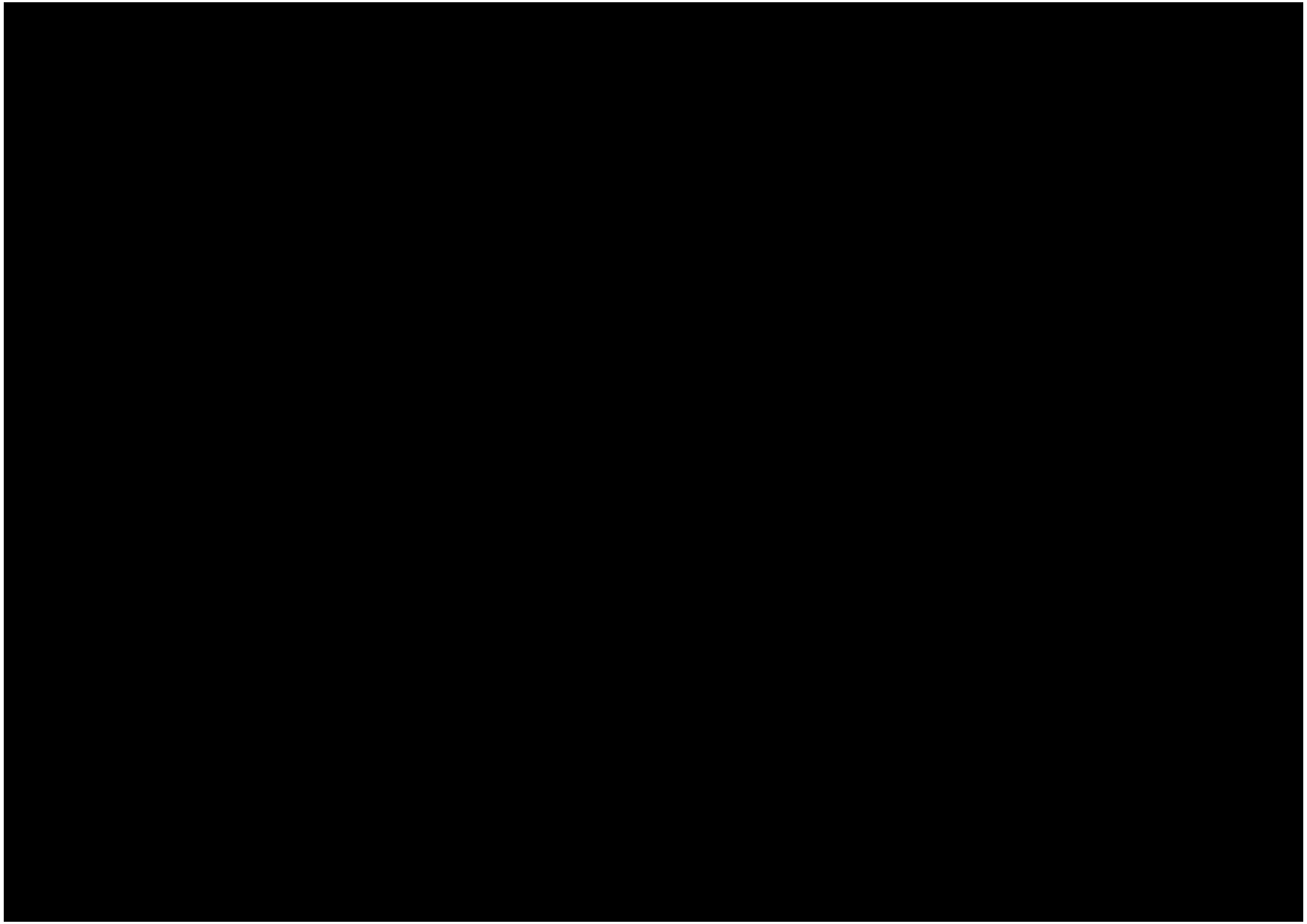








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4.4.2.5 Fuels and Materials Cells (FMC)

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4.4.2.6 Molybdenum-99 Production Facility (MPF)

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4.4.2.7 Tritium Facility ([redacted])

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4.4.2.8 Combined Electrolysis Catalytic Exchange Upgrading/Detritiation Test Facility (CECEUD)

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4.4.2.9 Waste Treatment Centre (WTC) & Associated Facilities

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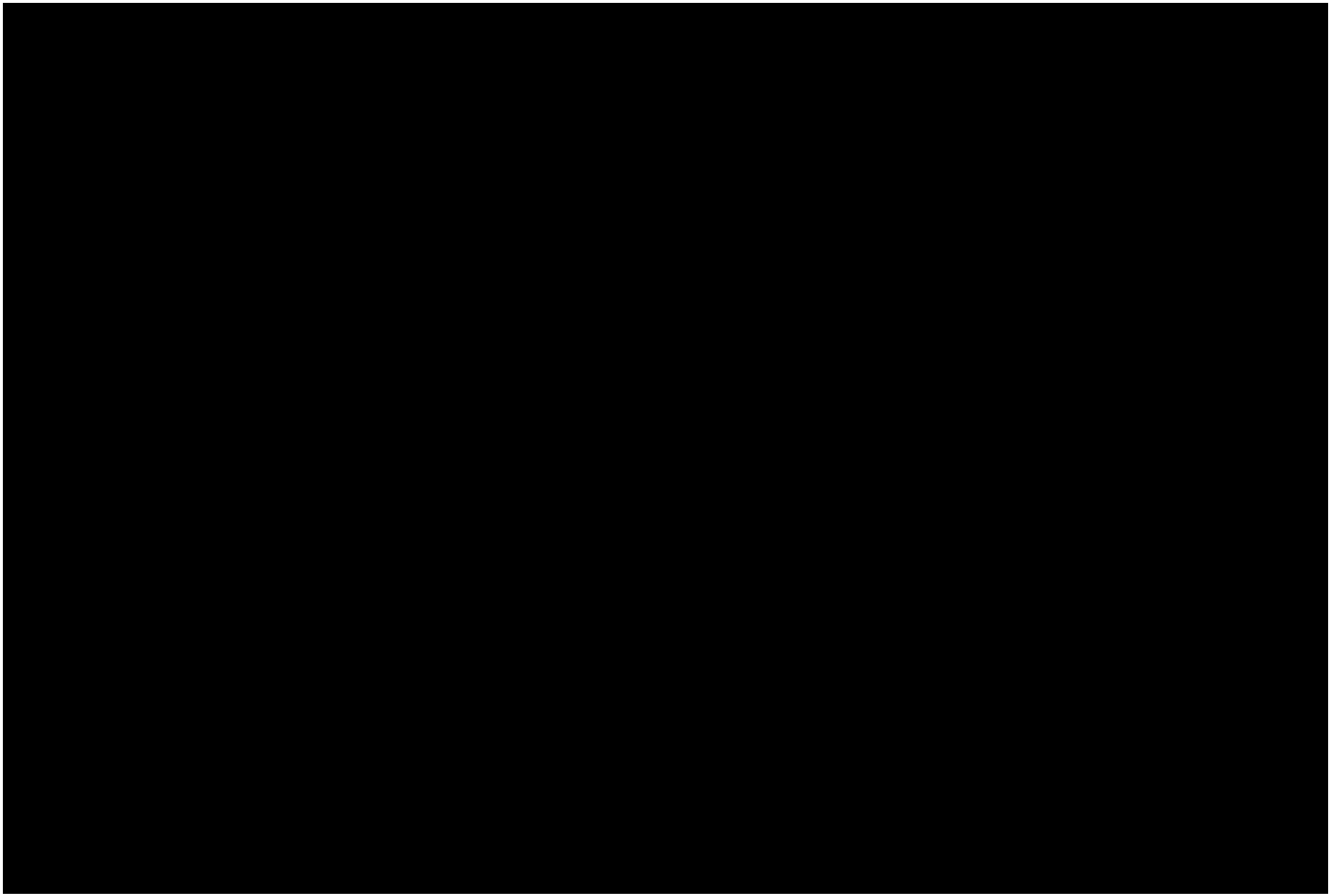
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4.4.2.10 Waste Management Areas (WMAs)

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4.5 Class II Nuclear Facilities

The Class II Nuclear Facilities include:

- Health Physics Neutron Generator Facility:
  - Neutron Generator Model DD-109; and
  - Neutron Generator Model DT-108 API;
- Gamma Beam Irradiation Facility:
  - Gamm Beam Irradiator Model GC60-1000; and
  - Gamma Bean Irradiator Model 150C;
- GC-60 Irradiation Facility:
  - Gamma Beam Irradiator Model GC60-10; and
  - X-Ray Irradiator Model X80;
- Van de Graaf Electron Accelerator.

All of these facilities are designated radiological contamination zone 1 or 2. Hence, minimal or no routine radioactive airborne emissions are expected.

As for postulated events, the relevant SARs [68] [69] [70] [71] do not identify any postulated events at a frequency >0.03/a that could lead to an off-site dose exceeding monitoring criterion (c).

4.6 Nuclear Facilities in Extended Shutdown State

The Nuclear Facilities in Extended Shutdown State includes the MAPLE 1 Reactor, MAPLE 2 Reactor, and the New Processing Facility. Monitoring of airborne emissions for all three facilities was suspended in 2008 October.

The MAPLE Reactors underwent their last commissioning activities in 2003 and between 2004 and 2008, airborne emission monitoring results indicated consistently low levels, either at background or below the Critical Level for detection [72].

The NPF has never contained active material [73].

4.7 Permanently Shut Down Facilities

4.7.1 Methodology

The methodology used to assess airborne emissions streams from permanently shut down facilities is the same as that described in Section 0 for Class I Nuclear Facilities, i.e., the stream is assessed against the emission stream and contaminant monitoring criteria outlined in Table 1 of *Management and Monitoring of Effluents and Emissions* [4], and an MPER may be calculated using one or more sources of information (e.g., knowledge of source term or knowledge of lack of-, designated radiological safety contamination zones, safety cases, etc.).

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4.7.2 National Research Universal (NRU) Reactor

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4.8 Nuclear Facilities Undergoing Decommissioning Activities

4.8.1 Methodology

Airborne effluent streams stemming from the facilities in Storage-with-Surveillance state are assessed against the applicable effluent stream and contaminant monitoring criteria outlined in Table 1 of *Management and Monitoring of Effluents and Emissions* [4].

For an assessment against criterion (c), MPERs were calculated based on routine emissions only. No event-based emissions were included in the MPER since no documented postulated events are available.

Where airborne emissions monitoring is conducted, the normal, measured emission rates are compared with the monitoring criteria. Where no airborne emissions monitoring is conducted, the risk of re-suspension is evaluated by assessing the radiological safety contamination zones. If a building includes areas designated as Radiological Safety Contamination Zone 4 and/or if the effluent stream is filtered by a HEPA filter system then this may in some cases trigger monitoring criterion (k).

For some facilities, the building ventilation system and other systems are shut down or physically removed. In these cases, there are no airborne emissions. This is often the case when the building has been transferred from operations to decommissioning, and preliminary decommissioning scoping and characterization surveys are completed. Once active decommissioning work begins, temporary ventilation units equipped with HEPA filtration are installed to vent temporary enclosures in which the decommissioning work is taking place. These are typically monitored for due diligence reasons given the uncertainty in the level of anticipated emissions.

Environmental Assessment Follow up report recommendations and information from Detailed Decommissioning Plans are used when available.

The contribution of the emission streams to site-wide emissions of radioactive contaminants is assessed by applying the 70% rule as presented in the tables in Criterion (l).

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4.8.2 Assessment Tables

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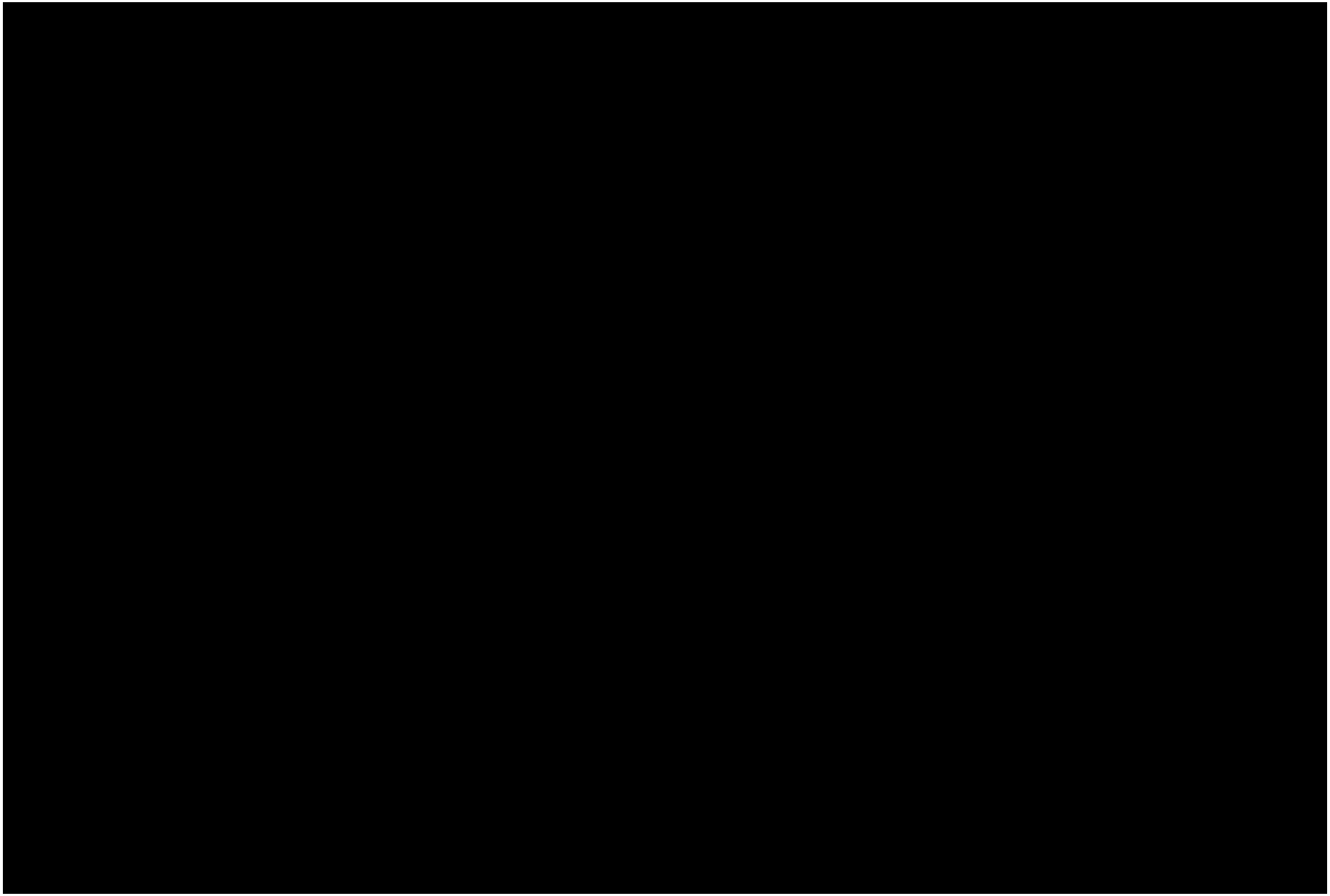
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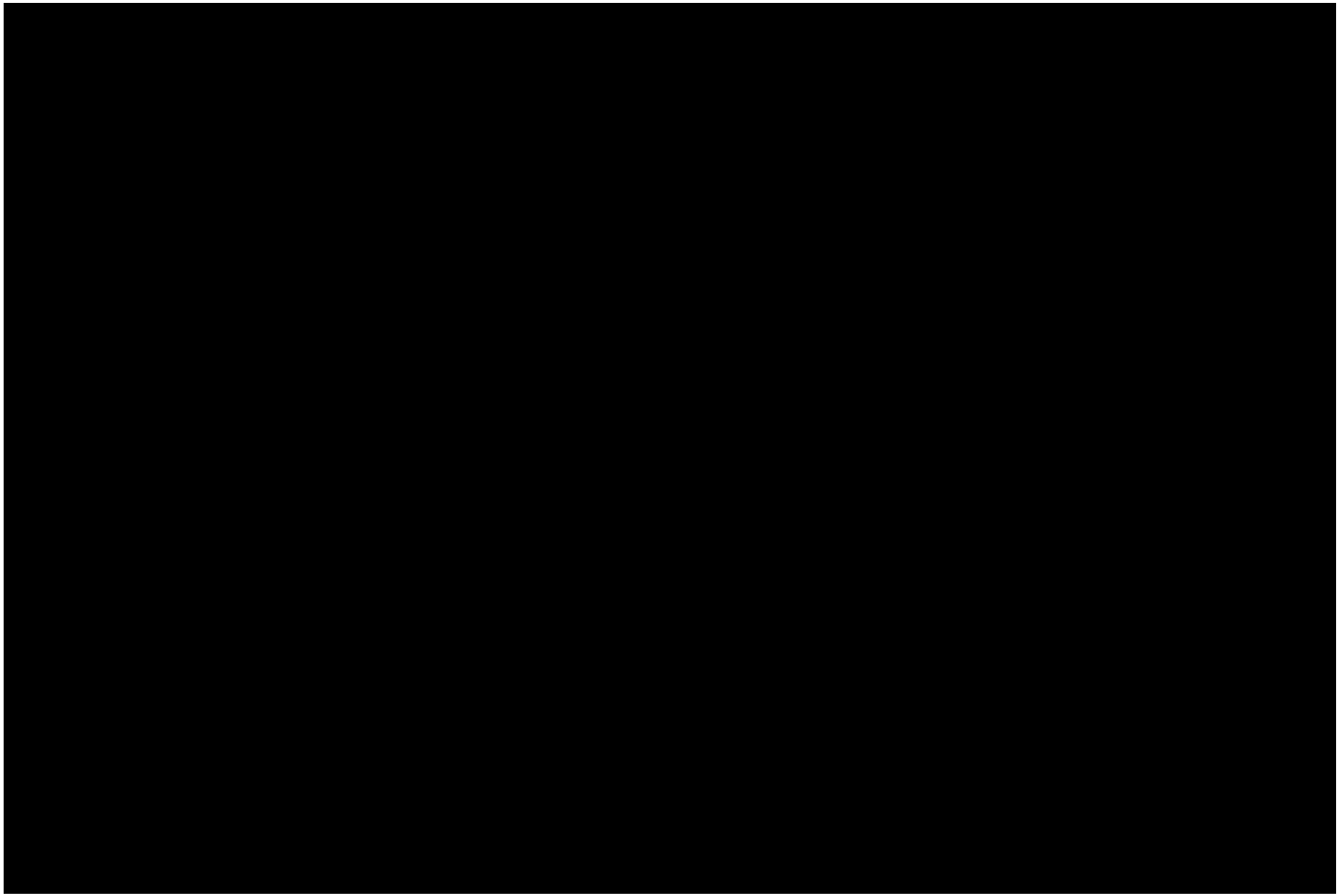
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4.9 Radioisotope Laboratories (Class A, B, C)

4.9.1 Methodology

There are no Safety Analysis Reports for Class A, B, and C Radioisotope Laboratories. Instead, the laboratories are subject to an assessment via Radioisotope Laboratories Protocols (RLP) or as of 2024 an Operating Envelope (OE) that are reviewed and approved by the CNL Radiation Protection Program. Since the RLPs or OEs do not provide a frequency of postulated events that can be used for an MPER calculation, a fire event at the respective laboratories is used to estimate worst-case airborne emissions. In SARs, this type of fire is normally rated as a low probability event with a severity rating of high. Airborne emissions from this postulated fire event were assessed in order to justify the need for radiological emissions monitoring for the CRL Radioisotope Laboratories.

The CRL Licence Handbook [2] refers to 900-514300-LST-001, *Site Licences, Certificates, Permits, Building/Facility Contacts, & Licence Representatives* [18] for a list of the radioisotope laboratories found at the CRL site. The majority of these radioisotope labs have an authorized RLP document or OE document. The RLP or OE provides information such as: laboratory class, requirements, processes and sets the limits and restrictions on the type and quantity of radionuclides used, stored or in operations in the lab.

In general, information regarding the type and quantity of radionuclides found in the lab is gathered from the RLP or OE but in some occasions information was obtained from the lab staff. As mentioned above, the non-routine event chosen for this assessment, which could lead to airborne emissions, is a fire that will destroy completely the lab and the building. A very high level of conservatism was applied initially in the assessment by assuming that the entire radiological inventory will become released to the atmosphere and lead to off-site population radiological exposure. The off-site dose is calculated and then compared with the monitoring criteria. If the monitoring criteria were exceeded, the level of conservatism applied initially (when the entire inventory release was assumed) was reduced further by applying airborne release fractions that were available in the literature.

To summarize it, the justification for monitoring for the CRL Radioisotope Laboratories listed in 900-514300-LST-001 is based on the following assumptions.

- Information regarding the lab inventory is gathered from the RLPs or OEs ([85] to [123]). When the information was not sufficient/clear more information was requested from the lab staff such as: maximum number of samples used, typical activity, radionuclides found in the lab, etc.
- The radiological inventory is grouped by the Toxicity Groups [124] and, in general, the inventory is allocated to the most restrictive radionuclide from each group. This adds conservatism. There were situations where no DRLs were developed for certain radionuclides, in which case the most restrictive available DRL was used.
- In the event of a fire that would destroy the whole laboratory & building, the only pathway of exposure for an off-site person is assumed to be via airborne releases. Given

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that, during a fire, not all the radionuclide inventory will be completely released airborne release fractions were used (that were available in the literature). The literature provides the results from a number of tests conducted by different groups. Some of those results are presented as follows.

The CNL *Nuclear Fuel Fabrication Facility Building* [redacted] *Safety Analysis Report* presents the results of a number of tests conducted at Oak Ridge on uranium fires extinguishing agents [125]. The results imply that less than 0.01% (or 1E-04) of the material (uranium) becomes airborne in a fire.

The Mishima, J. report [126] [127] mentions that: "A fire in uranium chips or powders would result in only a very small fraction of the material becoming airborne. Qualitative observations by CRL personnel having experience with fires in uranium turnings or fines indicate these materials burn very slowly, essentially smoldering, with no significant loss of material".

Other tests conducted at the Pacific Northwest Laboratories involving burning pieces of plutonium metal concluded that the maximum observed airborne release would be 0.03% (3E-04). It is believed that uranium and plutonium behave in a similar manner during a fire [126] [127].

The ANSI/ANS-5.10 standard [128] presents the release fractions for volatile compounds, liquids, and solids found under thermal stress and other stressors (e.g. explosive forces, aerodynamic entrainment/resuspension). Airborne release fractions for thermal stress were provided more specifically for tritium, Pu, and U. The values used for Pu and U range between: (3E-05) for Solid Reactive Metal (Pu-less than ignition temperature of oxide formed) to (1E+00) for Solid Reactive Metal (U-explosive dispersal of thin sheets of metal). The ANSI standard is more specific in terms of particle generation mechanisms.

Since the probability of a fire that will completely destroy the lab and building is very small, the 1E-04 factor was used in this assessment for Pu and U. No credit was given to the HEPA and charcoal filters.

The United States Department of Energy (DOE) Handbook on *Airborne release fraction/rates and respirable fractions for non-reactor nuclear facilities* [129], presents the airborne releases of Cs, Th, and Ce measured in tests using a kerosene combustion process. The study presents the fraction reaching filters and the transfer coefficients for Cs, Th, and Ce. Other studies indicate that the airborne release fraction should be smaller than the transfer coefficient[2] but greater than the fraction reaching filters (Table 8). Based on the assumption that the airborne release fraction should be greater than the fraction reaching the filter (Table 8), the following airborne release fractions were considered conservative.

[2] The transfer coefficient in air was determined by: [initial mass element] - [final mass element]/initial mass element. The decontamination factor was determined by: [initial concentration element] x [volume]/mass collected on filter.

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- Cs: release fraction 1E-02
- Th: release fraction 1E-02
- Ce: release fraction 1E-02

Table 8: Measured Transfer Coefficients and Decontamination Factors during the burning of TBP-kerosene solvent (Malet et al., April 1983)

Trace Element	Transfer Coefficient	Decontamination Factor	Fraction Reaching Filter
(Small Scale Experiments)			
Cs	0.47 0.32 0.27 0.49	1310 >5270 >4890 >3760	3.6E-4 <6.0E-5 <5.5E-5 <1.3E-4
Th	0.45 0.23 0.12	112 159 137	4.0E-3 1.4E-3 8.8E-4
(Large Scale Experiments)			
Ce	0.23 0.42 0.92 0.89 0.47	4260 1110 ----- ----- 5620	5.4E-5 3.8E-4 ----- ----- 5.4E-5

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In general, from a radiological point of view, Cs-137, tritium, and I-131 are the radionuclides that are responsible for general population radiological exposure via airborne releases from CRL [19].

The CRL labs involve a wide variety of operations/materials and it is not simple to characterize it accurately and choose the airborne release fractions. The assessment is not intended to focus on a complete understanding of all the mechanisms involved in the airborne releases because of the complexity of mechanisms involved in a fire and the complexity of each lab. A complete understanding of the intrinsic mechanisms is not commensurate with the level of details required in this assessment and it is not practical to be used at this time.

- In order to calculate the off-site dose the activity of a specific radionuclide (from the inventory) (Bq) is divided by the Derived Released Limit (DRL) (Bq/wk) for that radionuclide. The release is assumed to be a one-time event and not a routine weekly release. The DRLs used are those for airborne emissions released from CRL roof vents (Table 27, [19]). The value is divided further by 52 weeks (number of weeks in a year) since the event is not assumed to occur every week of the year[3]. The one-time release will occur over one week duration. The off-site dose is compared further to the monitoring criteria.
- Two monitoring criteria [4] were used to evaluate the need to monitor at the various labs:

[3] 100%DRL for every week of the year corresponds to 1mSv/y dose.

  - When more than one radionuclide is found in the lab Criterion (c) was applied: *(should) If the total MPER for an effluent or emission stream exceeds 0.0005 mSv per year to a member of an off-site critical group, then that effluent or emission stream should be monitored. Normal emission rates, instead of MPER, may be used if the effluent or emission stream has an OCMP in place.*
  - If only one radionuclide was found in the lab than criterion (l) was applied: *(should) If the site-wide MPER for a radioactive contaminant exceeds 0.0001 mSv per year to a member of an off-site critical group, then that radioactive contaminant should be monitored.*

- Since DRLs have not been developed for all the radionuclides found in the lab inventories, for those missing, the inventory is allocated to the most restrictive radionuclide from a Toxicity Group. This adds conservatism.
- For some of those labs the inventory used in the calculation is based on the most highly radioactive reactor artefact coupon/sample.
- The methodology did not account for any modifying factors[4] applied because of the large variation in the type of activities conducted in certain labs.
- For certain labs where different forms of iodine are used (e.g. volatile, semi-volatile, non-volatile) only the semi-volatile and volatile inventory was used. Iodine is very adherent to surfaces and as a result, not all the inventory would be released in the event of a fire. Assuming a 100% release of all forms of iodine would have been overly conservative.
- When a radiation source was found in the inventory (e.g. gamma cell lab) that source (Co-60) was not included in the total inventory[5]. It was assumed that a release would not be possible from the source in the event of a fire for the following reasons: adequate shielding to the source, non-combustible lab walls, lack of combustible load in the room, and incombustible source (Co-60 metallic source).
- Initially a 100% release is assumed. If the monitoring criteria were exceeded, airborne release fractions were included in the calculation to reduce the level of conservatism initially applied.
- Occasionally, when the inventory was not clear, the Class inventory limits were applied (e.g. [redacted]). This adds conservatism since, in general, the inventory in the labs are below the maximum allowable inventory for the Class lab.
- For labs where enriched uranium was used and only the activity concentration (Bq/g) was provided by the RLP, the activity was calculated based on the enrichment ratios (e.g., for labs [redacted] Rooms [redacted] and [redacted] – U<5wt%U235: 8.8E4 Bq/g).

[4] Modifying factors are applied to the inventory in certain labs to account for resuspension risk (e.g. storage of unsealed sources, complex wet, dry and dusty operations, etc).

[5] The Safety Analysis of the Gamma Beam Irradiation Facility at Chalk River Laboratories, GBF-03500-SAR-001, presents a similar case where Co-60 sources are used in a similar environment. The SAR concludes that it is highly unlikely that Co-60 source shielding will be affected in the event of a fire.

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The main source of uncertainty in this assessment is the variation of the lab inventory. This variation is attributable in general to the modifying factors that are applied under different circumstances.

The assessment is very conservative since the whole inventory was assumed to be released in a fire. Airborne release fractions were applied only for certain radionuclides. As mentioned earlier, no credit was given to the HEPA filters since it was initially assumed that the building will be completely destroyed by the fire. At the same time, the loaded HEPA[6] filters could become potential radiation sources during a fire event. The DOE Handbook on Airborne Release Fractions [129] estimates that, the airborne release fraction from the heat-induced damage to a HEPA filter is very small. The bounding airborne release fraction value is assessed to be 1E-04.

Furthermore, the CRL fire response will be prompt to extinguish a fire which will reduce the risk for prolonged airborne releases.

It is considered that sufficient conservatism was applied in the assessment to balance the associated inventory uncertainty.

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[6] HEPA filters are tested and replaced periodically as part of the maintenance activities.

4.9.2 Assessment Tables

Table 9: [redacted] Molten Fuel Moderator Interaction Laboratory, [redacted]: Class B

[redacted]

RE

Table 10: [redacted] Medium Activity Material Testing Facility, [redacted] Class B

[redacted]

Table 11: [redacted] Analytical Chemistry Branch Satellite Labs, [redacted] [redacted] Class B

[redacted]

Table 12: [redacted] Containment Chemistry Lab, Rm [redacted] Class B

[redacted]

Table 13: [redacted] GammaCell Lab, Rm [redacted]; Class B

[redacted]

RE

Table 14: [redacted] Fission Gas Analysis, Rm [redacted]: Class C

[redacted]

Table 15: [redacted] Environmental/Organics Analysis Lab, Rm [redacted] Class C

[redacted]

Table 16: [redacted] Chromatography Lab, Rm [redacted]: Class B

[redacted]

Table 17: [redacted] Environmental/Organics Analysis Laboratory, Rm [redacted] Class B

[redacted]

Table 18: [redacted] TIMS Sample Preparation Laboratory, Rm [redacted]: Class B

[redacted]

Table 19: [redacted] Environmental Analysis Laboratory, Rm [redacted] Class C

[redacted]

Table 20: [redacted] Radiochemistry Research Lab, Rm [redacted]: Class C

[redacted]

Table 21: [redacted] Radiochemical Analysis Lab Rm [redacted] [redacted]: Class B

[redacted]

Table 22: [redacted] Radiochemical Analysis Laboratory, Rm [redacted]: Class B

[redacted]

Table 23: [redacted] Neutron Activation Analysis and Radiochemistry Laboratory, Rm [redacted] Class B

[redacted]

[redacted]

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Table 24: [redacted] Hydrogen and Deuterium Analysis Laboratories, Rm [redacted] and [redacted] Class B

[redacted]

[redacted]

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Table 25: [redacted] ICP-MS Laboratory, [redacted] Class B

[redacted]

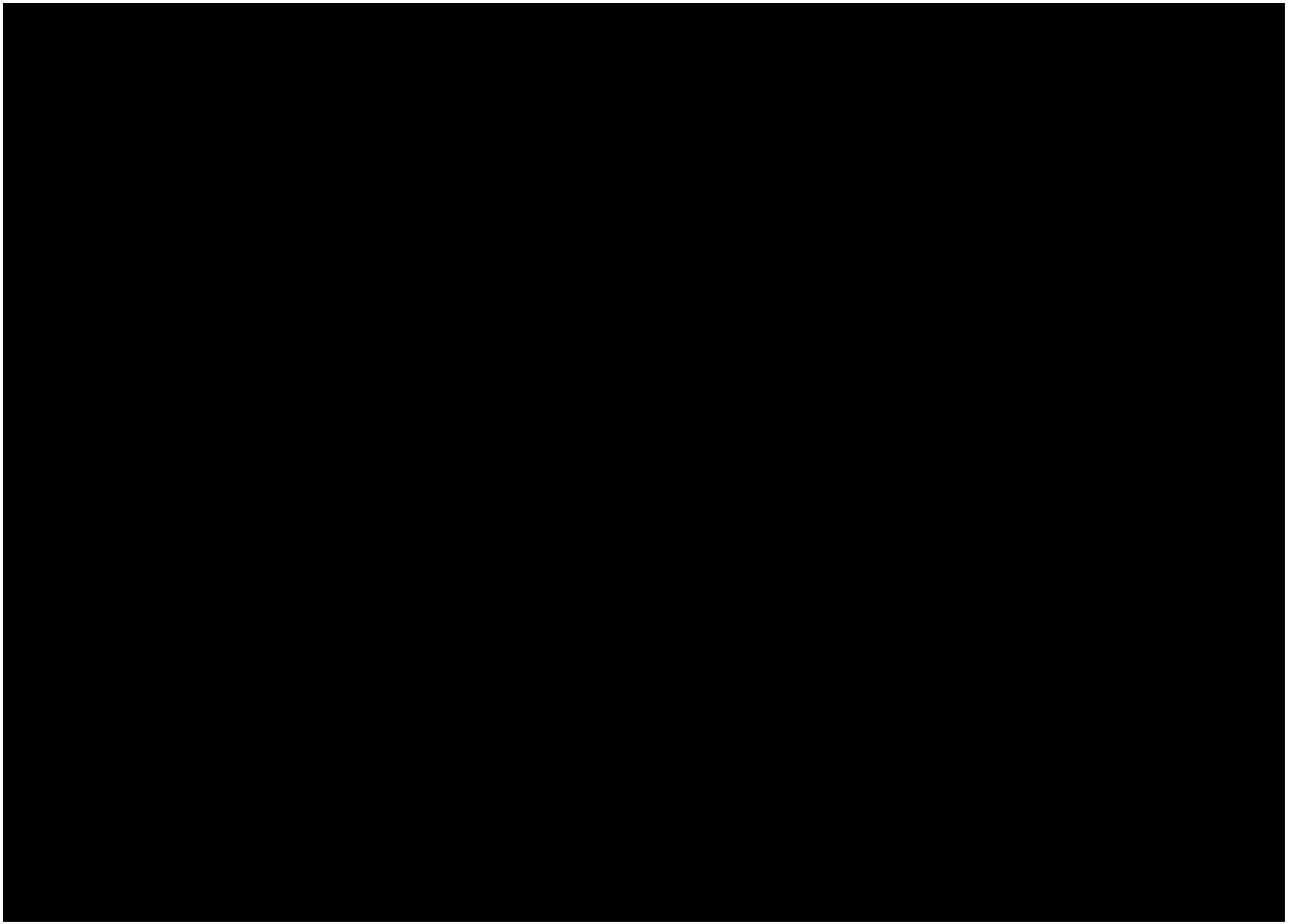


Table 26: [redacted] Decontamination Test Loops Laboratory, Artefact Storage Room, and Chemical Cleaning Laboratory, Rm [redacted] Class C

[redacted]

[redacted]

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Table 27: [redacted] Radiochemistry Applications Laboratory, [redacted]: Class B

[redacted]

Table 28: Chalk River Laboratories Toxicity Laboratory [redacted], [redacted] Class C

[redacted]

Table 29: [redacted] Research Reactor Fuel Development Laboratories, [redacted] Class B

[redacted]

[redacted]

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Table 30: [redacted] Fuel Fabrication Science & Technology (FFS&T) Section Laboratory, Rm [redacted] Class B

[redacted]

Table 31: [redacted] Advanced Technology Ceramics Section Laboratories, [redacted] Class B

[redacted]

Table 32: [redacted] Coulometric Titration Lab, [redacted] Class B

[redacted]

Table 33: [redacted] Deformation Technology Radioactive Specimen Preparation Lab, [redacted] Class B

[redacted]

[redacted]

Table 34: [redacted] Focussed Ion Beam Facility, Rm [redacted]: Class B

[redacted]

Table 35: [redacted] The SIMS, SEM and Radioactive Specimen Storage Laboratories, Rm [redacted] Class B

[redacted]

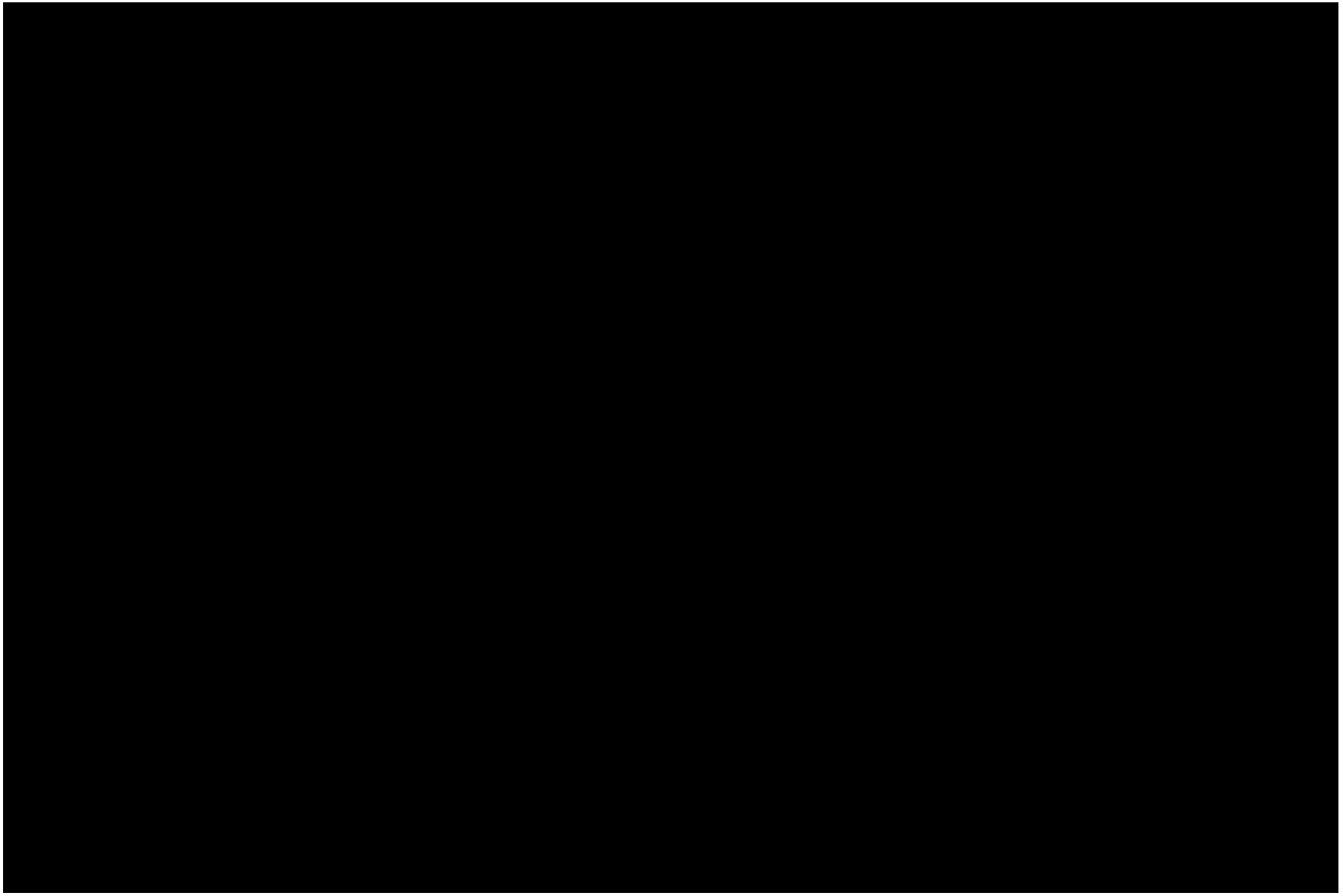


Table 36: [redacted] The Imaging XPS Laboratory, Rm [redacted]: Class B

[redacted]



Table 37: [redacted] Metallographic Services Laboratory, Rm [redacted] Class C

[redacted]

Table 38: [redacted] Surface Science Laboratory, Rm [redacted] Class C

[redacted]

Table 39: [redacted] Small Scale Mechanical Testing Laboratory, Rm [redacted] Class C

[redacted]

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Table 40: [redacted] Fuel Assembly Science and Technologies (FAST) Laboratory, Rm [redacted] Class C

[redacted]

RED

Table 41: [redacted] Waste Processing Technology Development Laboratory, Rm [redacted] Class B

[redacted]

Table 42: [redacted] Fission Product Release Group, Rm [redacted]: Class C

[redacted]

Table 43: [redacted] Tritium Instrument Calibration Laboratory, [redacted] Class C

[redacted]

REDAC

Table 44: [redacted] Bioassay Laboratory, [redacted]

[redacted]

Table 45: [redacted] Environmental Radiochemistry Laboratory, [redacted]: Class C

[redacted]

Table 46: [redacted] Radiochemistry Research Laboratory, Rm [redacted]

[redacted]

Table 47: [redacted] Radiochemistry Applications Laboratory, Rm [redacted] Class C

[redacted]

Table 48: [redacted] Biological Research Facility, Class C

[redacted]

4.10 Support Facilities

The Support Facilities include:

- Central Alarm Station
- Powerhouse;
- Emergency Power Generator; and
- Administration, Security Department, and Fire Department Services.

These facilities have no known sources of radioactive materials, and as a result, no monitoring is required.

4.11 Other Facilities that Handle or Have Handled Nuclear Materials

4.11.1 General

The Other Facilities that Handle or Have Handled Nuclear Materials include:

- Decontamination Centre;
- Nuclear Materials Storage Facility (2 buildings);
- Nuclear Safety Experiments Building;
- Metallurgy Area C;
- Metallurgy Building;
- Site Maintenance Building;
- Shipping/Receiving Facility;
- Low Background Counting Facility;
- Instrumentation and Control Laboratories;
- Flask/Radioactive-Contamination Equipment;
- Hydrogen Engineering Laboratory Building;
- Waste Analysis Facility Building;
- Effluent Monitoring/Filter Testing Building;
- Chemistry and Materials (2 buildings);
- Spring B Facility;
- Chemical Pit Facility;
- Spring B Pump and Treat Facility; and
- NRU/NRC Storage Equipment/Surplus Materials

All facilities with the exception of the Decontamination Centre (see section 4.11.2) and some of the laboratories in the Metallurgy Building are designated radiological contamination zones 1 or 2, such that the potential for routine radioactive airborne emissions is considered very low. Only a subset of these facilities has a radioactive inventory, and these consist of the Class B and Class C Radioisotope Laboratories situated within the facilities, which are covered in Section 4.9. The other facilities do not hold a substantive enough radioactive inventory that could lead to radioactive airborne emissions, with the exception of the Nuclear Facilities Operations

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Storage Building, which is covered in Section 4.11.3, and the Filter Testing Building ([redacted] Iodine Preparation Laboratory), which is covered in Section 4.11.4.

The Decontamination Centre is covered in Section 4.11.2 below.

The Metallurgy Building consists of Area A, Area B, and Area C. Area A is the FMC, a Class I Nuclear Facility covered in Section 4.4.2.5. Area B is the RFFL, a Class I Nuclear Facility covered in Section 4.4.2.1. Area C consists of various Radioisotope Laboratories, which are covered in Section 4.9.

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4.11.2 Decontamination Centre

[redacted]

[redacted]

4.11.3 NRU/NRC Storage Equipment/Surplus Materials

[redacted]

4.11.4 Filter Testing Building

[redacted]

[redacted]

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5. Detailed Design for Waterborne Effluents

5.1 Methodology

5.1.1 Need for Monitoring and Parameters

The waterborne effluents streams stemming from the CRL site that are assessed against the effluent stream and contaminant monitoring criteria outlined in Table 1 of *Management and Monitoring of Effluents and Emissions* [4] include:

- All final discharges to the Ottawa River. These are:
  - Process effluents (Process Outfall, Sanitary Outfall and Powerhouse Discharge);
  - Stormwater effluents associated with the Stormwater Management System [redacted];
  - Point-batch stormwater discharges associated with individual buildings and/or small catchment areas;
  - Inactive Landfill and Gray Crescent related effluents (i.e. Storm Outfall [redacted]); and
  - Groundwater discharges at the eastern boundary of the Controlled Area.
- Waste Management Area related effluents to the Ottawa River: As mentioned in Section 1, there are a number of contaminated groundwater plumes emanating from certain waste management areas that are (or could) discharge to surface waters. The need to monitor these surface waters is assessed as part of the CRL Environmental Monitoring Program and not the EVMP. A subset of these surface waters discharge directly to the Ottawa River, i.e., Perch Creek Weir and Maskinonge Lake Outlet (by way of Duke Stream, Bulk Storage Stream, and Lower Bass Lake Inlet) and these are considered part of the EVMP.
- Point-batch stormwater discharges to ground. Several stormwater discharges to ground exist within the developed area of the CRL site. These represent stormwater runoff from building roofs, foundation drains and small catchment areas that are routed to ground. The catchment areas are small and there is no known source of contaminants for these discharges.
- Not included are the various groundwater plumes on site. These are addressed by the CRL Groundwater Monitoring Program.

The assessment of the need for monitoring and determination of parameters to monitor for in these discharges is provided in Section 5.2.1. Maps identifying the monitoring locations for the EVMP on the CRL site can be found in Appendix A.

Note that a measure of conservatism is applied to waterborne effluent streams that discharge directly to the Ottawa River. Because of the diverse nature of the activities that take place at the CRL site and the resulting physical complexity of the site, all process effluents, WMA-related final effluents, Inactive Landfill- and Gray Crescent- related final effluents, and the more significant stormwater effluents are monitored, regardless of whether or not their MPERs are

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significant. Further conservatism is afforded in that all of these effluents are monitored for at least gross alpha particulates, gross beta particulates, and tritium. This ensures that the majority of contaminants are captured. For those effluent streams that are expected to contain beta-gamma emitting radioactive contaminants, a periodic gamma spectrometry analysis is also performed allowing for speciation of contaminants. These periodic speciation activities serve to confirm the gross analyses and also serve as an investigation tool in the case of an observed rise in gross analysis results.

To allow for an assessment against criterion (c), MPERs for each effluent stream were calculated using an estimate of routine emissions. Based on the definition of MPER in *Management and Monitoring of Effluents and Emissions* [4], the average monthly emissions were calculated based on three years of representative effluent (data from 2021 to 2023 for all locations). Releases during normal operations (Bq/month for waterborne effluent releases), were determined as 1 standard deviation above this computed average. This was calculated for each current monitoring location for gross alpha, gross beta and tritium oxide and summed to provide the MPER for the effluent stream for comparison to criterion (c).

Appendix D provides similar detailed design tables for liquid effluent streams that were at one time but are no longer part of the CRL EVMP.

5.1.2 Sample Collection and Analysis Frequency

Frequencies of sample collection and analysis for the effluent streams are provided in Section 5.2. Sample collection and analysis frequencies follow the recommendations set by the CNL Standard *Management and Monitoring of Effluents and Emissions* [4] with appropriate customization to each effluent based on known sources, effluent performance, etc. Details are provided within each assessment tables for the specific locations and monitored parameters.

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5.2 Assessment Tables

5.2.1 Need for Monitoring and Parameters

5.2.1.1 Process Effluents



[redacted]

[redacted]

RE

Detailed Design – Sewage Treatment Plant (STP)



RE



[redacted]

Detailed Design – Powerhouse Discharge (PPD



REDAC





5.2.1.2 Stormwater Effluents Associated with the Stormwater Management System

Detailed Design – Storm Outfall [redacted] ([redacted])

[redacted]



[redacted]

Detailed Design – Storm Outfall [redacted] ([redacted])

[redacted]

RED

[redacted]

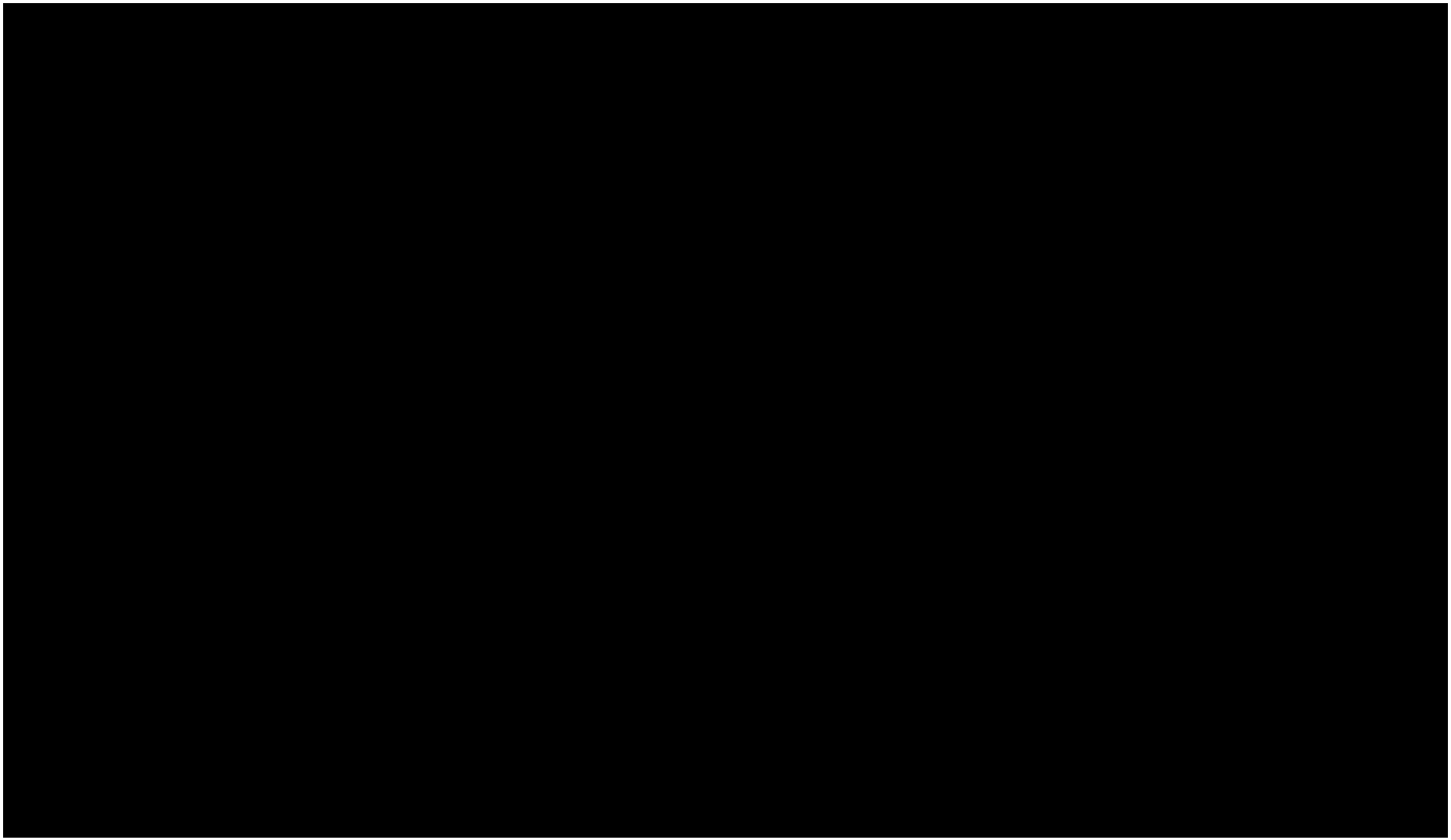
[redacted]

Detailed Design – Storm Outfall [redacted] ([redacted])

[redacted]

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[redacted]

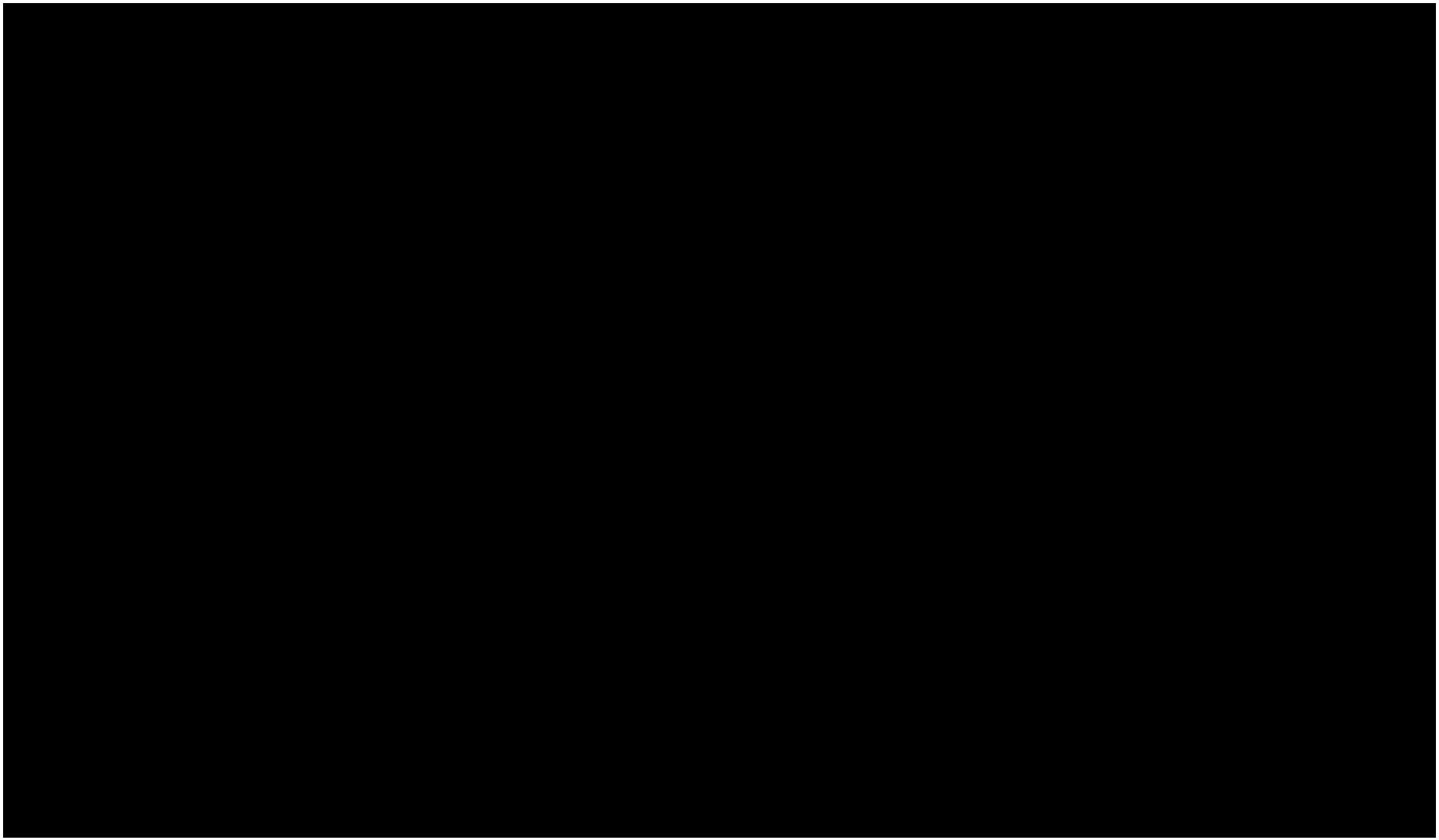


Detailed Design – Manhole/Storm Outfall [redacted]

[redacted]

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Detailed Design – Manhole/Storm Outfall [redacted]

[redacted]

REDA



[redacted]

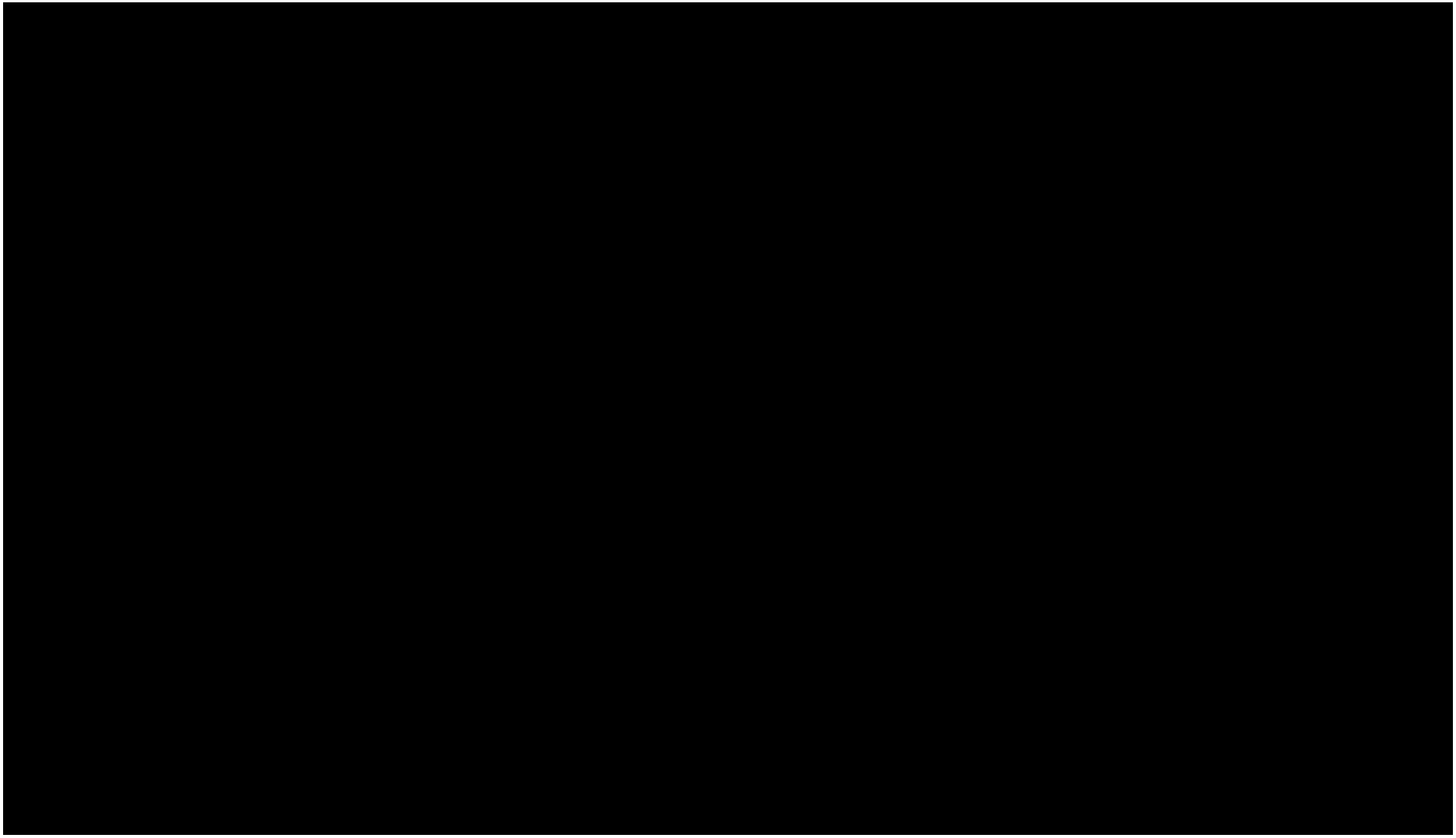
5.2.1.3 Inactive Landfill and Gray Crescent Related Effluents

Detailed Design – Storm Outfall [redacted]

[redacted]

RE

[redacted]



5.2.1.4 Groundwater Discharges to the Ottawa River

Detailed Design – Groundwater to Ottawa River

[redacted]

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[redacted]

5.2.1.5 Waste Management Area Discharges

Detailed Design – Perch Creek Weir (PCW)

[redacted]

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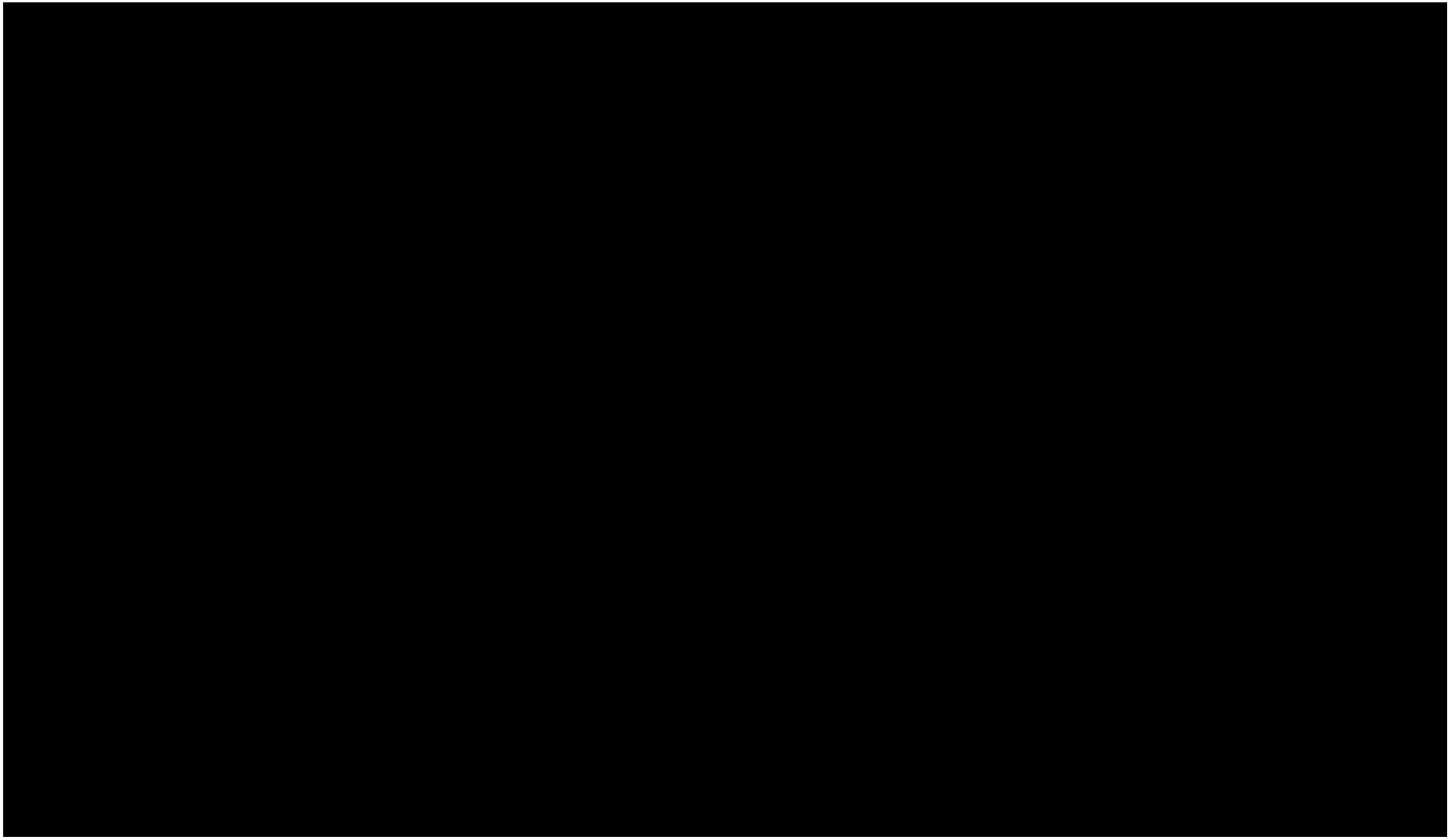
[redacted]

Detailed Design – Discharges to Maskinonge Lake: Bulk Storage Stream, Duke Stream Weir, & Lower Bass Lake Inlet Weir (BSW, DSW, LBL)

[redacted]

REDA

[redacted]



Detailed Design – Spring B Groundwater Treatment Facility ([redacted]) SBT

[redacted]

RE



5.2.1.6 Point-batch Stormwater Discharges

[redacted]

[redacted]

[redacted]

[redacted]

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Appendix A Maps of Effluent/Emission Verification Monitoring Program Locations

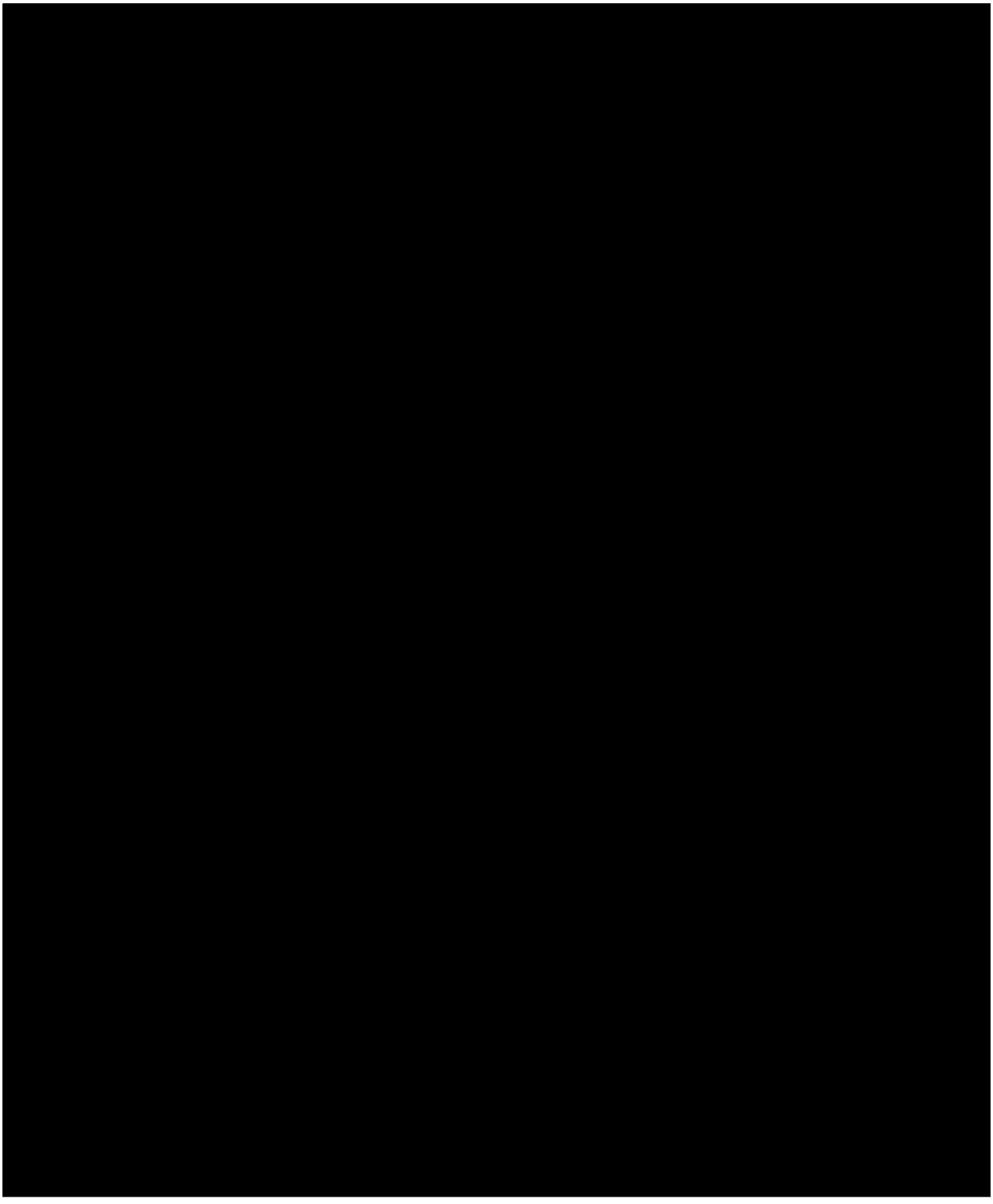


Figure 1: Overall Controlled Area Radiological Airborne Emissions Monitoring Locations



Figure 2: Zoom of North End of the Controlled Area and Associated Radiological Airborne Emissions Monitoring Locations


[redacted]

Figure 3: Zoom of South End of the Controlled Area and Associated Radiological Airborne Emissions Monitoring Locations

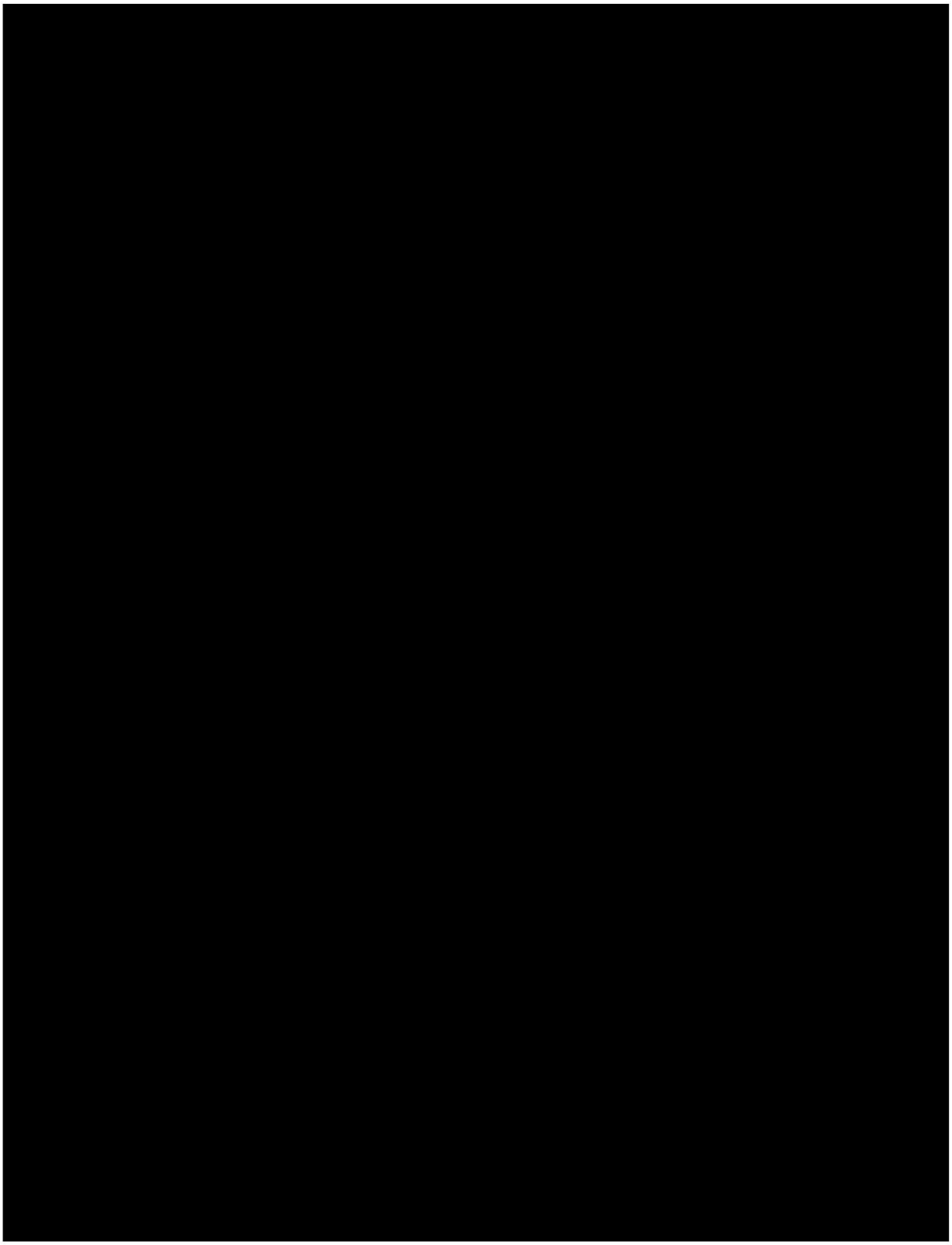


Figure 4: Supervised Area Radiological Airborne Emissions Monitoring Locations



Figure 5: Controlled Area Radiological Liquid Effluent Monitoring Locations

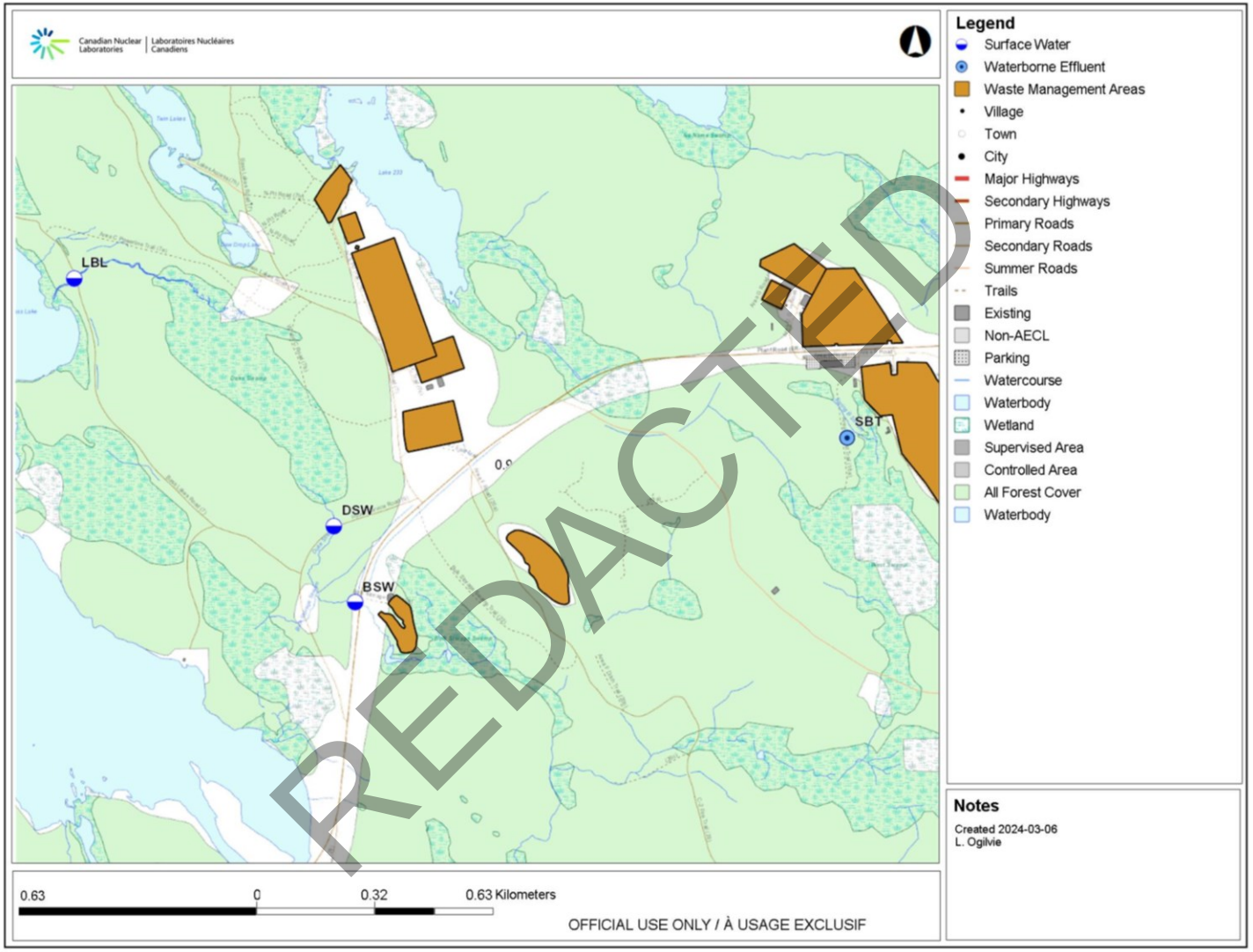


Figure 6: Supervised Area Radiological Liquid Effluent Monitoring Locations

Appendix B Calculation of Maximum α and β-γ Emission Rates for Various Effluent Streams Based on Radiological Safety Contamination Zoning of Vented Areas

(See Section 0 for more detail)

Exhaust Fan	Fan Exhaust Rate (m^3/s)	Highest Radiological Safety Contam. Zone	Maximum Ambient Air Concentrations in Zones (Bq/m^3)				Maximum Emission Rate (Bq/wk)				Maximum Emission Rate (%DRL)				Total Maximum Emission Rate (Total %DRL)	Maximum Dose to Public (mSv/yr)
			α Emitters	U-nat, depleted U, LEU	Sr-90, radio-iodines	β-γ Emitters	α Emitters	U-nat, depleted U, LEU	Sr-90, radio-iodines	β-γ Emitters	α Emitters	U-nat, depleted U, LEU	Sr-90, radio-iodines	β-γ Emitters		
NRU Reactor																
[redacted]Fan[redacted]	0.7	2	1.00E-04	2.00E-03	5.00E-04	2.00E-03	4.23E+01	8.47E+02	2.12E+02	8.47E+02	6.86E-06	1.10E-05	4.97E-06	1.13E-05	3.41E-05	3.41E-07
[redacted]Fan[redacted]	1.4	2	1.00E-04	2.00E-03	5.00E-04	2.00E-03	8.47E+01	1.69E+03	4.23E+02	1.69E+03	1.37E-05	2.20E-05	9.94E-06	2.26E-05	6.83E-05	6.83E-07
[redacted]Fan[redacted]	10.1	2	1.00E-04	2.00E-03	5.00E-04	2.00E-03	6.11E+02	1.22E+04	3.05E+03	1.22E+04	9.90E-05	1.58E-04	7.17E-05	1.63E-04	4.92E-04	4.92E-06
[redacted]Fan[redacted]	0.94	2	1.00E-04	2.00E-03	5.00E-04	2.00E-03	5.69E+01	1.14E+03	2.84E+02	1.14E+03	9.21E-06	1.47E-05	6.67E-06	1.52E-05	4.58E-05	4.58E-07
[redacted]Fan[redacted]	1.9	2	1.00E-04	2.00E-03	5.00E-04	2.00E-03	1.15E+02	2.30E+03	5.75E+02	2.30E+03	1.86E-05	2.98E-05	1.35E-05	3.07E-05	9.26E-05	9.26E-07
[redacted]Fan[redacted]4	0.7	2	1.00E-04	2.00E-03	5.00E-04	2.00E-03	4.23E+01	8.47E+02	2.12E+02	8.47E+02	6.86E-06	1.10E-05	4.97E-06	1.13E-05	3.41E-05	3.41E-07
[redacted]F[redacted]	2.69	2	1.00E-04	2.00E-03	5.00E-04	2.00E-03	1.63E+02	3.25E+03	8.13E+02	3.25E+03	2.64E-05	4.22E-05	1.91E-05	4.35E-05	1.31E-04	1.31E-06
ZED-2																
[redacted]ZED-2	2.42	2	1.00E-04	2.00E-03	5.00E-04	2.00E-03	1.46E+02	2.92E+03	7.29E+02	2.92E+03	2.36E-05	3.78E-05	1.71E-05	3.90E-05	1.18E-04	1.18E-06
WTC & Associated Facilities																
[redacted]Fan[redacted]	0.19	1	1.00E-04	2.00E-03	5.00E-04	2.00E-03	1.15E+01	2.30E+02	5.75E+01	2.30E+02	1.86E-06	2.98E-06	1.35E-06	3.07E-06	9.26E-06	9.26E-08
[redacted]Fan[redacted]	0.661	1	1.00E-04	2.00E-03	5.00E-04	2.00E-03	4.00E+01	8.00E+02	2.00E+02	8.00E+02	6.48E-06	1.04E-05	4.69E-06	1.07E-05	3.22E-05	3.22E-07
[redacted]Fan[redacted]	0.5	1	1.00E-04	2.00E-03	5.00E-04	2.00E-03	3.02E+01	6.05E+02	1.51E+02	6.05E+02	4.90E-06	7.84E-06	3.55E-06	8.09E-06	2.44E-05	2.44E-07
[redacted]Fan[redacted]	0.19	1	1.00E-04	2.00E-03	5.00E-04	2.00E-03	1.15E+01	2.30E+02	5.75E+01	2.30E+02	1.86E-06	2.98E-06	1.35E-06	3.07E-06	9.26E-06	9.26E-08
[redacted]Fan[redacted]	0.42	2	1.00E-04	2.00E-03	5.00E-04	2.00E-03	2.54E+01	5.08E+02	1.27E+02	5.08E+02	4.12E-06	6.59E-06	2.98E-06	6.79E-06	2.05E-05	2.05E-07
[redacted]Fan[redacted]	0.59	2	1.00E-04	2.00E-03	5.00E-04	2.00E-03	3.57E+01	7.14E+02	1.78E+02	7.14E+02	5.78E-06	9.26E-06	4.19E-06	9.54E-06	2.88E-05	2.88E-07
[redacted]Fan[redacted]1	0.142	3	1.00E-03	2.00E-02	5.00E-03	2.00E-02	8.59E+01	1.72E+03	4.29E+02	1.72E+03	1.39E-05	2.23E-05	1.01E-05	2.30E-05	6.92E-05	6.92E-07

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Exhaust Fan	Fan Exhaust Rate (m^3/s)	Highest Radiological Safety Contam. Zone	Maximum Ambient Air Concentrations in Zones (Bq/m^3)				Maximum Emission Rate (Bq/wk)				Maximum Emission Rate (%DRL)				Total Maximum Emission Rate (Total %DRL)	Maximum Dose to Public (mSv/yr)
			α Emitters	U-nat, depleted U, LEU	Sr-90, radio-iodines	β-γ Emitters	α Emitters	U-nat, depleted U, LEU	Sr-90, radio-iodines	β-γ Emitters	α Emitters	U-nat, depleted U, LEU	Sr-90, radio-iodines	β-γ Emitters		
NFFF																
[redacted] Fan [redacted]	1.416	1	1.00E-04	2.00E-03	5.00E-04	2.00E-03	8.56E+01	1.71E+03	4.28E+02	1.71E+03	1.39E-05	2.22E-05	1.01E-05	2.29E-05	6.90E-05	6.90E-07
[redacted] Fan [redacted]	0.85	2	1.00E-04	2.00E-03	5.00E-04	2.00E-03	5.14E+01	1.03E+03	2.57E+02	1.03E+03	8.33E-06	1.33E-05	6.03E-06	1.37E-05	4.14E-05	4.14E-07
[redacted] Fan [redacted]	1.416	1	1.00E-04	2.00E-03	5.00E-04	2.00E-03	8.56E+01	1.71E+03	4.28E+02	1.71E+03	1.39E-05	2.22E-05	1.01E-05	2.29E-05	6.90E-05	6.90E-07
[redacted] Fan [redacted]	1.416	2	1.00E-04	2.00E-03	5.00E-04	2.00E-03	8.56E+01	1.71E+03	4.28E+02	1.71E+03	1.39E-05	2.22E-05	1.01E-05	2.29E-05	6.90E-05	6.90E-07
UC																
[redacted] Fan [redacted]	0.02	2	1.00E-04	2.00E-03	5.00E-04	2.00E-03	1.21E+00	2.42E+01	6.05E+00	2.42E+01	1.96E-07	3.14E-07	1.42E-07	3.23E-07	9.75E-07	9.75E-09
[redacted] Fan [redacted]	0.02	2	1.00E-04	2.00E-03	5.00E-04	2.00E-03	1.21E+00	2.42E+01	6.05E+00	2.42E+01	1.96E-07	3.14E-07	1.42E-07	3.23E-07	9.75E-07	9.75E-09
MPF																
[redacted] Fan [redacted]	2.81	2	1.00E-04	2.00E-03	5.00E-04	2.00E-03	1.70E+02	3.40E+03	8.50E+02	3.40E+03	2.75E-05	4.41E-05	1.99E-05	4.54E-05	1.37E-04	1.37E-06
Tritium Facility																
[redacted] Fan [redacted]	0.255	1	1.00E-04	2.00E-03	5.00E-04	2.00E-03	1.54E+01	3.08E+02	7.71E+01	3.08E+02	2.50E-06	4.00E-06	1.81E-06	4.12E-06	1.24E-05	1.24E-07

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Appendix C Estimates of Airborne Radioactive Emissions from WTC's Associated Facilities Tanks

The following describes the method used to estimate airborne emissions from all unmonitored tanks that are part of the WTC Associated Facilities. Calculations are shown in the tables below.

Many of the tanks containing legacy liquid radioactive waste that are part of the WTC Associated Facilities are not currently monitored for airborne effluents ([redacted] and the tanks comprising the Waste Tank Farm), and neither are some of the operational collection tanks ([redacted]). Postulated events associated with these tanks that could result in airborne contaminant releases include failure of primary containment, failure of secondary containment, and building fire [49]. However, these events either do not meet the >0.03/a MPER event frequency, or do not result in a dose to the public exceeding the monitoring criterion (c) 0.0005 mSv trigger [49]. Hence, the MPER calculation was performed for routine emissions, and not event-based emissions.

It can be expected that on a routine basis, some of the radioactivity in the tanks becomes airborne and contaminates the ambient air above the tanks (hereafter referred to as the 'static state'). Furthermore, one can expect that when a tank is in the process of receiving waste, airborne releases from that tank would increase given the increased turbulence of tank contents and ensuing splashing which results in more contact with air (hereafter referred to as the 'waste transfer state'). Each of these tanks is situated in its own vault within a building that is subject to forced ventilation, with the exception of the 7 tanks that make up the Waste Tank Farm. The latter tanks are situated in concrete vaults below-grade and are passively vented to the atmosphere [133]. The fraction of contaminants that becomes airborne either mixes with building air and is exhausted from the building to the atmosphere, or mixes with the air in the void space of the tank and is exhausted directly from the tank to the atmosphere.

In order to assess the need to monitor any airborne radioactive emissions arising from these tanks, estimates of routine emission rates in Bq/s were calculated as follows:

$$Emission\ Rate\ in\ Bq.s^{-1} = ([Contaminant\ Concentration\ in\ Building\ Air])_{Bq.(m^3)^{-1}}(Exhaust\ Speed)_{m^3.s^{-1}}$$

Equation1

For the purpose of simplicity, it is assumed that the tanks vent directly to the building ambient air instead of first to their respective vaults; this is conservative because it ignores the hold-up time from vault air to building air.

Note that at as radioactive contaminants in the tanks become airborne with time, the contaminant concentrations in building air rise. However, the building air exhaust to atmosphere adds an opposite dynamic to the system, reducing contaminant concentrations in building air over time.

Hence, the contaminant concentration in building air was calculated using a *production* minus *loss* equation. The change in contaminant concentration in building air over time is equal to a contaminant concentration in building air production rate (P) due to airborne releases from the tank *minus* a contaminant concentration in building air loss rate (λC) due to forced ventilation

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out of the building to the atmosphere (the effect of forced ventilation is represented by λ as a removal constant):

$$\frac{dC}{dt} = P - \lambda C$$

The solution to the differential equation is:

$$Contaminant\ concentration\ in\ building\ air\ at\ time\ t = C(t) = \frac{P}{\lambda}\left(1 - e^{\lambda t}\right)$$

To obtain the contaminant concentration in building air at equilibrium, C_{eq}, (i.e., at a time when there has been sufficient production build-up in building air such that the production rate equals the loss rate), t is equated to infinity in the above equation. This yields the largest possible C:

$$C(\infty) = C_{eq} = \frac{P}{\lambda}$$

Conservatively assuming that the contaminant inventory in a tank is constant and not decreasing with time because of loss to air or decay, one can replace the production rate, P, by $(Tank\ Inventory \times Fractional\ Airborne\ Release\ Rate)$. In addition, one can replace the removal constant, λ, by the $Exhaust\ Speed$:

$$C_{eq} = \frac{(Tank\ Inventory)_{Bq} \times (Fractional\ Airborne\ Release\ Rate)_{s^{-1}}}{(Exhaust\ Speed)_{m^3 \cdot s^{-1}}}$$

Because contaminant concentrations in tank liquids are known and conservatively assuming that tanks are at volume capacity:

$$C_{eq} = \frac{([Contaminant])_{Bq \cdot mL^{-1}} \times (Tank\ Capacity)_{mL} \times (Fractional\ Airborne\ Release\ Rate)_{s^{-1}}}{(Exhaust\ Speed)_{m^3 \cdot s^{-1}}}$$

Plugging this equilibrium-state contaminant concentration in building air, i.e., C_{eq}, back into Equation 1 described earlier yields an estimate of routine airborne emission rates from a tank to the atmosphere:

$$Emission\ Rate\ in\ Bq.s^{-1} = \left(\frac{([Contaminant])_{Bq \cdot mL^{-1}} \times (Tank\ Capacity)_{mL} \times (Fractional\ Airborne\ Release\ Rate)_{s^{-1}}}{(Exhaust\ Speed)_{m^3 \cdot s^{-1}}}\right)_{Bq.(m^3)^{-1}} \times (Exhaust\ Speed)_{m^3.s^{-1}}$$

The above equation effectively translates to ignoring building confinement and ventilation entirely (both exhaust rates refer to the same building exhaust rate and cancel each other out) and assuming the tank is outdoors, constantly releasing airborne contaminants to the atmosphere according to a fractional airborne release rate.

The Department of Energy (DOE) *Handbook on Airborne Release Fraction/Rates for Non-Reactor Nuclear Facilities* [129] provides a bounding assessment of aerodynamic entrainment and contaminant resuspension in ambient air from contaminated liquids. It defines an Airborne Release Rate (ARR) as "the coefficient used to estimate the amount of material that can be suspended in air and made available for airborne transport under a specific set of induced physical stresses over time". The bounding assessment recommends a conservative ARR of 4E-7/hr (1.11E-10/sec) for liquids held indoors and exposed to forced building ventilation. Hence

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this ARR was used for the operational collection tanks in [redacted] and [redacted] since these are open top tanks subject to forced ventilation. But it was only used for the 'static state' of these tanks, i.e., when the tanks are not in the process of receiving waste.

For the operational collection tanks in [redacted] and all of the legacy waste tanks, this ARR does not suit since it is derived from experiments that reflect very different conditions that those that exist for these tanks. The DOE ARR is derived from experiments on spray release from large surface area outdoor ponds subjected to a 5 m/s wind speed. In comparison, the WTC Associated Facilities legacy waste tanks and the [redacted] tanks all have a relatively small surface area and are closed top with only a small opening (~3 inches) that is subject to a forced ventilation which does not exceed 1 $m^3 \cdot s^{-1}$. The DOE handbook describes a lower ARR of <1.0E-14/s which was chosen instead. This latter ARR is still conservative for use on the legacy waste and [redacted] tanks because it is derived from experiments on shallow pools (i.e., simulating spills) and not on liquids held in large closed top tanks that are less susceptible to aerodynamic stress and resulting resuspension. Furthermore, the DOE handbook indicates that the ARR values are intended for estimating releases for the short-term only and would result in an overestimate if used to estimate cumulative long-term releases. Since this is conservative and since a more realistic ARR was not available, a value of <1.0E-14/s was used.

The 'waste transfer' state applies only to operational collection tanks, i.e., [redacted] tanks, which receive waste on a routine basis. For this state, a DOE Airborne Release Fraction (ARF) of 2E-4 was chosen [129]. This ARF is derived from experimentation on free-fall spills with uncontrolled dispersion, which is more reflective of the condition experienced by a tank while it is receiving waste, i.e., ensuing splashing, extensive droplet formation on surfaces, etc. No other ARF was found that would better suit this scenario. A sensitivity test was performed using a greater iodine-specific ARF, 2.3E-3, listed in [128]. This latter ARF was derived from experimentation on free-fall spills of spent nuclear fuel. Applying this ARF did not result in a different conclusion with respect to whether or not to monitor the tank(s) in question.

Details on each tank's MPER estimation are provided in the tables below.

Conservatism in these estimations is afforded by the following assumptions:

- Tanks are full, i.e., at tank capacity. This is often not the case in reality and making this assumption ensures that maximum total radioactivity inventory is assumed;
- Tank radionuclide inventory remains constant over time. In reality, the inventory will decrease over time due to decay and loss to air;
- Tanks vent directly to the building air instead of first to their respective vaults; this is conservative because it ignores the hold-up time from vault air to building air;
- The most conservative, bounding ARR applicable to liquids from DOE [129] is used for open top tanks in a 'static state', 4E-7/hr. This ARR is derived from experiments on spray release from large outdoor ponds subject to 5 m/s wind speed. The tanks being assessed in this document are contained indoors and not subject to outdoor winds. There are experiments that have produced much lower estimates of aerodynamic entrainment [129].

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- A conservative ARR applicable to liquids from DOE [129] is used for closed top tanks in a ‘static state’, <1.04E-14/s. This ARR is derived from experiments on shallow outdoor pools exposed to outdoor winds. The tanks being assessed in this document are contained, closed top, not exposed to outdoor winds, and are not shallow pools.

If based on the emission estimate calculations, the monitoring criterion of 0.0005 mSv/yr was exceeded, the level of conservatism applied initially was reduced further by applying some realism, e.g., crediting HEPA filtration or using actual known tank volumes instead of assuming tank volume is at capacity.

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The ambient air concentration of contaminants above a body of water are estimated as follows:

Section 3.2.4 of the Department of Energy (DOE) Handbook [129] provides a conservative fractional Airborne Release Rate (ARR) of <1.0E-14/sec for estimating the airborne release of contaminants from liquids due to aerodynamic entrainment and contaminant resuspension. Note that this ARR is derived from experiments on shallow pools (i.e., simulating spills), and when used on liquids held in large tanks that are less susceptible to aerodynamic stress (as is done below), the resulting resuspension calculation will afford large, conservative estimations.

For tritium, a different estimation is performed (see table below). This estimation method is used by the Tritium Facility to estimate ambient air concentration of tritium above a source of tritiated water. It is overly conservative in that 100% relative humidity is assumed, i.e., the air is saturated with water vapour. Hence the calculation does not need as input the total volume of water or the surface area exposed to air. A common practice within the Radiation Protection department, developed from experience with NRU rod bays, is to divide the result of this estimation by 10, providing a slightly more realistic estimation although still on the conservative side. For the purpose of estimating weekly airborne emissions to the atmosphere, the 20°C results of the estimation calculation below are used for indoor tanks, as this is deemed to be representative of a full year's temperature within the building. For outdoor tanks, the 15°C results are used instead to represent a year's worth of temperature conditions.

Estimation of Tritium Concentration in Air Above Tritiated Water

Tritium Concentration in Water: [redacted] 1.10E+03 **Bq/mL**

Temperature (°C)	Vapour Pressure (kPa)	Water Vapour Conc'n[1] (ppm)	Weight of H2O in 1 m3 of Air[2] (mL or g)	Tritium Vapour in Air (Bq/m3)	(µCi/m3)
0	0.6113	6033	4.84	5.33E+03	1.44E-01
5	0.8726	8612	6.92	7.61E+03	2.06E-01
10	1.2281	12120	9.73	1.07E+04	2.89E-01
15	1.7056	16833	13.52	1.49E+04	4.02E-01
20	**2.3388**	**23082**	**18.54**	**2.04E+04**	**5.51E-01**
25	3.1690	31276	25.12	2.76E+04	7.47E-01
30	4.2455	41900	33.65	3.70E+04	1.00E+00

[1] Assumes air saturated with water vapour (I.e. 100% relative humidity)

[2] Calculate the volume of liquid water (or weight, assuming a density of 1) in 1 cubic meter of air

Vapour Pressure data is from the CRC Handbook (Vol 71, p 6-12)

22.414 Litres per Mole is the molar volume of a perfect gas.

18 g/more is the molar mass of water.

1000 litres per m^3

REDACTED

[redacted] sludge):

NO LONGER RECEIVING WASTE

Premises:

- Tanks are actively vented to individual vaults, which in turn are collectively vented to atmosphere via 4" by 8" ventilation slots. Assume 1 m^3/s to the atmosphere.
- Max tank volumes are used.
- Contaminant concentrations in tanks remain constant.
- Tank assumed to vent directly to building air instead of first to vault.

Contaminant	Max Contaminant Concentration in Tank (Bq/mL) [214-106170-TD-001 Rev 6]	Other than Tritium: Use tank's total inventory & DOE ARR				Tritium	Fan Exhaust Rate (m^3/s)	Emission (Bq/s)	Emission (Bq/wk)	# of Tanks	Derived Release Limit (Bq/wk) [CRL-509200-RRD-001 Rev 3]	%DRL	EVMP Monitoring Criterion (c) [900-509200-STD-009]: >0.0005 mSv to off-site critical group, i.e. > 0.05%DRL?
		Tank Volume (m^3) [214-106170-TD-001 Rev 6]	Total Activity in Tank (Bq)	Airborne Release Rate Per Second [DOE p.3-40, Table 3-10]	Activity Released to Building Air (Bq/s)	Building Air Concentration (Bq/m^3)							
Gross Alpha:	1.60E+02	12.7	2.03E+09	1.0E-14	2.03E-05		1	2.03E-05	1.23E+01	4	6.17E+08	7.97E-06	NO
Gross Beta:	1.10E+05	12.7	1.40E+12	1.0E-14	1.40E-02		1	1.40E-02	8.45E+03	4	7.48E+09	4.52E-04	NO
Tritium:	2.79E+01					5.17E+01	1	5.17E+01	3.13E+07	4	3.98E+14	3.14E-05	NO
I-129:	2.23E-03	12.7	2.83E+04	1.0E-14	2.83E-10		1	2.83E-10	1.71E-04	4	4.26E+09	1.61E-11	NO
Total:												**4.91E-04**	**NO**

REDACTED

[redacted]

NO LONGER RECEIVING WASTE

Premises:

- Tanks are actively vented to individual vaults, and then collectively vented to the atmosphere via Fan [redacted]

[redacted]	0.071 m3/s	0.023	m3/s
	0.071 m3/s	0.023	m3/s
	0.071 m3/s	0.023	m3/s
	0.071 m3/s	0.023	m3/s
Fan [redacted] to atmosphere:	0.33 m3/s		

- Max tank volumes are used.
- Contaminant concentrations in tanks remain constant.
- Tank assumed to vent directly to building air instead of first to vault.
- HEPA removal efficiency applied to the final assessment for gross alpha and gross beta.

Tank [redacted]

Contaminant	Max Contaminant Concentration in Tank (Bq/mL) [214-106170-TD-001 Rev 6]	Other than Tritium: Use tank's total inventory & DOE ARR				Tritium	Fan Exhaust Rate (m^3/s)	Emission (Bq/s)	Emission (Bq/wk)	# of Tanks	Derived Release Limit (Bq/wk) [CRL-509200-RRD-001 Rev 3]	%DRL	EVMP Monitoring Criterion (c) [900-509200-STD-009]: >0.0005 mSv to off-site critical group, i.e. > 0.05%DRL?
		Tank Volume (m^3) [214-106170-TD-001 Rev 6]	Total Activity in Tank (Bq)	Airborne Release Rate Per Second [DOE p.3-40, Table 3-10]	Activity Released to Building Air (Bq/s)	Building Air Concentration (Bq/m^3)							
Gross Alpha:	2.45E+01	47.2	1.16E+09	1.0E-14	1.16E-05		0.023	1.16E-05	6.99E+00	1	6.17E+08	1.13E-06	NO
Gross Beta:	1.51E+05	47.2	7.13E+12	1.0E-14	7.13E-02		0.023	7.13E-02	4.31E+04	1	7.48E+09	5.76E-04	NO
I-129:	5.75E-02	47.2	2.71E+06	1.0E-14	2.71E-08		0.023	2.71E-08	1.64E-02	1	4.26E+09	3.85E-10	NO

Tank [redacted]

Contaminant	Max Contaminant Concentration in Tank (Bq/mL) [214-106170-TD-001 Rev 6]	Other than Tritium: Use tank's total inventory & DOE ARR				Tritium	Fan Exhaust Rate (m^3/s)	Emission (Bq/s)	Emission (Bq/wk)	# of Tanks	Derived Release Limit (Bq/wk) [CRL-509200-RRD-001 Rev 3]	%DRL	EVMP Monitoring Criterion (c) [900-509200-STD-009]: >0.0005 mSv to off-site critical group, i.e. > 0.05%DRL?
		Tank Volume (m^3) [214-106170-TD-001 Rev 6]	Total Activity in Tank (Bq)	Airborne Release Rate Per Second [DOE p.3-40, Table 3-10]	Activity Released to Building Air (Bq/s)	Building Air Concentration (Bq/m^3)							
Gross Alpha:	8.00E+03	47.2	3.78E+11	1.0E-14	3.78E-03		0.023	3.78E-03	2.28E+03	1	6.17E+08	3.70E-04	NO
Gross Beta:	2.41E+05	47.2	1.14E+13	1.0E-14	1.14E-01		0.023	1.14E-01	6.88E+04	1	7.48E+09	9.20E-04	NO
Tritium:	1.22E+02					2.26E+02	0.023	5.21E+00	3.15E+06	1	3.98E+14	7.92E-07	NO
I-129:	4.20E-02	47.2	1.98E+06	1.0E-14	1.98E-08		0.023	1.98E-08	1.20E-02	1	4.26E+09	2.81E-10	NO

REDACTED

Tank [redacted]

Contaminant	Max Contaminant Concentration in Tank (Bq/mL) [214-106170-TD-001 Rev 6]	Other than Tritium: Use tank's total inventory & DOE ARR				Tritium	Fan Exhaust Rate (m^3/s)	Emission (Bq/s)	Emission (Bq/wk)	# of Tanks	Derived Release Limit (Bq/wk) [CRL-509200-RRD-001 Rev 3]	%DRL	EVMP Monitoring Criterion (c) [900-509200-STD-000]: >0.0005 mSv to off-site critical group, i.e. > 0.05%DRL?
		Tank Volume (m^3) [214-106170-TD-001 Rev 6]	Total Activity in Tank (Bq)	Airborne Release Rate Per Second [DOE p.3-40, Table 3-10]	Activity Released to Building Air (Bq/s)	Building Air Concentration (Bq/m^3)							
Gross Alpha:	4.56E+03	47.2	2.15E+11	1.0E-14	2.15E-03		0.023	2.15E-03	1.30E+03	1	6.17E+08	2.11E-04	NO
Gross Beta:	1.73E+05	47.2	8.17E+12	1.0E-14	8.17E-02		0.023	8.17E-02	4.94E+04	1	7.48E+09	6.60E-04	NO
Tritium:							0.023	0.00E+00	0.00E+00	1	3.98E+14	0.00E+00	NO
I-129:	5.95E-02	47.2	2.81E+06	1.0E-14	2.81E-08		0.023	2.81E-08	1.70E-02	1	4.26E+09	3.99E-10	NO

Tank [redacted]

Contaminant	Max Contaminant Concentration in Tank (Bq/mL) [214-106170-TD-001 Rev 6]	Other than Tritium: Use tank's total inventory & DOE ARR				Tritium	Fan Exhaust Rate (m^3/s)	Emission (Bq/s)	Emission (Bq/wk)	# of Tanks	Derived Release Limit (Bq/wk) [CRL-509200-RRD-001 Rev 3]	%DRL	EVMP Monitoring Criterion (c) [900-509200-STD-009]: >0.0005 mSv to off-site critical group, i.e. > 0.05%DRL?
		Tank Volume (m^3) [214-106170-TD-001 Rev 6]	Total Activity in Tank (Bq)	Airborne Release Rate Per Second [DOE p.3-40, Table 3-10]	Activity Released to Building Air (Bq/s)	Building Air Concentration (Bq/m^3)							
Gross Alpha:	5.80E+02	47.2	2.74E+10	1.0E-14	2.74E-04		0.023	2.74E-04	1.66E+02	1	6.17E+08	2.68E-05	NO
Gross Beta:	1.34E+07	47.2	6.31E+14	1.0E-14	6.31E+00		0.023	6.31E+00	3.82E+06	1	7.48E+09	5.10E-02	YES
Tritium:	1.29E+02					2.39E+02	0.023	5.50E+00	3.33E+06	1	3.98E+14	8.36E-07	NO
I-129:	2.05E-01	47.2	9.68E+06	1.0E-14	9.68E-08		0.023	9.68E-08	5.85E-02	1	4.26E+09	1.37E-09	NO

Total Emissions from this Effluent Stream

Contaminant	Sum (%DRL)	HEPA Filter Present?	Charcoal Filter Present?	Mitigated Release - HEPA filtration (%DRL)	EVMP Monitoring Criterion (c) [900-509200-STD-009]: >0.0005 mSv to off-site critical group, i.e. > 0.05%DRL?
Gross Alpha:	6.09E-04	YES	NA	6.09E-05	NO
Gross Beta:	5.32E-02	YES	NA	5.32E-03	NO
Tritium:	1.63E-06	NA	NA	1.63E-06	NO
I-129:	2.44E-09	NA	NO	2.44E-09	NO
TOTAL:	**5.38E-02**			**5.38E-03**	NO

REDACTED

[redacted]

NO LONGER RECEIVING WASTE [except for Tank [redacted]]

Premises:

- Tanks are actively vented to individual vaults, and then collectively vented to the atmosphere via Fan [redacted]:

[redacted]	0.212 m3/s	0.170	m3/s
	0.566 m3/s	0.454	m3/s
	0.212 m3/s	0.170	m3/s
	0.33 m3/s	0.265	m3/s
	0.33 m3/s	0.265	m3/s
	0.33 m3/s	0.265	m3/s
Fan [redacted] to atmosphere:	0.802 m3/s		

- Max tank volumes are used.
- Contaminant concentrations in tanks remain constant.
- Tank assumed to vent directly to building air instead of first to vault.

Tank [redacted]

Contaminant	Max Contaminant Concentration in Tank (Bq/mL) [214-106170-TD-001 Rev 6]	Other than Tritium: Use tank's total inventory & DOE ARR				Tritium	Fan Exhaust Rate (m^3/s)	Emission (Bq/s)	Emission (Bq/wk)	# of Tanks	Derived Release Limit (Bq/wk) [CRL-509200-RRD-001 Rev 3]	%DRL	EVMP Monitoring Criterion (c) [900-509200-STD-009]: >0.0005 mSv to off-site critical group, i.e. > 0.05%DRL?
		Tank Volume (m^3) [214-106170-TD-001 Rev 6]	Total Activity in Tank (Bq)	Airborne Release Rate Per Second [DOE p.3-40, Table 3-10]	Activity Released to Building Air (Bq/s)	Building Air Concentration (Bq/m^3)							
Gross Alpha:	4.44E+00	47.2	2.10E+08	1.0E-14	2.10E-06		0.170	2.10E-06	1.27E+00	1	6.17E+08	2.05E-07	NO
Gross Beta:	6.60E+03	47.2	3.12E+11	1.0E-14	3.12E-03		0.170	3.12E-03	1.88E+03	1	7.48E+09	2.52E-05	NO
Tritium:	1.02E+05					1.89E+05	0.170	3.21E+04	1.94E+10	1	3.98E+14	4.88E-03	NO
I-129:	1.91E-03	47.2	9.02E+04	1.0E-14	9.02E-10		0.170	9.02E-10	5.45E-04	1	4.26E+09	1.28E-11	NO

Tank [redacted]

Contaminant	Max Contaminant Concentration in Tank (Bq/mL) [214-106170-TD-001 Rev 6]	Other than Tritium: Use tank's total inventory & DOE ARR				Tritium	Fan Exhaust Rate (m^3/s)	Emission (Bq/s)	Emission (Bq/wk)	# of Tanks	Derived Release Limit (Bq/wk) [CRL-509200-RRD-001 Rev 3]	%DRL	EVMP Monitoring Criterion (c) [900-509200-STD-009]: >0.0005 mSv to off-site critical group, i.e. > 0.05%DRL?
		Tank Volume (m^3) [214-106170-TD-001 Rev 6]	Total Activity in Tank (Bq)	Airborne Release Rate Per Second [DOE p.3-40, Table 3-10]	Activity Released to Building Air (Bq/s)	Building Air Concentration (Bq/m^3)							
Gross Alpha:	1.80E+02	47.2	8.50E+09	1.0E-14	8.50E-05		0.454	8.50E-05	5.14E+01	1	6.17E+08	8.33E-06	NO
Gross Beta:	1.12E+04	47.2	5.29E+11	1.0E-14	5.29E-03		0.454	5.29E-03	3.20E+03	1	7.48E+09	4.27E-05	NO
Tritium:	4.78E+03					8.86E+03	0.454	4.02E+03	2.43E+09	1	3.98E+14	6.11E-04	NO
I-129:	1.85E-03	47.2	8.73E+04	1.0E-14	8.73E-10		0.454	8.73E-10	5.28E-04	1	4.26E+09	1.24E-11	NO

REDACTED

Tank [redacted]

Contaminant	Max Contaminant Concentration in Tank (Bq/mL) [214-106170-TD-001 Rev 6]	Other than Tritium: Use tank's total inventory & DOE ARR				Tritium	Fan Exhaust Rate (m^3/s)	Emission (Bq/s)	Emission (Bq/wk)	# of Tanks	Derived Release Limit (Bq/wk) [CRL-509200-RRD-001 Rev 3]	%DRL	EVMP Monitoring Criterion (c) [900-509200-STD-009]: >0.0005 mSv to off-site critical group, i.e. > 0.05%DRL?
		Tank Volume (m^3) [214-106170-TD-001 Rev 6]	Total Activity in Tank (Bq)	Airborne Release Rate Per Second [DOE p.3-40, Table 3-10]	Activity Released to Building Air (Bq/s)	Building Air Concentration (Bq/m^3)							
Gross Alpha:	5.16E+03	47.2	2.44E+11	1.0E-14	2.44E-03		0.170	2.44E-03	1.47E+03	1	6.17E+08	2.39E-04	NO
Gross Beta:	8.12E+01	47.2	3.83E+09	1.0E-14	3.83E-05		0.170	3.83E-05	2.32E+01	1	7.48E+09	3.10E-07	NO
Tritium:	5.16E+03					9.56E+03	0.170	1.63E+03	9.84E+08	1	3.98E+14	2.47E-04	NO
I-129:	1.84E-03	47.2	8.68E+04	1.0E-14	8.68E-10		0.170	8.68E-10	5.25E-04	1	4.26E+09	1.23E-11	NO

Tank [redacted] sludge)

Contaminant	Max Contaminant Concentration in Tank (Bq/mL) [214-106170-TD-001 Rev 6]	Other than Tritium: Use tank's total inventory & DOE ARR				Tritium	Fan Exhaust Rate (m^3/s)	Emission (Bq/s)	Emission (Bq/wk)	# of Tanks	Derived Release Limit (Bq/wk) [CRL-509200-RRD-001	%DRL	EVMP Monitoring Criterion (c) [900-509200-STD-009]: >0.0005 mSv to off-site critical group, i.e. > 0.05%DRL?
		Tank Volume (m^3) [214-106170-TD-001 Rev 6]	Total Activity in Tank (Bq)	Airborne Release Rate Per Second [DOE p.3-40, Table 3-10]	Activity Released to Building Air (Bq/s)	Building Air Concentration (Bq/m^3)							
Gross Alpha:	2.80E+05	18	5.04E+12	1.0E-14	5.04E-02		0.265	5.04E-02	3.05E+04	1	6.17E+08	4.94E-03	NO
Gross Beta:	2.54E+05	18	4.57E+12	1.0E-14	4.57E-02		0.265	4.57E-02	2.77E+04	1	7.48E+09	3.70E-04	NO
Tritium:	8.93E+01					1.66E+03	0.265	4.38E+02	2.65E+08	1	3.98E+14	6.66E-05	NO
I-129:	2.45E-02	18	4.41E+05	1.0E-14	4.41E-09		0.265	4.41E-09	2.67E-03	1	4.26E+09	6.26E-11	NO

Tank [redacted] (sludge)

Contaminant	Max Contaminant Concentration in Tank (Bq/mL) [214-106170-TD-001 Rev 6]	Other than Tritium: Use tank's total inventory & DOE ARR				Tritium	Fan Exhaust Rate (m^3/s)	Emission (Bq/s)	Emission (Bq/wk)	# of Tanks	Derived Release Limit (Bq/wk) [CRL-509200-RRD-001 Rev 3]	%DRL	EVMP Monitoring Criterion (c) [900-509200-STD-009]: >0.0005 mSv to off-site critical group, i.e. > 0.05%DRL?
		Tank Volume (m^3) [214-106170-TD-001 Rev 6]	Total Activity in Tank (Bq)	Airborne Release Rate Per Second [DOE p.3-40, Table 3-10]	Activity Released to Building Air (Bq/s)	Building Air Concentration (Bq/m^3)							
Gross Alpha:	6.76E+04	18.2	1.23E+12	1.0E-14	1.23E-02		0.265	1.23E-02	7.44E+03	1	6.17E+08	1.21E-03	NO
Gross Beta:	1.29E+05	18.2	2.35E+12	1.0E-14	2.35E-02		0.265	2.35E-02	1.42E+04	1	7.48E+09	1.90E-04	NO
Tritium:	4.47E+01					8.26E+01	0.265	2.19E+01	1.32E+07	1	3.98E+14	3.32E-06	NO
I-129:	5.13E-03	18.2	9.34E+04	1.0E-14	9.34E-10		0.265	9.34E-10	5.65E-04	1	4.26E+09	1.33E-11	NO

REDACTED

Tank [redacted] sludge)

Contaminant	Max Contaminant Concentration in Tank (Bq/mL) [214-106170-TD-001 Rev 6]	Other than Tritium: Use tank's total inventory & DOE ARR				Tritium	Fan Exhaust Rate (m^3/s)	Emission (Bq/s)	Emission (Bq/wk)	# of Tanks	Derived Release Limit (Bq/wk) [CRL-509200-RRD-001 Rev 3]	%DRL	EVMP Monitoring Criterion (c) [900-509200-STD-009]: >0.0005 mSv to off-site critical group, i.e. > 0.05%DRL?
		Tank Volume (m^3) [214-106170-TD-001 Rev 6]	Total Activity in Tank (Bq)	Airborne Release Rate Per Second [DOE p.3-40, Table 3-10]	Activity Released to Building Air (Bq/s)	Building Air Concentration (Bq/m^3)							
Gross Alpha:	7.80E+03	12.7	9.91E+10	1.00E-14	9.91E-04		0.265	9.91E-04	5.99E+02	1	6.17E+08	9.71E-05	NO
Gross Beta:	2.01E+05	12.7	2.55E+12	1.00E-14	2.55E-02		0.265	2.55E-02	1.54E+04	1	7.48E+09	2.06E-04	NO
Tritium:							0.265	0.00E+00	0.00E+00	1	3.98E+14	0.00E+00	NO
I-129:	2.68E-02	12.7	3.40E+05	1.00E-14	3.40E-09		0.265	3.40E-09	2.06E-03	1	4.26E+09	4.83E-11	NO

Total Emissions from this Effluent Stream

Contaminant	Sum (%DRL)	EVMP Monitoring Criterion (c) [900-509200-STD-009]: >0.0005 mSv to off-site critical group, i.e. > 0.05%DRL?
Gross Alpha:	6.49E-03	NO
Gross Beta:	8.34E-04	NO
Tritium:	5.81E-03	NO
I-129:	1.62E-10	NO
TOTAL:	**1.31E-02**	NO

REDACTED

[redacted]

NO LONGER RECEIVING WASTE

Premises:

- Fugitive Emission (each tank is passively vented to atmosphere via its own 5 cm ventilation slot).
- Assume 5E-06 m^3/s dissipation to the atmosphere via this slot for each tank (based on empiricial data for [redacted].
- Tank [redacted] is empty.
- Contaminant concentrations in tanks remain constant.

Tank [redacted] (sludge)

Contaminant	Max Contaminant Concentration in Tank (Bq/mL) [214-106170-TD-001 Rev 6]	Other than Tritium: Use tank's total inventory & DOE ARR				Tritium	Fan Exhaust Rate (m^3/s)	Emission (Bq/s)	Emission (Bq/wk)	# of Tanks	Derived Release Limit (Bq/wk) [CRL-509200-RRD-001 Rev 3]	%DRL	EVMP Monitoring Criterion (c) [900-509200-STD-009]: >0.0005 mSv to off-site critical group, i.e. > 0.05%DRL?
		Tank Volume (m^3) [214-106170-TD-001 Rev 6]	Total Activity in Tank (Bq)	Airborne Release Rate Per Second [DOE p.3-40, Table 3-10]	Activity Released to Building Air (Bq/s)	Building Air Concentration (Bq/m^3)							
Gross Alpha:	9.77E+03	6.5	6.35E+10	1.0E-14	6.35E-04		5.E-06	6.35E-04	3.84E+02	1	6.17E+08	6.22E-05	NO
Gross Beta:	4.47E+06	6.5	2.91E+13	1.0E-14	2.91E-01		5.E-06	2.91E-01	1.76E+05	1	7.48E+09	2.35E-03	NO
Tritium:	2.05E+02					3.80E+02	5.E-06	1.90E-03	1.15E+03	1	3.98E+14	2.89E-10	NO
I-129:	2.07E-01	6.5	1.35E+06	1.0E-14	1.35E-08		5.E-06	1.35E-08	8.14E-03	1	4.26E+09	1.91E-10	NO
TOTAL:												**2.41E-03**	NO

Tank [redacted]

Contaminant	Max Contaminant Concentration in Tank (Bq/mL) [214-106170-TD-001 Rev 6]	Other than Tritium: Use tank's total inventory & DOE ARR				Tritium	Fan Exhaust Rate (m^3/s)	Emission (Bq/s)	Emission (Bq/wk)	# of Tanks	Derived Release Limit (Bq/wk) [CRL-509200-RRD-001 Rev 3]	%DRL	EVMP Monitoring Criterion (c) [900-509200-STD-009]: >0.0005 mSv to off-site critical group, i.e. > 0.05%DRL?
		Tank Volume (m^3) [214-106170-TD-001 Rev 6]	Total Activity in Tank (Bq)	Airborne Release Rate Per Second [DOE p.3-40, Table 3-10]	Activity Released to Building Air (Bq/s)	Building Air Concentration (Bq/m^3)							
Gross Alpha:	5.38E+00	1.18	6.35E+06	1.0E-14	6.35E-08		5.E-06	6.35E-08	3.84E-02	1	6.17E+08	6.22E-09	NO
Gross Beta:	1.02E+06	1.18	1.21E+12	1.0E-14	1.21E-02		5.E-06	1.21E-02	7.29E+03	1	7.48E+09	9.75E-05	NO
Tritium:	1.26E+01					2.36E+01	5.E-06	1.18E-04	7.12E+01	1	3.98E+14	1.79E-11	NO
I-129:		1.18	0.00E+00	1.0E-14	0.00E+00		5.E-06	0.00E+00	0.00E+00	1	4.26E+09	0.00E+00	NO
TOTAL:												**9.75E-05**	NO

Tank [redacted] (sludge)

Contaminant	Max Contaminant Concentration in Tank (Bq/mL) [214-106170-TD-001 Rev 6]	Other than Tritium: Use tank's total inventory & DOE ARR				Tritium	Fan Exhaust Rate (m^3/s)	Emission (Bq/s)	Emission (Bq/wk)	# of Tanks	Derived Release Limit (Bq/wk) [CRL-509200-RRD-001 Rev 3]	%DRL	EVMP Monitoring Criterion (c) [900-509200-STD-009]: >0.0005 mSv to off-site critical group, i.e. > 0.05%DRL?
		Tank Volume (m^3) [214-106170-TD-001 Rev 6]	Total Activity in Tank (Bq)	Airborne Release Rate Per Second [DOE p.3-40, Table 3-10]	Activity Released to Building Air (Bq/s)	Building Air Concentration (Bq/m^3)							
Gross Alpha:		0.05	0.00E+00	1.0E-14	0.00E+00		5.E-06	0.00E+00	0.00E+00	1	6.17E+08	0.00E+00	NO
Gross Beta:		0.05	0.00E+00	1.0E-14	0.00E+00		5.E-06	0.00E+00	0.00E+00	1	7.48E+09	0.00E+00	NO
Tritium:	1.26E+01					2.36E+01	5.E-06	1.18E-04	7.12E+01	1	3.98E+14	1.79E-11	NO
I-129:		0.05	0.00E+00	1.0E-14	0.00E+00		5.E-06	0.00E+00	0.00E+00	1	4.26E+09	0.00E+00	NO
TOTAL:												**1.79E-11**	NO

REDACTED

Tank [redacted]

Contaminant	Max Contaminant Concentration in Tank (Bq/mL) [214-106170-TD-001 Rev 6]	Other than Tritium: Use tank's total inventory & DOE ARR				Tritium	Fan Exhaust Rate (m^3/s)	Emission (Bq/s)	Emission (Bq/wk)	# of Tanks	Derived Release Limit (Bq/wk) [CRL-509200-RRD-001 Rev 3]	%DRL	EVMP Monitoring Criterion (c) [900-509200-STD-009]: >0.0005 mSv to off-site critical group, i.e. > 0.05%DRL?
		Tank Volume (m^3) [214-106170-TD-001 Rev 6]	Total Activity in Tank (Bq)	Airborne Release Rate Per Second [DOE p.3-40, Table 3-10]	Activity Released to Building Air (Bq/s)	Building Air Concentration (Bq/m^3)							
Gross Alpha:	1.72E+05	7.3	1.26E+12	1.0E-14	1.26E-02		5.E-06	1.26E-02	7.59E+03	1	6.17E+08	1.23E-03	NO
Gross Beta:	7.96E+07	7.3	5.81E+14	1.0E-14	5.81E+00		5.E-06	5.81E+00	3.51E+06	1	7.48E+09	4.70E-02	NO
Tritium:							5.E-06	0.00E+00	0.00E+00	1	3.98E+14	0.00E+00	NO
I-129:		7.3	0.00E+00	1.0E-14	0.00E+00		5.E-06	0.00E+00	0.00E+00	1	4.26E+09	0.00E+00	NO
TOTAL:												**4.82E-02**	NO

Tank [redacted]

Contaminant	Max Contaminant Concentration in Tank (Bq/mL) [214-106170-TD-001 Rev 6]	Other than Tritium: Use tank's total inventory & DOE ARR				Tritium	Fan Exhaust Rate (m^3/s)	Emission (Bq/s)	Emission (Bq/wk)	# of Tanks	Derived Release Limit (Bq/wk) [CRL-509200-RRD-001 Rev 3]	%DRL	EVMP Monitoring Criterion (c) [900-509200-STD-009]: >0.0005 mSv to off-site critical group, i.e. > 0.05%DRL?
		Tank Volume (m^3) [214-106170-TD-001 Rev 6]	Total Activity in Tank (Bq)	Airborne Release Rate Per Second [DOE p.3-40, Table 3-10]	Activity Released to Building Air (Bq/s)	Building Air Concentration (Bq/m^3)							
Gross Alpha:	7.50E+04	1.8	1.35E+11	1.0E-14	1.35E-03		5.E-06	1.35E-03	8.16E+02	1	6.17E+08	1.32E-04	NO
Gross Beta:	1.15E+07	1.8	2.07E+13	1.0E-14	2.07E-01		5.E-06	2.07E-01	1.25E+05	1	7.48E+09	1.67E-03	NO
Tritium:							5.E-06	0.00E+00	0.00E+00	1	3.98E+14	0.00E+00	NO
I-129:		1.8	0.00E+00	1.0E-14	0.00E+00		5.E-06	0.00E+00	0.00E+00	1	4.26E+09	0.00E+00	NO
TOTAL:												**1.81E-03**	NO

Tank [redacted]

Contaminant	Max Contaminant Concentration in Tank (Bq/mL) [214-106170-TD-001 Rev 6]	Other than Tritium: Use tank's total inventory & DOE ARR				Tritium	Fan Exhaust Rate (m^3/s)	Emission (Bq/s)	Emission (Bq/wk)	# of Tanks	Derived Release Limit (Bq/wk) [CRL-509200-RRD-001 Rev 3]	%DRL	EVMP Monitoring Criterion (c) [900-509200-STD-009]: >0.0005 mSv to off-site critical group, i.e. > 0.05%DRL?
		Tank Volume (m^3) [214-106170-TD-001 Rev 6]	Total Activity in Tank (Bq)	Airborne Release Rate Per Second [DOE p.3-40, Table 3-10]	Activity Released to Building Air (Bq/s)	Building Air Concentration (Bq/m^3)							
Gross Alpha:	1.15E+05	6.4	7.36E+11	1.0E-14	7.36E-03		5.E-06	7.36E-03	4.45E+03	1	6.17E+08	7.21E-04	NO
Gross Beta:	4.84E+07	6.4	3.10E+14	1.0E-14	3.10E+00		5.E-06	3.10E+00	1.87E+06	1	7.48E+09	2.50E-02	NO
Tritium:							5.E-06	0.00E+00	0.00E+00	1	3.98E+14	0.00E+00	NO
I-129:		6.4	0.00E+00	1.0E-14	0.00E+00		5.E-06	0.00E+00	0.00E+00	1	4.26E+09	0.00E+00	NO
TOTAL:												**2.57E-02**	NO

REDACTED

[redacted] - MPF Active Drain Waste

OPERATIONAL

Premises:

- 3" stainless steel vent line direct to building air which is then exhausted via building exhaust fan [redacted] at 0.223 m^3/s (this is faster than Fan [redacted])
- For contaminants other than tritium, two tank states are considered and added to obtain a weekly release:
  - (1) Static State: Maximum tank volume is assumed, and an airborne resuspension release rate (ARR) from aerodynamic entrainment is applied
  - (2) Waste Transfer State: [redacted] is the only active tank in 2025 and receives approximately 3 transfers a year, and an airborne resuspension factor (ARF) from free fall spill is applied
- For tritium, 100% relative humidity is assumed such that the air is saturated with tritium.
- Contaminant concentrations in tanks remain constant.

Tanks [redacted] Guard Tank (except tritium)

Contaminant	A Contaminant Concentrations in Tank (Bq/mL) ["CAD" from Table 1 of NSN-318/ADS-05424-SAR-1]	STATIC STATE EMISSION Use tank's total inventory & DOE ARR applicable to static condition B Max. Tank Volume (m^3) [NSN-318/ADS-05424-SAR-1]	C Total Activity in Tank (Bq) [A*B*1,000,000]	D Airborne Release Rate Per Second [DOE p.3-40, Section 3.2.4.2, Table 3-10]	E Activity Released to Building Air (Bq/s) [C*D]	F Emission Per Tank (Bq/wk) [G*604800]	G # of Tanks	H Emission (Bq/wk) [F*G]	WASTE TRANSFER STATE EMISSION Use B205 processed volumes & DOE ARF applicable to waste transfer condition I Total Annual Transfer Volume (m^3/a) [WTC Staff Records]	J Annual Activity Transferred (Bq/a) [A*I*1,000,000]	K Airborne Release Fraction [DOE, Section 3.2.3.1]	L Annual Airborne Release (Bq/a) [J*K]	M Emission (Bq/wk) [L/52wks]	Total Emission (Bq/wk) [H+M]	Derived Release Limit (Bq/wk) [CRL-509200-RRD-001 Rev 3]	%DRL	EVMP Monitoring Criterion (c) : >0.0005 mSv to off-site critical group, i.e. > 0.05%DRL? [900-509200-STD-009]
Gross Alpha:	5.1E-01	25	1.28E+07	1.0E-14	1.28E-07	7.71E-02	5	3.86E-01	75	4.E+07	2.E-04	7.65E+03	1.47E+02	1.48E+02	6.17E+08	2.39E-05	**NO**
Gross Beta:	4.2E+03	25	1.05E+11	1.0E-14	1.05E-03	6.35E+02	5	3.18E+03	75	3.E+11	2.E-04	6.30E+07	1.21E+06	1.21E+06	7.48E+09	1.62E-02	**NO**
I-131:	1.3E+00	25	3.25E+07	1.0E-14	3.25E-07	1.97E-01	5	9.83E-01	75	1.E+08	2.E-04	1.95E+04	3.75E+02	3.76E+02	1.53E+11	2.46E-07	**NO**

Tanks [redacted] Guard Tank (tritium)

Contaminant	Contaminant Concentrations in Tank (Bq/mL) ["CAD" from Table 1 of NSN-318/ADS-05424-SAR-1]	Building Air Concentration (Bq/m^3) [From inserting concentration in Table 1]	Fan Exhaust Rate (m^3/s)	Emission Per Tank (Bq/wk)	# of Tanks	Emission (Bq/wk)	Derived Release Limit (Bq/wk) [CRL-509200-RRD-001 Rev 3]	%DRL	EVMP Monitoring Criterion (c) : >0.0005 mSv to off-site critical group, i.e. > 0.05%DRL? [900-509200-STD-009]
Tritium:	2.7E+03	5.00E+04	0.233	7.05E+09	5	3.53E+10	3.98E+14	8.86E-03	**NO**

Total Emissions from this Effluent Stream

Contaminant	Sum (%DRL)	EVMP Monitoring Criterion (c) : >0.0005 mSv to off-site critical group, i.e. > 0.05%DRL? [900-509200-STD-009]
Gross Alpha:	2.39E-05	**NO**
Gross Beta:	1.62E-02	**NO**
I-131:	2.46E-07	**NO**
Tritium:	8.86E-03	**NO**
TOTAL:	**2.51E-02**	**NO**

REDACTED

[redacted] - Decontamination Waste (DC)

OPERATIONAL

Premises:

- Open top tanks venting direct to building air which is then exhausted via building exhaust at assumed 1 m^3/s.
- For contaminants other than tritium, two tank states are considered and added to obtain a weekly release:
  - (1) Static State: Maximum tank volume is assumed, and an airborne resuspension release rate (ARR) from aerodynamic entrainment is applied (used a more conservative ARR of 4E-07/h or 1E-10/s because tanks are open top and exposed to forced building ventilation)
  - (2) Waste Transfer State: Average of annual processed volumes 2019 to 2023 + 10% cushion is assumed, and an airborne resuspension factor (ARF) from free fall spill is applied
- For tritium, 100% relative humidity is assumed such that the air is saturated with tritium.
- Contaminant concentrations in tanks remain constant.

Tank [redacted] (except tritium)

		STATIC STATE EMISSION Use tank's total inventory & DOE ARR applicable to static condition							WASTE TRANSFER STATE EMISSION Use Avg (2019 to 2023) processed volumes + 10% & DOE ARF applicable to waste transfer condition								
Contaminant	**A** Contaminant Concentrations in Tank (Bq/mL) ["DC" from Table 1 of NSN-318/ADS-05424-SAR-1]	**B** Max. Tank Volume (m^3) [NSN-318/ADS-05424-SAR-1]	**C** Total Activity in Tank (Bq) [A*B*1,000,000]	**D** Airborne Release Rate Per Second [DOE p.3-40, Section 3.2.4.2, Table 3-10]	**E** Activity Released to Building Air (Bq/s) [C*D]	**F** Emission Per Tank (Bq/wk) [G*604800]	**G** # of Tanks	**H** Emission (Bq/wk) [F*G]	**I** Total Annual Transfer Volume (m^3/a) [CRL-00583-ACMR-2023]	**J** Annual Activity Transferred (Bq/a) [A*I*1,000,000]	**K** Airborne Release Fraction [DOE, Section 3.2.3.1]	**L** Annual Airborne Release (Bq/a) [J*K]	**M** Emission (Bq/wk) [L/52wks]	**Total Emission (Bq/wk)** [H+M]	**Derived Release Limit (Bq/wk)** [CRL-509200-RRD-001 Rev 3]	**%DRL**	**EVMP Monitoring Criterion (c) : >0.0005 mSv to off-site critical group, i.e. > 0.05%DRL?** [900-509200-STD-009]
Gross Alpha:	3.2E+00	55	1.76E+08	1.0E-10	1.76E-02	1.06E+04	2	2.13E+04	382	1.E+09	2.E-04	2.44E+05	4.70E+03	2.60E+04	6.17E+08	4.21E-03	**NO**
Gross Beta:	2.9E+02	55	1.60E+10	1.0E-10	1.60E+00	9.65E+05	2	1.93E+06	382	1.E+11	2.E-04	2.22E+07	4.26E+05	2.36E+06	7.48E+09	3.15E-02	**NO**
I-131:	9.0E-01	55	4.95E+07	1.0E-10	4.95E-03	2.99E+03	2	5.99E+03	382	3.E+08	2.E-04	6.88E+04	1.32E+03	7.31E+03	1.53E+11	4.78E-06	**NO**

Tank [redacted] (tritium)

Contaminant	**Contaminant Concentrations in Tank (Bq/mL)** ["DC" from Table 1 of NSN-318/ADS-05424-SAR-1]	**Building Air Concentration (Bq/m^3)** [From inserting concentration in Table 1]	**Fan Exhaust Rate (m^3/s)**	**Emission Per Tank (Bq/wk)**	**# of Tanks**	**Emission (Bq/wk)**	**Derived Release Limit (Bq/wk)** [CRL-509200-RRD-001 Rev 3]	**%DRL**	**EVMP Monitoring Criterion (c) : >0.0005 mSv to off-site critical group, i.e. > 0.05%DRL?** [900-509200-STD-009]
Tritium:	1.1E+03	2.04E+04	1.000	1.23E+10	2	2.47E+10	3.98E+14	6.20E-03	**NO**

Total Emissions from this Effluent Stream

Contaminant	**Sum (%DRL)**	**EVMP Monitoring Criterion (c) : >0.0005 mSv to off-site critical group, i.e. > 0.05%DRL?** [900-509200-STD-009]
Gross Alpha:	4.21E-03	**NO**
Gross Beta:	3.15E-02	**NO**
I-131:	4.78E-06	**NO**
Tritium:	6.20E-03	**NO**
TOTAL:	**4.19E-02**	**NO**

REDACTED

[redacted] - Chemical Active Drain Waste (CAD)

OPERATIONAL

Premises:

- Open top tanks venting direct to building air which is then exhausted via building exhaust at 0.436 m3/s.
- For contaminants other than tritium, two tank states are considered and added to obtain a weekly release:
  - (1) Static State: Maximum tank volume is assumed, and an airborne resuspension release rate (ARR) from aerodynamic entrainment is applied (used a more conservative ARR of 4E-07/h or 1E-10/s because tanks are open top and exposed to forced building ventilation)
  - (2) Waste Transfer State: Average of annual processed volumes 2019 to 2023 + 10% cushion is assumed, and an airborne resuspension factor (ARF) from free fall spill is applied
- For tritium, 100% relative humidity is assumed such that the air is saturated with tritium.
- Contaminant concentrations in tanks remain constant. 80% of maximum tank volume used as WTC confirmed they do not exceed that volume.
- HEPA removal efficiency applied to the final assessment for gross alpha and gross beta.

Tank [redacted] (except tritium)

		STATIC STATE EMISSION Use tank's total inventory & DOE ARR applicable to static condition							WASTE TRANSFER STATE EMISSION Use Avg (2019 to 2023) processed volumes + 10% & DOE ARF applicable to waste transfer condition								
Contaminant	**A** **Contaminant Concentrations in Tank (Bq/mL)** ["CAD" from Table 1 of NSN-318/ADS-05424-SAR-1]	**B** **80% Tank Volume (m^3)** [NSN-318/ADS-05424-SAR-1]	**C** **Total Activity in Tank (Bq)** [A*B*1,000,000]	**D** **Airborne Release Rate Per Second** [DOE p.3-40, Section 3.2.4.2, Table 3-10]	**E** **Activity Released to Building Air (Bq/s)** [C*D]	**F** **Emission Per Tank (Bq/wk)** [G*604800]	**G** **# of Tanks**	**H** **Emission (Bq/wk)** [F*G]	**I** **Total Annual Transfer Volume (m^3/a)** [CRL-00583-ACMR-2023]	**J** **Annual Activity Transferred (Bq/a)** [A*I*1,000,000]	**K** **Airborne Release Fraction** [DOE, Section 3.2.3.1]	**L** **Annual Airborne Release (Bq/a)** [J*K]	**M** **Emission (Bq/wk)** [L/52wks]	**Total Emission (Bq/wk)** [H+M]	**Derived Release Limit (Bq/wk)** [CRL-509200-RRD-001 Rev 3]	**%DRL**	**EVMP Monitoring Criterion (c) : >0.0005 mSv to off-site critical group, i.e. > 0.05%DRL?** [900-509200-STD-009]
Gross Alpha:	5.10E-01	109	5.56E+07	1.0E-10	5.56E-03	3.36E+03	1	3.36E+03	27	1.E+07	2.E-04	2.75E+03	5.30E+01	3.42E+03	6.17E+08	5.53E-04	**NO**
Gross Beta:	4.20E+03	109	4.58E+11	1.0E-10	4.58E+01	2.77E+07	1	2.77E+07	27	1.E+11	2.E-04	2.27E+07	4.36E+05	2.81E+07	7.48E+09	3.76E-01	**YES**
I-131:	1.30E+00	109	1.42E+08	1.0E-10	1.42E-02	8.57E+03	1	8.57E+03	27	4.E+07	2.E-04	7.02E+03	1.35E+02	8.71E+03	1.53E+11	5.69E-06	**NO**

Tanks [redacted] tritium)

Contaminant	**Contaminant Concentrations in Tank (Bq/mL)** ["CAD" from Table 1 of NSN-318/ADS-05424-SAR-1]	**Building Air Concentration (Bq/m^3)** [From inserting concentration in Table 1]	**Fan Exhaust Rate (m3/s)**	**Emission Per Tank (Bq/wk)**	**# of Tanks**	**Emission (Bq/wk)**	**Derived Release Limit (Bq/wk)** [CRL-509200-RRD-001 Rev 3]	**%DRL**	**EVMP Monitoring Criterion (c) : >0.0005 mSv to off-site critical group, i.e. > 0.05%DRL?** [900-509200-STD-009]
Tritium:	2.7E+03	5.00E+04	0.436	1.32E+10	1	1.32E+10	3.98E+14	3.32E-03	**NO**

Total Emissions from this Effluent Stream

Contaminant	**Sum (%DRL)**	**HEPA Filter Present?**	**Charcoal Filter Present?**	**Mitigated Release - HEPA filtration (%DRL)**	**EVMP Monitoring Criterion (c) : >0.0005 mSv to off-site critical group, i.e. > 0.05%DRL?** [900-509200-STD-009]
Gross Alpha:	5.53E-04	YES	NA	5.53E-05	**NO**
Gross Beta:	3.76E-01	YES	NA	3.76E-02	**NO**
I-131:	5.69E-06	NA	NO	5.69E-06	**NO**
Tritium:	3.32E-03	NA	NA	3.32E-03	**NO**
TOTAL:	**3.80E-01**			**4.10E-02**	**NO**

REDACTED

[redacted] - MPF (non-radioactive) condensate

OPERATIONAL

Premises:

- Open top tanks venting direct to building air which is then exhausted via building exhaust fan [redacted] at 0.180 m^3/s.
- For contaminants other than tritium, two tank states are considered and added to obtain a weekly release:
  - (1) Static State: Maximum tank volume is assumed, and an airborne resuspension release rate (ARR) from aerodynamic entrainment is applied
  - (2) Waste Transfer State: Using three transfers per year at a 100% tank volume, and an airborne resuspension factor (ARF) from free fall spill is applied
- Max tank volumes are used.
- For tritium, 100% relative humidity is assumed such that the air is saturated with tritium.
- Contaminant concentrations in tanks remain constant

Tanks [redacted] except tritium)

		STATIC STATE EMISSION Use tank's total inventory & DOE ARR applicable to static condition							WASTE TRANSFER STATE EMISSION Use B205 2012 processed volumes + 10% & DOE ARF applicable to waste transfer condition								
Contaminant	**A** **Contaminant Concentrations in Tank (Bq/mL)** [WTC Staff Communication]	**B** **Max. Tank Volume (m^3)** [NSN-318/ADS-05424-SAR-1]	**C** **Total Activity in Tank (Bq)** [A*B*1,000,000]	**D** **Airborne Release Rate Per Second** [DOE p.3-40, Table 3-10]	**E** **Activity Released to Building Air (Bq/s)** [C*D]	**F** **Emission Per Tank (Bq/wk)** [G*604800]	**G** **# of Tanks**	**H** **Emission (Bq/wk)** [F*G]	**I** **Total Annual Transfer Volume (m3/a)** [WTC Staff Records]	**J** **Annual Activity Transferred (Bq/a)** [A*I*1,000,000]	**K** **Airborne Release Fraction** [DOE, Section 3.2.3.1]	**L** **Annual Airborne Release (Bq/a)** [J*K]	**M** **Emission (Bq/wk)** [L/52wks]	**Total Emission (Bq/wk)** [H+M]	**Derived Release Limit (Bq/wk)** [CRL-509200-RRD-001 Rev 3]	**%DRL**	**EVMP Monitoring Criterion (c) [900-509200-STD-009]: >0.0005 mSv to off-site critical group, i.e. > 0.05%DRL?**
Gross Alpha:	5.35E-04	89	4.76E+04	1.E-10	5.29E-06	3.20E+00	3	9.60E+00	267	1.43E+05	2.E-04	2.86E+01	5.50E-01	1.02E+01	6.17E+08	1.65E-06	**NO**
Gross Beta:	3.46E-02	89	3.08E+06	1.E-10	3.42E-04	2.07E+02	3	6.21E+02	267	9.24E+06	2.E-04	1.85E+03	3.55E+01	6.57E+02	7.48E+09	8.78E-06	**NO**

Tanks [redacted] (tritium)

Contaminant	**Contaminant Concentrations in Tank (Bq/mL)** [WTC Staff Communication]	**Building Air Concentration (Bq/m3)** [From inserting concentration in Table 1]	**Fan Exhaust Rate (m3/s)**	**Emission Per Tank (Bq/wk)**	**# of Tanks**	**Emission (Bq/wk)**	**Derived Release Limit (Bq/wk)** [CRL-509200-RRD-001 Rev 3]	**%DRL**	**EVMP Monitoring Criterion (c) : >0.0005 mSv to off-site critical group, i.e. > 0.05%DRL?** [900-509200-STD-009]
Tritium:	1.21E+01	2.28E+01	0.180	2.49E+06	3	7.46E+06	3.98E+14	1.87E-06	**NO**

Total Emissions from this Effluent Stream

Contaminant	**Sum (%DRL)**	**EVMP Monitoring Criterion (c) : >0.0005 mSv to off-site critical group, i.e. > 0.05%DRL?** [900-509200-STD-009]
Gross Alpha:	1.65E-06	**NO**
Gross Beta:	8.78E-06	**NO**
Tritium:	1.87E-06	**NO**
TOTAL:	**1.23E-05**	**NO**

REDACTED

Appendix D Historical Liquid Monitoring Locations Removed from the EVMP

Effluent Stream (Type)	Source Description	Total MPER (mSv)	Monitored? (Est. or Meas.)	Justification: Effluent Stream (criteria from [4])	Justification: Contaminant (criteria from [4])
				Criterion (a): (shall) If monitoring of the effluent or emission stream is designated for monitoring in, or is required to demonstrate compliance with, a site or facility operating/decommissioning licence, statute, regulation, or permit, then that effluent or emission stream shall be monitored. **Criterion (c):** (should) If total MPER for an effluent or emission stream exceeds 0.0005 mSv/yr (or 0.05% DRL) to off-site critical group, then that effluent or emission stream should be monitored. Normal emission rates, instead of MPER, may be used if an OCMP is in place. **Criterion (q):** (should) Required for other business reasons (e.g. stakeholder concerns, due diligence, etc.)	**Criterion (h):** (shall) If effluent monitoring of a contaminant, physical stressor or acute lethality toxicity is explicitly specified by a site or facility operating/decommissioning licence or required by a statute, regulation or permit to discharge, then that contaminant or physical stressor shall be monitored. **Criterion (j):** (shall) If effluent or emission monitoring of a contaminant supports a radiation dose assessment or assessment of potential exposure, then that contaminant shall be monitored. **Criterion (k):** (shall) If there is an operational need to identify an unplanned or uncontrolled effluent or emission (reasonably foreseeable upset event) of a contaminant into the environment, then that contaminant shall be monitored. **Criterion (l):** (should) If the site-wide MPER for a contaminant exceeds 0.0001 mSv/yr (or 0.01 %DRL) to off-site critical group, then that radioactive contaminant [at least 70% of site emissions] should be monitored. **Criterion (n):** (should) If a contaminant is likely to approach or has the potential to exceed regulatory release limits or internal release limits, then that contaminant should be monitored. **Criterion (q):** (should) Required for other business reasons (e.g. stakeholder concerns, due diligence, etc.)
Stormwater Effluents Associated with the Stormwater Management System -> to River					
Storm Outfall [redacted] [redacted] (Waterborne-Point-Continuous)	Inputs include: • Road and roof run-off from the vicinity of Bldg [redacted] • Contaminated groundwater associated with the NRX Rod Bays Plume that is collected by Bldg [redacted] tile drains and routed to the [redacted] storm drain Historically, the [redacted] Storm Outfall collection system extended to a number of buildings in the Controlled Area. It collected surface runoff from a series of roads in the built-up area, roof and foundation drainage with its main source of volume coming from site cooling water. The flow for this storm sewer was heavily dependent on the cooling water and therefore did not significantly fluctuate throughout the calendar year. In 2017, the stormwater diversion project diverted 80% of the original flow into the [redacted] storm outfall collection system. The remainder of the water that was not re-routed in 2017 was subsequently diverted in 2018 with a large portion transferred via underground piping to the Process Outfall. The [redacted] Storm Outfall discharges directly into the Ottawa River with no prior treatment.	NA	Not Req'd	Minimal or no source of radioactivity. Minimal road and roof run-off from the vicinity of Bldg [redacted] as well as tile drains around Bldg [redacted] Minimal or non-existent flows. Contributes only 0.25% to site total liquid effluent releases. History: 2022: Discontinued monitoring, no more flow. With the diversion of most of the [redacted] collection system to the [redacted] storm collection system, and a large remainder to the Process Outfall, flows and radiological loading has been significantly reduced. In 2020 measurable flows in the [redacted] outfall were only observed three times during the year. Percent contribution of [redacted] storm sewer to site total liquid effluent releases in 2020 was just 0.25%. The monitoring location, an access point to the line via [redacted] was situated after all contributions to the effluent but prior to the	NA History: 2022: Discontinued monitoring for GA, GB, HTO, and γ-spec. No more flow.

REDACTED

Effluent Stream (Type)	Source Description	Total MPER (mSv)	Monitored? (Est. or Meas.)	Justification: Effluent Stream (criteria from [4])	Justification: Contaminant (criteria from [4])
				Criterion (a): (shall) If monitoring of the effluent or emission stream is designated for monitoring in, or is required to demonstrate compliance with, a site or facility operating/decommissioning licence, statute, regulation, or permit, then that effluent or emission stream shall be monitored. **Criterion (c):** (should) If total MPER for an effluent or emission stream exceeds 0.0005 mSv/yr (or 0.05% DRL) to off-site critical group, then that effluent or emission stream should be monitored. Normal emission rates, instead of MPER, may be used if an OCMP is in place. **Criterion (q):** (should) Required for other business reasons (e.g. stakeholder concerns, due diligence, etc.)	**Criterion (h):** (shall) If effluent monitoring of a contaminant, physical stressor or acute lethality toxicity is explicitly specified by a site or facility operating/decommissioning licence or required by a statute, regulation or permit to discharge, then that contaminant or physical stressor shall be monitored. **Criterion (j):** (shall) If effluent or emission monitoring of a contaminant supports a radiation dose assessment or assessment of potential exposure, then that contaminant shall be monitored. **Criterion (k):** (shall) If there is an operational need to identify an unplanned or uncontrolled effluent or emission (reasonably foreseeable upset event) of a contaminant into the environment, then that contaminant shall be monitored. **Criterion (l):** (should) If the site-wide MPER for a contaminant exceeds 0.0001 mSv/yr (or 0.01 %DRL) to off-site critical group, then that radioactive contaminant [at least 70% of site emissions] should be monitored. **Criterion (n):** (should) If a contaminant is likely to approach or has the potential to exceed regulatory release limits or internal release limits, then that contaminant should be monitored. **Criterion (q):** (should) Required for other business reasons (e.g. stakeholder concerns, due diligence, etc.)
				effluent reaching the environment (Ottawa River).	
Storm Outfall [redacted] [redacted]	NO LONGER A DISCHARGE POINT Up until 2018, the [redacted] Storm Outfall collection system extended to a small number of buildings in the northeastern built-up portion of the Controlled Area. It collected surface runoff from a few roads as well as some roof and foundation drainage, and discharged these to the Ottawa River. By 2018, as part of a larger site-wide Stormwater Diversion Project, the entire [redacted] Storm Outfall collection system was re-routed into the [redacted] Storm Outfall collection system, which feeds into a storm water retention pond prior to release to the Ottawa River. The [redacted] Storm Outfall collection system is monitored under the EVMP.	NA	NA	NA History: 2018: Discontinued monitoring in in 2018 given the re-routing of the entire network to the [redacted] Storm Outfall network.	NA History: 2018: Discontinued monitoring for GA, GB, HTO, and γ-spec in 2018 given the re-routing of the entire network to the [redacted] Storm Outfall network.
[redacted] Alternate Name: [redacted]	NO LONGER A DISCHARGE POINT Manhole [redacted] (originally known as [redacted] was the last manhole of a storm sewer collection system prior to discharging to the Ottawa River. The collection system was located in the Controlled Area with a series of branches in the vicinity of the Sanitary Sewage Treatment Facility. It collected surface runoff from a few roads in the northeast portion of the built-up area as well as some roof drainage from the Sanitary Sewage Treatment Facility building itself. There was no prior treatment of this stormwater before it is discharged to the River. The monitoring location was removed from the program in 2016 due to issues with accessing the sampling location. In 2018, the effluent was	NA	NA	NA	NA

REDACTED

Effluent Stream (Type)	Source Description	Total MPER (mSv)	Monitored? (Est. or Meas.)	Justification: Effluent Stream (criteria from [4])	Justification: Contaminant (criteria from [4])
				Criterion (a): (shall) If monitoring of the effluent or emission stream is designated for monitoring in, or is required to demonstrate compliance with, a site or facility operating/decommissioning licence, statute, regulation, or permit, then that effluent or emission stream shall be monitored. **Criterion (c):** (should) If total MPER for an effluent or emission stream exceeds 0.0005 mSv/yr (or 0.05% DRL) to off-site critical group, then that effluent or emission stream should be monitored. Normal emission rates, instead of MPER, may be used if an OCMP is in place. **Criterion (q):** (should) Required for other business reasons (e.g. stakeholder concerns, due diligence, etc.)	**Criterion (h):** (shall) If effluent monitoring of a contaminant, physical stressor or acute lethality toxicity is explicitly specified by a site or facility operating/decommissioning licence or required by a statute, regulation or permit to discharge, then that contaminant or physical stressor shall be monitored. **Criterion (j):** (shall) If effluent or emission monitoring of a contaminant supports a radiation dose assessment or assessment of potential exposure, then that contaminant shall be monitored. **Criterion (k):** (shall) If there is an operational need to identify an unplanned or uncontrolled effluent or emission (reasonably foreseeable upset event) of a contaminant into the environment, then that contaminant shall be monitored. **Criterion (l):** (should) If the site-wide MPER for a contaminant exceeds 0.0001 mSv/yr (or 0.01 %DRL) to off-site critical group, then that radioactive contaminant [at least 70% of site emissions] should be monitored. **Criterion (n):** (should) If a contaminant is likely to approach or has the potential to exceed regulatory release limits or internal release limits, then that contaminant should be monitored. **Criterion (q):** (should) Required for other business reasons (e.g. stakeholder concerns, due diligence, etc.)
	redirected during the site stormwater redirection project and was instead incorporated into the [redacted] stormwater collection system so the [redacted] effluent to the River no longer exists.				
Point-batch Stormwater Discharges Associated with Individual Buildings and/or Small Catchment Areas -> to River					
[redacted]	NO LONGER A DISCHARGE [redacted] was eliminated by redirecting the [redacted] Storm Collection System during the 2018 stormwater redirection project.	NA	NA	NA	NA
[redacted]	NO LONGER A DISCHARGE [redacted] was eliminated by redirecting the [redacted] Storm Collection System during the 2018 stormwater redirection project.	NA	NA	NA	NA
Point-batch Stormwater Discharges -> to Ground					
[redacted]	NO LONGER A DISCHARGE POINT [redacted] was eliminated during the 2018 stormwater redirection project.	NA	NA	NA	NA
[redacted]	NO LONGER A DISCHARGE POINT [redacted] was eliminated during the 2018 stormwater redirection project.	NA	NA	NA	NA

REDACTED

Effluent Stream (Type)	Source Description	Total MPER (mSv)	Monitored? (Est. or Meas.)	Justification: Effluent Stream (criteria from [4])	Justification: Contaminant (criteria from [4])
				Criterion (a): (shall) If monitoring of the effluent or emission stream is designated for monitoring in, or is required to demonstrate compliance with, a site or facility operating/decommissioning licence, statute, regulation, or permit, then that effluent or emission stream shall be monitored. **Criterion (c):** (should) If total MPER for an effluent or emission stream exceeds 0.0005 mSv/yr (or 0.05% DRL) to off-site critical group, then that effluent or emission stream should be monitored. Normal emission rates, instead of MPER, may be used if an OCMP is in place. **Criterion (q):** (should) Required for other business reasons (e.g. stakeholder concerns, due diligence, etc.)	**Criterion (h):** (shall) If effluent monitoring of a contaminant, physical stressor or acute lethality toxicity is explicitly specified by a site or facility operating/decommissioning licence or required by a statute, regulation or permit to discharge, then that contaminant or physical stressor shall be monitored. **Criterion (j):** (shall) If effluent or emission monitoring of a contaminant supports a radiation dose assessment or assessment of potential exposure, then that contaminant shall be monitored. **Criterion (k):** (shall) If there is an operational need to identify an unplanned or uncontrolled effluent or emission (reasonably foreseeable upset event) of a contaminant into the environment, then that contaminant shall be monitored. **Criterion (l):** (should) If the site-wide MPER for a contaminant exceeds 0.0001 mSv/yr (or 0.01 %DRL) to off-site critical group, then that radioactive contaminant [at least 70% of site emissions] should be monitored. **Criterion (n):** (should) If a contaminant is likely to approach or has the potential to exceed regulatory release limits or internal release limits, then that contaminant should be monitored. **Criterion (q):** (should) Required for other business reasons (e.g. stakeholder concerns, due diligence, etc.)
[redacted]	NO LONGER A DISCHARGE POINT [redacted] was eliminated during the 2018 stormwater redirection project.	NA	NA	NA	NA
Condensate Discharges					
Steam Condensate [redacted]	Monitoring discontinued as of 2019, no longer a source term. Prior to 2019, the steam condensate in the Controlled Area was being monitored for GB and HTO. The U-2 Loop Steam Generator was a heat exchanger installed in the NRU U-2 loop as an energy conservation initiative to use rejected heat from the loops for the heating of buildings in the Controlled Area. A potential fugitive emission existed from loop water contamination leaking into the generated steam and being dispersed to the environment via the plant steam system (to air from steam pressure relief valve, to river from steam dump system). Note that there was OCM in place – regular sampling and a radiation monitor on the steam side immediately after the steam generator with automatic redirection of steam upon reaching action limits, but monitoring as part of the EVMP served as defense-in-depth approach. Monitoring was discontinued once the NRU Reactor was shut down and the NRU U-2 Loop stopped operations.	NA	NA	NA	NA

REDACTED

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

Chalk River Laboratories Environmental Monitoring Plan

CRL-509200-PLA-007

Revision 1.0

Approved by:	George Dolinar	2025/03/31
	Director, Corporate Environmen	Date

Effective Date: 2025/03/31
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Revision History

Rev. No.	Date	Details of Rev.	Authored By	Reviewed By	Approved By
1	2025/03/27	Issued as “Approved for Use”	L. Howat M. Burns	C. De Waele	G. Dolinar
1D1	2025/03/07	Issued for “Review and Comment” Major Changes include: - Alignment with the CSA N288.4-19 standard - Changes to the monitoring schedule since last revision - Alignment with recent ERA and DRL document revisions	L. Howat M. Burns	C. De Waele K. Lambert R. Silke S. Richards	
0	2022/03/25	Issued as “Approved for Use”. Effective date 2022 May 16	L. Howat		G. Dolinar
0D1	2022/01/17	Issued for “Review and Comment”. - Cancels and supersedes CRL-509200-PLA-002 and CRL-509200-PLA-005 -Updates include: Organization of document into a design by objective format to describe how monitoring activities achieve objectives Combining radiological and non-radiological monitoring activities into one document	L. Howat	C. De Waele M. Klukas K. Lambert	

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1. Scope

This Environmental Monitoring Plan, in combination with the Environmental Protection Program procedure, *Environmental Monitoring Programs* [1], and the *Integrated Environmental Monitoring Program Framework* [2], describes the Environmental Monitoring Program (EMP) for Chalk River Laboratories (CRL), including:

- Monitoring of radioactive and non-radioactive contaminants and physical stressors in the receiving environment, and monitoring of meteorological parameters;
- The justification for needing an EMP at CRL;
- The detailed design of the CRL EMP with justification for the individual monitoring activities;
- A high-level summary of the sampling and analysis procedures used for the EMP;
- A high-level description of the Quality Assurance (QA) and Quality Control (QC) which is in place for each of the groups performing sampling and analysis for the EMP;
- A summary of the EMP's Records and Data Management.

This plan does not cover:

- The assessment of the need for, nor the design of, the CRL Effluent Verification Monitoring Program (subject to the Canadian Standards Association (CSA) N288.5 Standard, *Effluent and Emissions monitoring programs at nuclear facilities* [3]). This is instead covered under the Chalk River Laboratories' Effluent Verification Monitoring Plans [4] [5], and the Environmental Protection Program procedure, *Management and Monitoring of Effluents and Emissions* [6];
- Groundwater monitoring, the purpose of which would be to prevent or minimize releases and effects to groundwater and confirm that adequate measures are in place to control and/or monitor any releases; the program is in line with CSA Standard N288.7, *Groundwater Protection Programs at Class I nuclear facilities and uranium mines and mills* [7]. This is instead covered in the *Chalk River Laboratories' Groundwater Monitoring Plan* [8] and the *Protection and Monitoring of Groundwater Standard* [9];
- The routine monitoring of Valued Components (VC); described in Section 4.5, this is covered in a separate site-specific document [10];
- Non-routine environmental monitoring that may be performed temporarily for a specific project taking place;
- Supplementary Studies that are performed to support program objectives, design, or interpretation of data but are not normally part of the routine monitoring program and tend to be time limited [1];
- The reviews, assessments and audits of the CRL EMP. These are instead covered in the *Environmental Monitoring Program* [1] and the *Environmental Monitoring Framework* [2]; and,

- Data analysis and interpretation of data generated by the CRL EMP. These are instead covered in the *Environmental Monitoring Program* [1].

The EMP was developed and is executed in such a way as to comply with:

- Conditions in the CRL Operating Licence [11] and Licence Conditions Handbook [12];
- CSA N288.4-19 [13];
- Canadian Nuclear Safety Commission (CNSC) Regulatory Document (REGDOC) 2.9.1 [14];
- Other applicable regulations and standards; and
- Canadian Nuclear Laboratories (CNL) policies.

This document is primarily intended for use by groups or laboratories which are directly involved in both the radiological and non-radiological EMP at CRL. Note that the EMP is dynamic in nature and is continually evolving. As a result, this plan is current as of its issuance but does not necessarily completely reflect the program after this date. The most current monitoring schedule should always be consulted.

2. Purpose

The purpose of this monitoring plan is to:

- Document and justify the decision for needing an EMP for CRL; and
- Document the design of the EMP (i.e., design by Environmental Risk Assessment (ERA) and systematic planning process), justify all of the monitoring activities under the program, and show how these activities meet the objectives of the program.

3. Definitions

3.1 Terms

Term definitions are found in the *Environmental Protection Program Description Document* [10] and *Environmental Monitoring Program* [1].

3.2 Acronyms

ACB	Analytical Chemistry Branch
ACMR	Annual Compliance Monitoring Report
ALARA	As Low As Reasonably Achievable
ATG	Analytical Test Group
BEM	Biological Effects Monitoring
CANDU	CANada Deuterium Uranium
CCME	Canadian Council of Ministers of the Environment
CEPA	Canadian Environmental Protection Act
CL	Critical Level
CNL	Canadian Nuclear Laboratories

CNSC	Canadian Nuclear Safety Commission
CRL	Chalk River Laboratories
COG	CANDU Owners' Group
COPC	Contaminant of Potential Concern
CSA	Canadian Standards Association
CWQG	Canadian Water Quality Guideline
DC	Dose Coefficient
DCF	Dose Conversion factor
DQO	Data Quality Objective
DRL	Derived Release Limits
EA	Environmental Assessment
EAFMP	Environmental Assessment Follow-up Monitoring Plan
EcoRA	Ecological Risk Assessment
EDMS	Environmental Data Management System
EMB	Environmental Monitoring Branch
EMP	Environmental Monitoring Program
ENEV	Estimated No-Effect Values
ERA	Environmental Risk Assessment
EVMP	Effluent Verification Monitoring Program
FMC	Fuels and Materials Cells
GWMP	Groundwater Monitoring Program
HHRA	Human Health Risk Assessment
LCH	License Condition Handbook
LDA	Liquid Dispersal Area
LLD	Lower Limit of Detection
LMDL	Laboratory Method Detection Limit
MISA	Municipal/Industrial Strategy for Abatement
MOE	Ministry of the Environment
MPF	Molybdenum-99 Production Facility
MU	Management Unit
NAWQ	National Ambient Water Quality
NEW	Nuclear Energy Worker
NOEC	No Observed Effect Concentration
NRU	National Research Universal
NRX	National Research Experimental
NSCA	Nuclear Safety and Control Act
NSDF	Near Surface Disposal Facility
ORR	Ottawa Riverbed Remediation

PCB	Polychlorinated Biphenyl
PIP	Public Information Program
PWQO	Provincial Water Quality Objective
QA/QC	Quality Assurance/Quality Control
REGDOC	Regulatory Document
RPC	Research and Productivity Council
SC	Screening Criteria
SEA	Significant Environmental Aspects
SMR	Small Modular Reactor
SRC	Safety Review Committee
SSTF	Sanitary Sewage Treatment Facility
TLD	Thermoluminescent Dosimeter
TSS	Total Suspended Solids
UC	Universal Cells
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
VC	Valued Component
VOC	Volatile Organic Compound
WMA	Waste Management Area
WTC	Waste Treatment Centre

4. Site Description

Canadian Nuclear Laboratories' CRL is a large nuclear science and technology site that operates a variety of nuclear facilities. The portion of the site that is developed, referred to as the CRL Built-Up Area, covers about 3 km^2 of the 40 km^2 property. The larger undeveloped area, referred to as the CRL Outer Area, serves primarily as an exclusion zone but also contains several legacy and operating Waste Management Areas (WMA). The CRL Built-up Area consists of over 100 buildings and facilities including research and medical isotope production reactors (shutdown), nuclear fuel research facilities, hot cells, chemical and biology research laboratories, and waste storage and treatment facilities.

This section describes the CRL site and its surrounding communities, providing information on source areas and their emissions, as well as some of the unique features of the site that may affect the design of the EMP, including.

- The operating and historical WMAs and the resulting legacy contamination resulting from past waste management practices;
- The release of liquid effluent directly into the Ottawa River;
- The sparseness of the surrounding population, with approximately 6,000 people within a 20 km radius of the site; and
- The unsuitability of the area for commercial agriculture.

4.1 Location and Surrounding Communities

The CRL site exists on the unceded and unsurrendered territory of the Algonquin Anishinaabe Nation. It is located in Renfrew County, Ontario, about 180 km northwest of Ottawa, on the south shores of the Ottawa River. The Ottawa River, which flows northwest to southeast, forms the north-easterly boundary of the site. The Town of Deep River lies to the northwest of the site, Garrison Petawawa abuts the CRL property to the southeast, and the Village of Chalk River in the Municipality of Laurentian Hills lies immediately to the southwest of the site. Other nearby communities include Petawawa and Pembroke along the Ontario shore of the Ottawa River, and the smaller communities of Fort William and Sheenboro on the Québec side of the river.

A map of the CRL site and surrounding area is given in Figure 1 and Figure 2.

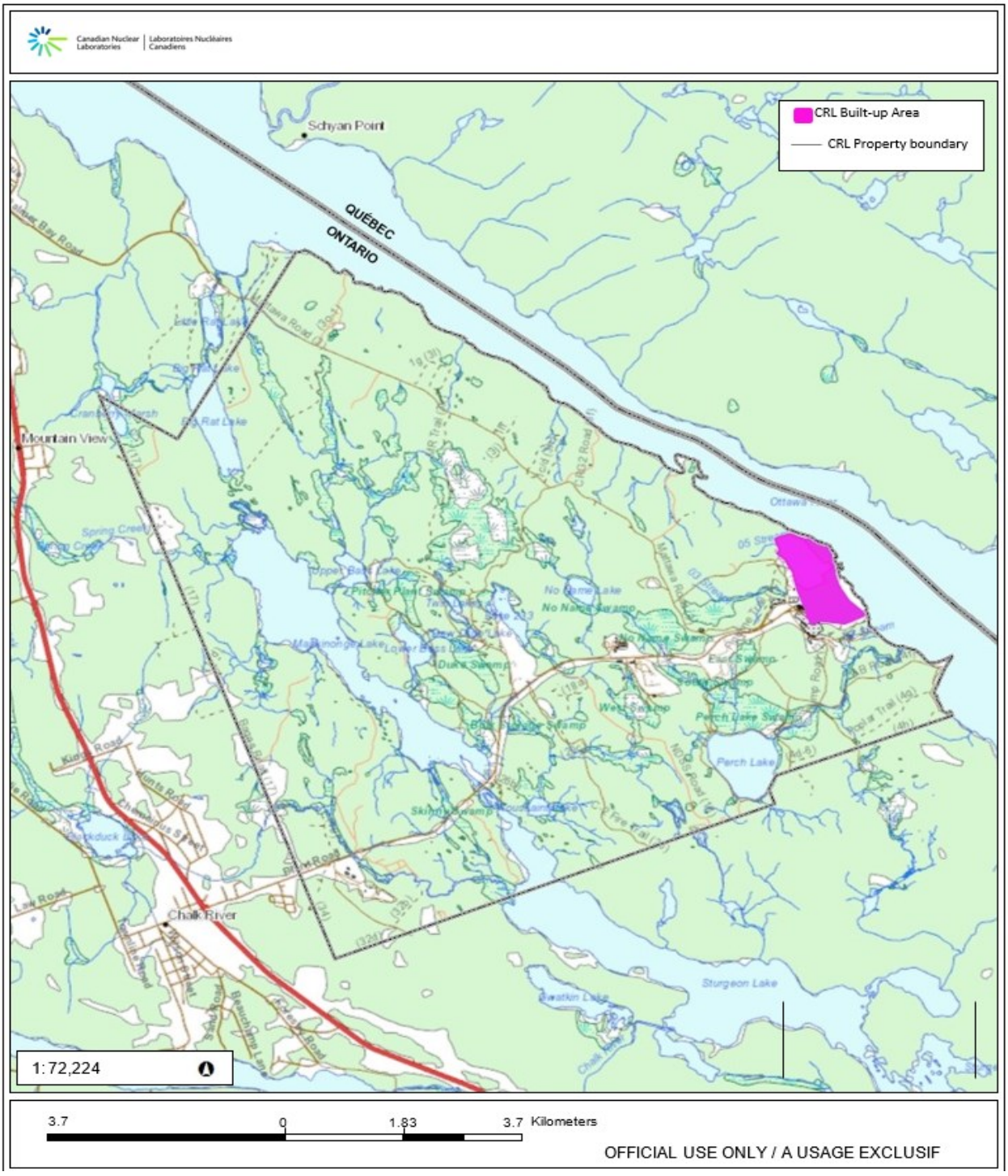


Figure 1: Chalk River Laboratories Local Property

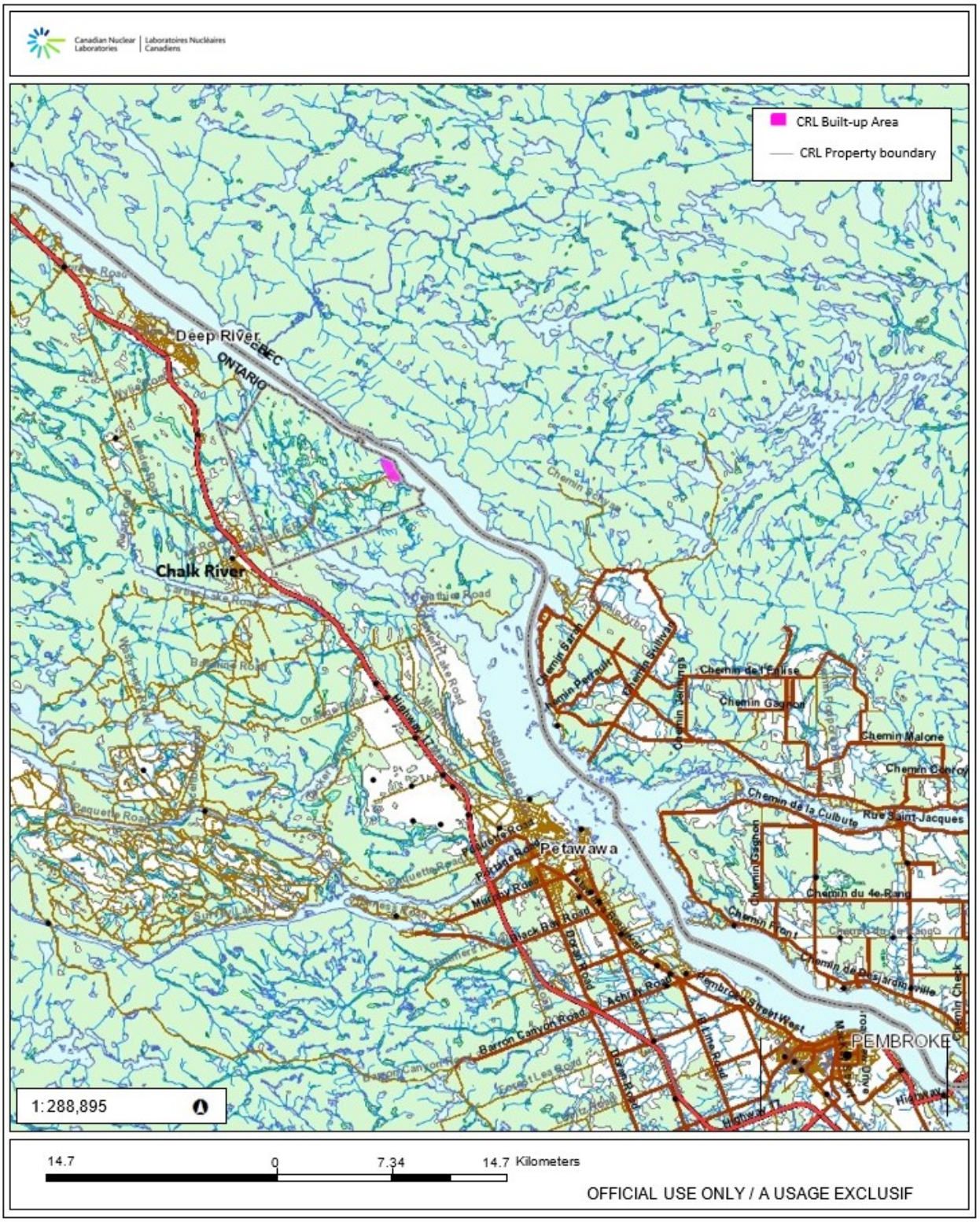


Figure 2: Chalk River Laboratories Location and Surrounding Areas

4.2 History and Current State

The CRL site was established in the mid-1940s and has a history of various nuclear operations and facilities, primarily related to research. Most of the nuclear and associated support facilities and buildings on the site are located within a relatively small built-up area adjacent to the Ottawa River near the southeast end of the property. The built-up area is contained within a designated and fenced “Controlled Area” and “Supervised Area” for security and radiation protection purposes, with most of the nuclear facilities contained within the higher security Controlled Area. Most non-nuclear facilities and offices are within the Supervised Area or CRL Outer Area. The CRL site includes ten Class I nuclear facilities in an operational state and seven that are either in extended shutdown or in storage with surveillance. These facilities include research reactors, processing facilities, fuel manufacturing facilities, hot cells, the Molybdenum-99 Production Facility (MPF, shut down 2016) and the National Research Universal reactor (NRU), which was placed in a safe state in March 2018. The site also includes WMAs, five of which are in operation and eight in long-term monitoring; four Class II nuclear facilities such as accelerators and irradiators, a Sanitary Sewage Treatment Facility (SSTF), and more than 50 radioisotope laboratories, support facilities and offices. The primary operating facilities include the WMAs, the Universal Cells (UC), the Fuels and Materials Cells (FMC), and the Waste Treatment Centre (WTC) and its Associated Facilities.

4.3 Use of Adjacent Land and Water

The CRL site is located in an area with a relatively low population density. Development is limited in this area of the river due to restricted access along the CRL site and Garrison Petawawa shorelines on the Ontario side and limited access due to the rugged terrain of the Laurentian Mountains on the Québec side. The next closest industry is a fibreboard plant down river near the city of Pembroke.

There is limited commercial agricultural land use nearby. Many local residents do cultivate small vegetable gardens for personal use.

The CRL site lies within the Ottawa River watershed. This reach of the Ottawa River has been regulated for purposes of hydroelectric power generation since 1950. The two closest generating sites are the Des Joachims Generating Station (approximately 30 km upstream) and the Chenaux Generating Station (approximately 70 km downstream). The Ottawa River is used by local boaters and recreational fishers. There are several public beaches along the Ontario side of the river, located in nearby towns of Deep River, Petawawa and Pembroke. There is a sand beach roughly 2 km downstream of the developed part of the CRL site that is used by the public (Pointe au Baptême). For security purposes access to the site is restricted to CNL employees, authorized visitors and contractors.

4.4 Drainage Basins

The dominant drainage feature is the Ottawa River, which runs northwest/southeast at CRL, parallel to a large bedrock ridge (altitude of 100-m above river level). This ridge, which generally runs parallel to the former Pembroke to Mattawa Road, separates surface drainage between

the Ottawa River and inland lakes. Figure 3 delineates the boundaries of major drainage basins on the CRL property.

Direct drainage to the Ottawa River occurs from 18% of the CRL site. This region hosts the CRL built-up areas: the Supervised Area and Controlled Area where most operational nuclear facilities are located, the Inactive Landfill, and a number of smaller historic landfill areas. In addition to radioactively contaminated groundwater plumes emanating from NRU and National Research Experimental (NRX) in the controlled area, most of the air emissions and liquid effluents resulting from CRL operations are discharged from the Ottawa River Direct Basin, with monitored liquid effluent discharges occurring directly to the Ottawa River [15]. The Perch Lake and Maskinonge Lake basins are of particular interest, since they drain the areas where WMAs are situated (Figure 4). Within each drainage basin, impacted areas have been strategically divided into Management Units (MU), which is further discussed in Section 5.2.2.

The Perch Lake Basin, which drains 19% of CRL site, contains many of the CRL's operating WMAs and those with early vintage waste storage practices, including the Liquid Dispersal Areas. Because of this history, Perch Lake Basin is the most affected by past operations.

Maskinonge Lake is the largest surface water body entirely within the CRL site boundary, and its drainage basin (75% of which is within the site boundaries) is also the largest on the CRL site, accounting for almost 40% of the site's area. WMA C, WMA F, and WMA J, as well as the Nitrate Plant and Thorium Pit compounds, are located in the Maskinonge Lake basin. Drainage from this basin is from Maskinonge Lake into Chalk (Sturgeon) Lake, which flows offsite via the Chalk River and into the Ottawa River.

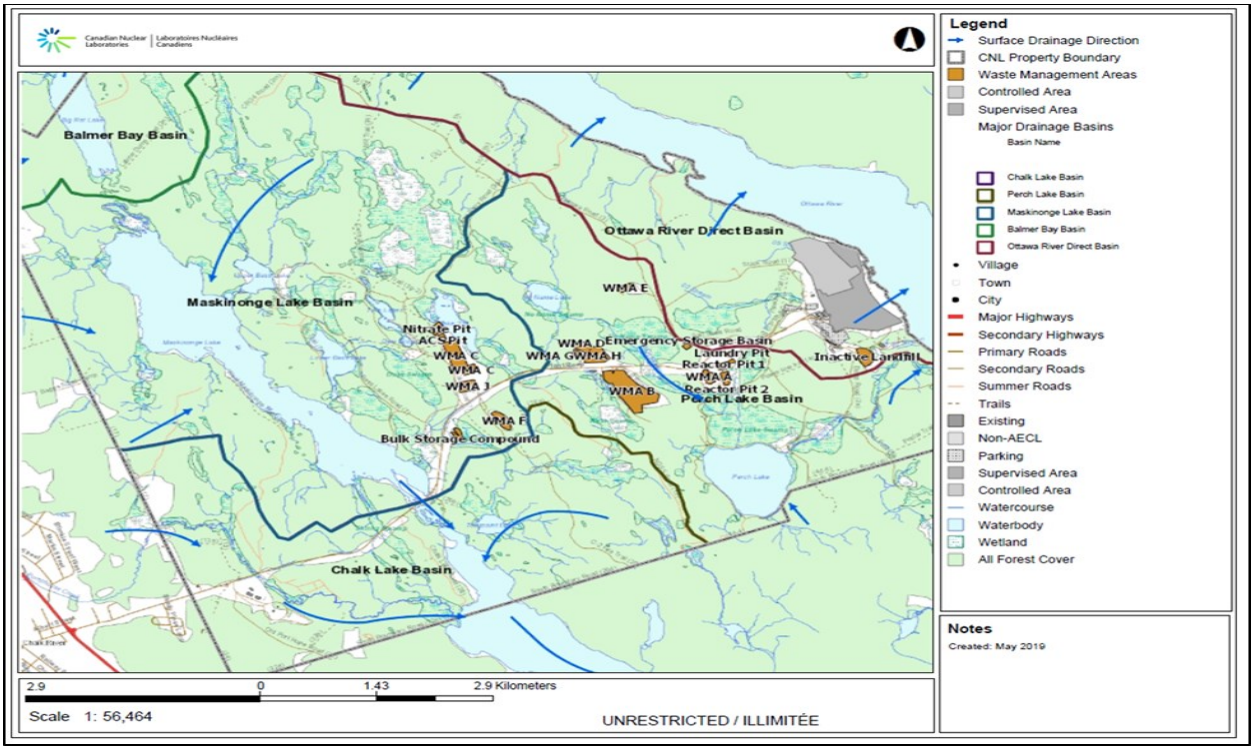


Figure 3: Chalk River Laboratories Drainage Basin Overview

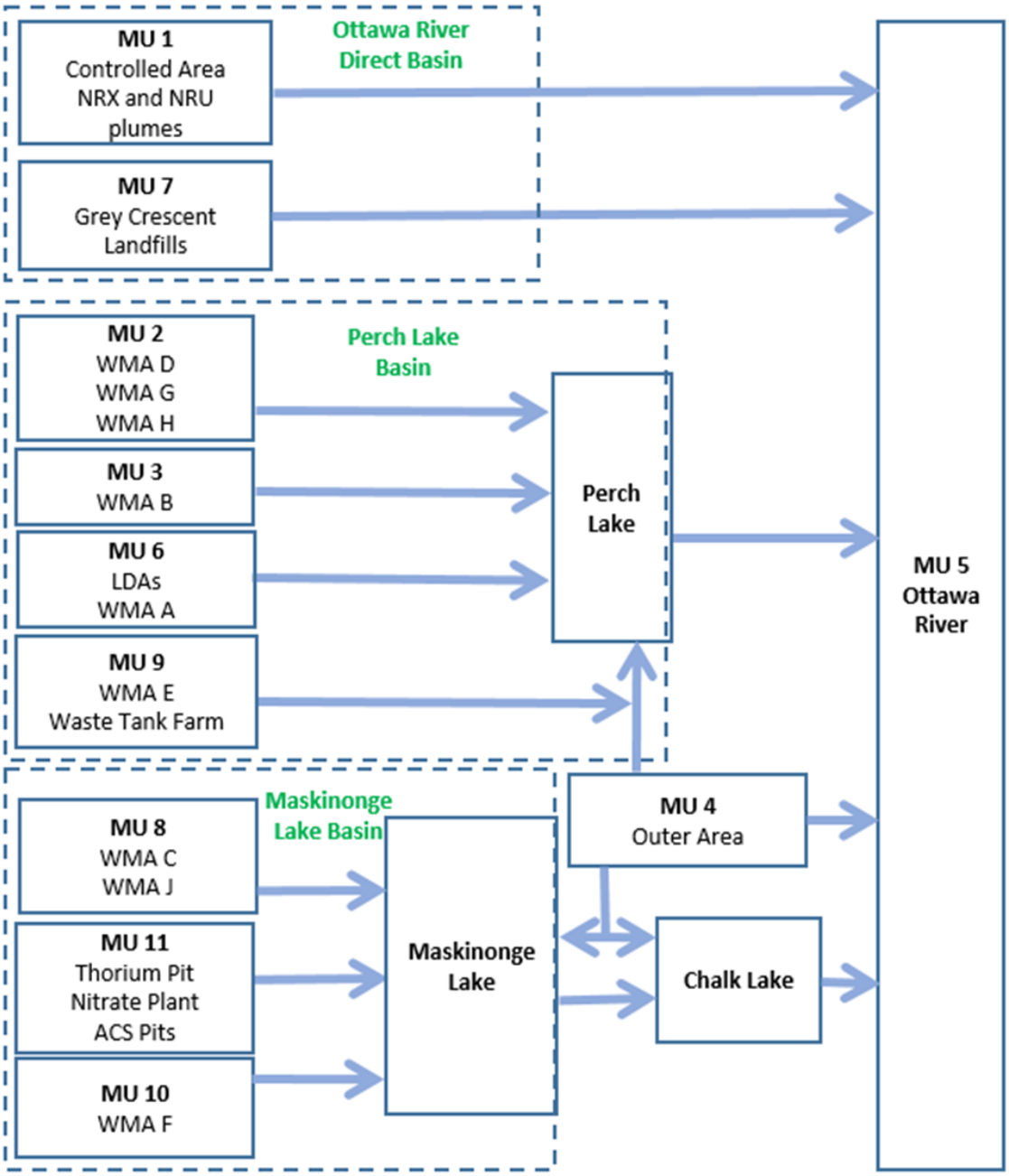


Figure 4: Chalk River Laboratories Site Model Overview

4.5 Vegetation and Wildlife

The CRL site is in the Middle Ottawa Section of the Great Lakes – St. Lawrence Forest, characterized by mixed forest, well represented by both deciduous and coniferous species. The CRL site consists of gently rolling forested hills, interspaced with several small lakes. This region of the province is generally heavily forested with limited agricultural capability due to climate, hilly topography, and unsuitable soils. The variable topography of the rolling Precambrian

Shield, as well as past disturbances, has a strong influence on the vegetation in the area. Much of the area is well drained sandy soils; however, wetlands have developed in many areas where there is imperfect drainage or beaver activity.

Several species at risk have been confirmed on the site, while others are considered "potentially present", as the CRL property is considered to be within their distribution range, but none have been recorded in the area [15]. Over the years, the presence of a number of vulnerable species have been confirmed on the CRL site, including endangered turtle, bat and bird species. The CRL site includes critical habitat for the following species: Blanding's turtle (*Emydoidea blandingii*), chimney swift (*Chaetura pelagica*), eastern whip-poor-will (*Antrostomus vociferus*) and goldenwinged warbler (*Vermivora chrysoptera*). CNL has undertaken a number of mitigative measures to help protect these animals and their habitat [15] There is some fish habitat within the CRL property itself, i.e., Perch Lake and Maskinonge Lake, as well as the Ottawa River.

As there are a large number of vertebrate, invertebrate, and plant species in Ontario, a species-by species approach for the conservation of biodiversity is impossible. For this reason, a sub-set of environmental values, known as VCs, have been identified as requiring special attention as CNL carries out its operations. The monitoring of VCs is covered in separate site-specific documents [10].

4.6 Meteorology

The wind speed distribution and direction show little seasonal or annual variability at CRL and are predominantly northwest and southeast (parallel to the Ottawa River). Figure 5 is a wind rose for CRL, using data from the 60 m tower location and averaged for the years 2018 to 2022 [15].

The climate of the area is classified as humid continental, with warm summers, cold winters, and no distinct dry season. The mean annual air temperature for the period 1961 to 2023 was 5.79 ± 1.10°C. The maximum annual recorded air temperature for the 1961 to 2023 period was 39.4°C (July 20, 1977), while the minimum annual temperature was -39.0°C (January 03, 1981). On average, 23% of the annual precipitation at CRL falls as snow, with the other 77% falling as rain. Annual precipitation for the 1963 to 2023 period averaged 857 ± 102 mm/yr [15].

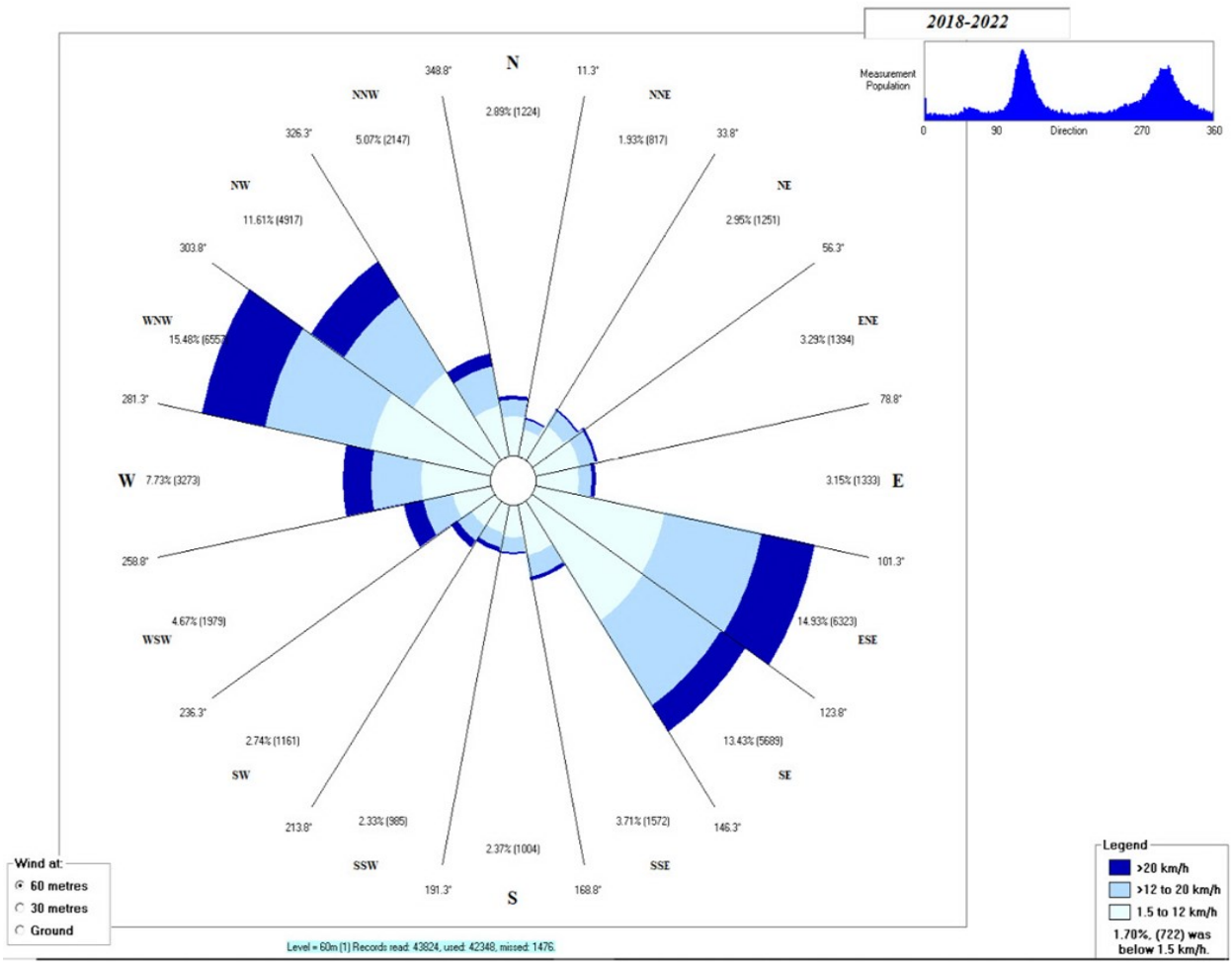


Figure 5: 2018 to 2022 Perch Lake Wind rose at 60m

4.7 Contaminant Sources and Potential Releases

There are a number of main nuclear facilities at the CRL site, as listed in the Operating Licence [12], as well as other non-nuclear supporting facilities, systems and areas that may contribute to environmental impacts.

The potential contamination sources associated with the CRL site are:

- WTC;
- Sanitary Sewage Treatment Facility (SSTF);
- Process Outfall (PRO);
- Various roof vents and stacks; and
- WMAs, both Operating and Legacy, and their associated groundwater plumes.

The main hazards at the CRL site are considered to be:

- Tritium migration from the WMAs;

- Sr-90 migration from the WMAs;
- Elevated metals in the wetlands;
- Polychlorinated biphenyls (PCBs) from WMA A; and
- Volatile Organic Compounds (VOCs) in groundwater plumes emanating from WMAs.

CRL has an Effluent Verification Monitoring Program (EVMP) covering both airborne emission and waterborne effluent monitoring for both normal operations and during reasonably foreseeable upset events. This program is thoroughly detailed in the *CRL Effluent and Emissions Verification Monitoring Plans* [4] [5]. These documents should be referred to for more detailed information on the contaminant sources mentioned above, characterization of effluent and emission streams and monitoring locations.

The CRL Effluent Verification and Environmental Monitoring Programs are related in that the information obtained from one program can be used to provide a better understanding of and to complement the other program. Effluent and emissions monitoring data can supplement existing EMP information or provide an alternative to environmental monitoring through modelling dilution and resulting environmental concentrations, especially when concentrations are very low. The division between the programs can be subjective, but the goal is to ensure that all significant releases are adequately assessed through one of the two monitoring programs.

5. Review of Environmental Risk Assessments

A number of documents have assessed environmental risks or provide information pertinent to potential environmental risks at CRL. These documented assessments provide an understanding of the risks to both ecological and human receptors on and around the site. The information contained within these documents was closely considered in the evaluation of the need to perform environmental monitoring for CRL, and in the design details of any warranted monitoring. As such, they are referenced throughout this document, as appropriate:

- The site's Derived Release Limit (DRL) report, *Derived Release Limits for CNL's Chalk River Laboratories* [16] provides a conceptual model (pathways analysis) for human (public) exposure to radioactive contaminants potentially emitted by the station and generates a DRL for each pertinent radionuclide based on the Nuclear Safety and Control Act (NSCA) public dose limit of 1 mSv/year [17]. The report identifies the critical groups, or locations of representative persons for this human radiological dose assessment;
- The site's ERA, *Environmental Risk Assessment of Chalk River Laboratories* [15] provides both a Human Health Risk Assessment (HHRA) focused on potential risks to off-site humans, and an Ecological Risk Assessment (EcoRA) focused on potential risks to non-human biota as a result of operations at CRL;
- The site's *Annual Compliance Monitoring Reports* (ACMR) [18] provide an annual assessment of site conditions, hazards, and monitoring results for the EMP and

summarizes the results for radiological and non-radiological releases for the calendar year; and

- Fish Impingement and Entrainment studies have been completed over time with the most recent completed in 2015-2017. This confirmed findings of earlier studies in that overall, annual fish impingement at CRL is low compared to similar CANada Deuterium Uranium (CANDU) facilities. Biomass loss as a result of entrainment represented a small fraction (less than 1%) of the commercial catch [19]. No Lake Sturgeon (a species at risk) have been impinged since 2017 [15].

The two wide-breadth reviews (DRL and ERA) are summarized in the following two subsections.

5.1 Derived Release Limit Model

The DRLs for CRL are calculated in *Derived Release Limits for CNL's Chalk River Laboratories* [16]. The DRL document establishes limits for airborne and liquid releases to aid in ensuring that dose to the Representative Person is kept below 1 mSv/year.

The DRLs apply to the release point for each of the four major effluent/emission pathways for CRL: (1) the reactor stack for airborne releases, (2) the short stacks and vents for airborne releases, (3) discharge point of the Process Outfall (PRO) duct into the Ottawa River for liquid releases, and (4) releases from the Maskinonge Lake basin for liquid releases. The releases are assumed to be continuous.

All relevant exposure routes to the public are factored into the DRL calculations. The airborne exposure pathways from CRL to the public are:

- Internal from inhalation;
- External from immersion in a plume;
- External from contaminated ground (groundshine);
- Internal from ingestion of contaminated well water;
- External from immersion in contaminated well water; and
- Internal from incidental ingestion of contaminated soil, plants, and animals.

The liquid exposure pathways from CRL to the public are:

- External from immersion in contaminated water;
- Internal from ingestion of contaminated water;
- External from exposure to contaminated sediment or sand; and
- Internal from ingestion of contaminated fish.

Crossover routes between the airborne and liquid pathways are insignificant, and therefore are not considered.

The DRL document identifies the representative persons associated with radioactive airborne and liquid effluent releases from CRL and documents the magnitude of activity of each nuclide released through either pathway in one calendar year that would cause the representative person to receive or be committed to the regulatory dose limit for a member of the public. This

activity is called the DRL for that nuclide.

The selection of representative persons is based upon which local residential areas receive the greatest exposure from airborne and liquid releases, and the potential for intakes based upon dietary and behavioral habits. The DRL model [16] identifies the representative persons associated with radioactive airborne and liquid effluent releases from CRL as being:

Local resident (airborne from stack): An adult, child and infant who live at Balmer Bay, obtain their water (for bathing, swimming and drinking) from a shallow well, and consume local fruit, vegetables, potatoes, and deer.

Seasonal resident (airborne from roof vents): An adult, child and infant who live at Québec Cottage Location A on the north shore of the Ottawa River in close proximity to CRL. The cottage properties are generally not accessible by road and are not occupied on a permanent basis, with rare exceptions (Figure 6).

Local resident (liquid): An adult, child and infant who live on the shore of the Ottawa River, and communities that are serviced with water drawn from the Ottawa River, i.e., Petawawa (Figure 7).

Prior to 2019, the critical group considered for airborne emissions from CRL was a local resident at Balmer Bay. Therefore, this group was selected (along with the Petawawa liquid effluent group) as the public health receptors in the HHRA for the site (as part of the ERA), for exposure to both radionuclides and hazardous substances [15]. Prior to the shutdown of NRU in 2018 releases from the stack were more significant than releases from roof vents and fans. Since the shutdown of the NRU reactor, and the updated DRL document [16], airborne releases from roof vents and stack releases are reaching similar magnitudes, thus the Québec cottage location is now also considered for airborne releases. The characteristics of each group are given in [16] and Table 1, and conceptual models for each representative group are shown in Figure 6 (airborne) and Figure 7 (liquid). These representative receptor characteristics are based on a lifestyle survey completed in 2017 [20] [21] [22]. In plotting the locations of Indigenous survey respondents, it was apparent that there is no specific location where Indigenous Peoples live; they live among non-Indigenous people in most of the communities near CRL. While a distinction was not made between Indigenous and non-Indigenous residents in the local community, the dietary and behavioural habits of all local residents were included in the receptor groups.

Table 1: Characteristics of Representative Person

Receptor Group	Age Group	Characteristics
Local resident at Balmer Bay (airborne)	Adult Child Infant	• Lives in Balmer Bay year round • Drinks, swims and baths in water from a shallow well • Maintains a small garden from which they supply a fraction of their fruit and vegetable needs: ○ 27% of their own vegetables ○ 13% of their own fruit

Receptor Group	Age Group	Characteristics
		○ 19% of their own potatoes • Acquires a fraction of their meat requirements from a specialty shop that is supplied with beef from farms in the region • Partakes in hunting, from which a fraction of their meat requirement is supplied from game (deer)
Seasonal resident of Québec Cottage location (airborne) Figure 6	Adult Child Infant	• Resides at cottage for limited period (estimated 76 days per year) • Obtains water (in part) from springs • Maintains a small garden from which they supply a fraction of their fruit and vegetable needs: ○ 13% of their own vegetables ○ 11% of their own fruit ○ 10% of their own potatoes • Acquires a fraction of their meat requirements from a specialty shop that is supplied with beef from farms in the region • Does not raise animals for self-consumption purposes • Does not partake in hunting, nor in fishing in nearby ponds
Local resident at Petawawa (liquid) Figure 7	Adult Child Infant	• Resides at location on a full-time basis • Use and consumption of their water from municipal supply drawn from the Ottawa River ○ 86% of their drinking water ○ 96% of their washing and bathing • Swims in the Ottawa River during the summer months • Spends a fraction of time walking on the shoreline • Irrigates their lawns and gardens with river water • Consumes local fish from the Ottawa River

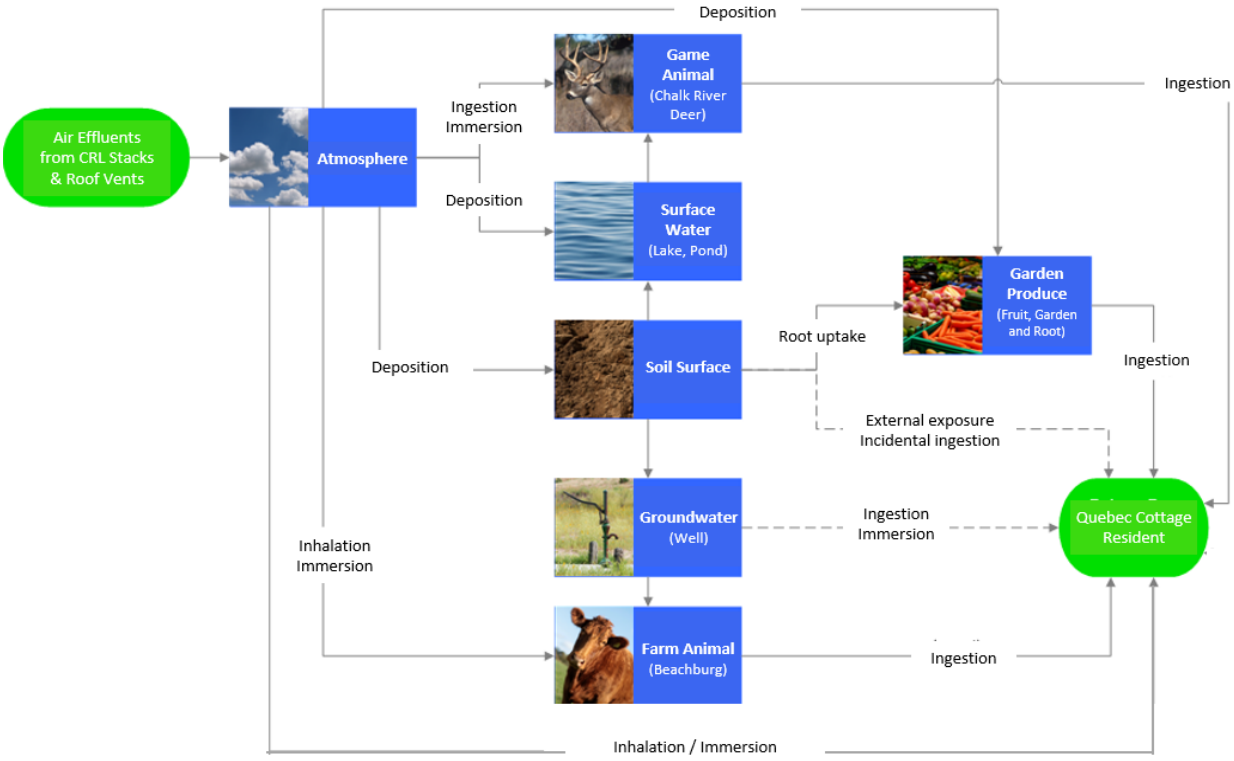


Figure 6: Conceptual Model of Exposure Pathways from CRL Airborne Emissions

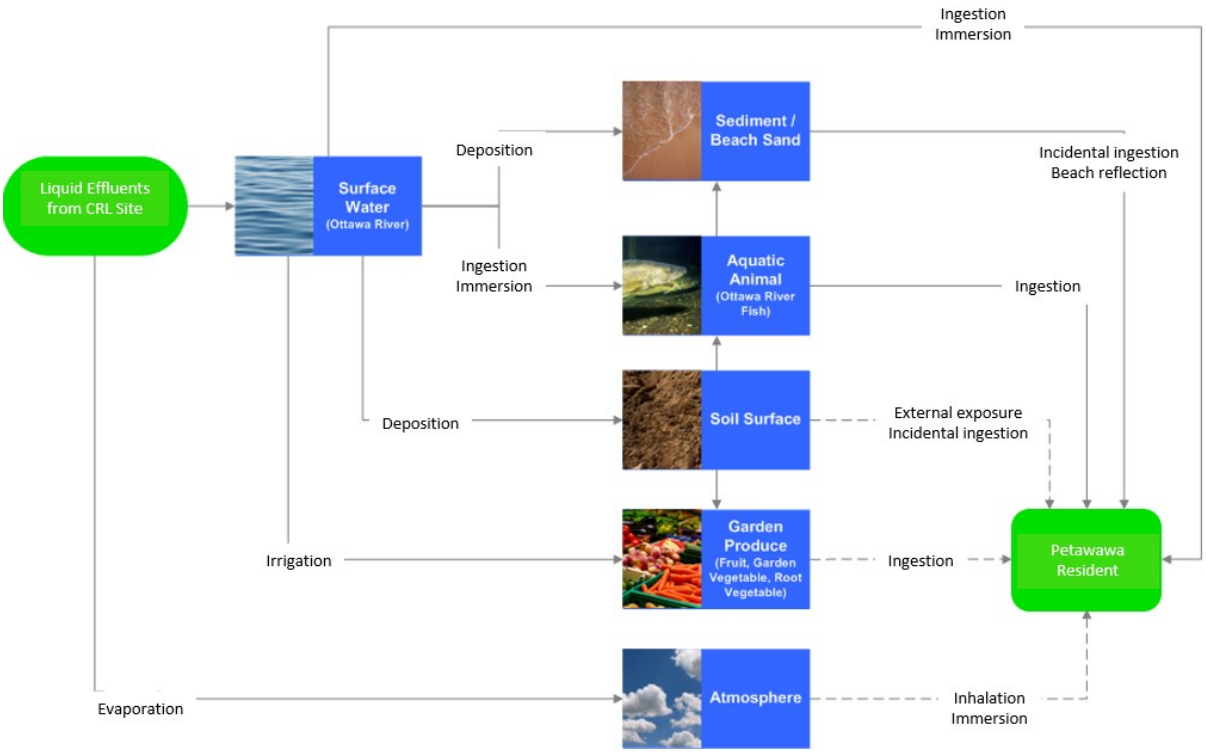


Figure 7: Conceptual Model of Exposure Pathways from CRL Liquid Effluents

The most restrictive annual DRLs for each nuclide are listed in *Derived Release Limits for CNL's Chalk River Laboratories* [16]. Dose estimates to members of the local communities that are based on the DRLs are conservative. The CSA Standard N288.1 [23], which forms the basis for development of DRLs, includes conservative values for food intake and other parameters. In some cases, even more conservative site-specific data are used.

5.2 Environmental Risk Assessment

An important part of a site's Environmental Protection Program (Effluent and Environmental) is the ERA, a process that evaluates the likelihood and probability that adverse effects may occur as a result of past and present operations. The ERA for the CRL site evaluates both the potential health risks to human receptors (HHRA), and the potential population effects to ecological receptors (EcoRA) [15]. The results of the ERA, together with recommendations associated with gaps and uncertainties, provide guidance in the detailed design of the EMP.

The following two subsections outline the HHRA and EcoRA, and uncertainties or gaps associated with the current ERA are covered in Section 11.5.2.

5.2.1 Human Health Risk Assessment

The HHRA examined potential health risks to human receptors that may be exposed to contaminants released from CRL. Off-site human receptors (i.e., members of the public) selected for evaluation in the HHRA included local residents and cottagers, similar to those described by the DRL model (see Section 5.1). Figure 6 and Figure 7 show the relevant exposure pathways for the human receptors.

Radiological dose estimates for all human receptors were found to be below the NSCA dose limit of 1 mSv/y [17], therefore, no adverse effects are expected.

For non-radiological contaminants in air, there were no exceedances of the non-carcinogenic benchmarks, and no exceedances of the carcinogenic risk threshold, therefore no undue risk to human receptors is expected, based on the available data and assumptions made.

5.2.2 Ecological Risk Assessment

The EcoRA identifies eleven different MUs on CRL property that may be associated with radiological and non-radiological releases from operations at CRL (Figure 8). CNL has organized the CRL Site into MUs to better plan for remediation. A MU is an area of affected land within a specified boundary that has been defined to enable a coordinated approach to the planning of preliminary modelling and assessments, remedial investigations, remedial actions and the development of interim management plans, as well as long term remediation/decommissioning strategies and cleanup criteria. Different contaminant concentrations and ecological receptor species are located within each MU.

The results of the ERA for each MU are summarized in Table 2. The applicable receptor pathways and the specific ecological receptors for each area are further described in the ERA [15].

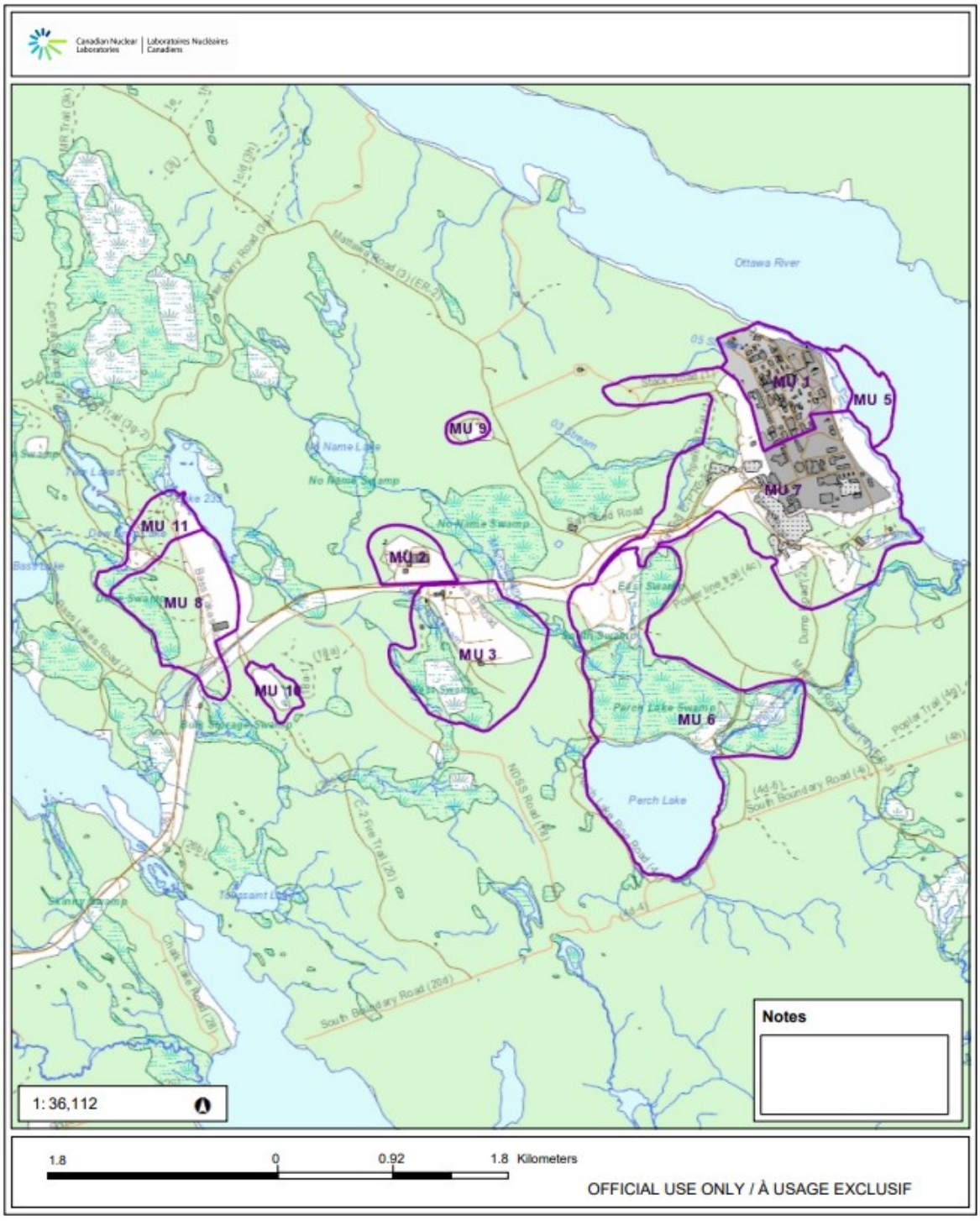


Figure 8: Management Unit Boundaries

Note: Management Unit #4 is considered to be all of the Outer Area not included any of the above defined locations.

Table 2: Potential Physical and Chemical Hazards Associated with each Management Unit at CRL

Location	Hazard Characterization Conclusions
MU 1 (Controlled Area)	**Radiological:** This area has well-characterized tritium and Sr-90 groundwater plumes that are documented in the Groundwater Monitoring Program (GWMP) documents [8]. **Non-radiological:** Several non-radiological contaminants of potential concern (COPCs) were identified for effluent streams 4F6 Manhole, 4F7 Manhole, Process Outfall, and 05 Outfall. These releases are characterized and tracked in the EVMP [5].
MU 2 (WMA D, G, H)	No radiological or non-radiological COPC identified.
MU 3 (WMA B)	**Radiological:** Sr-90 plume in the Spring B and West Swamp areas have resulted in appreciable quantities in aquatic and terrestrial environments. Also, tritium plume (south area of WMA B) is moving towards Main Stream. **Non-radiological:** VOCs are elevated in a solvent plume (north-east area of WMA B) that is well documented in GWMP documents [8]. Several metal COPCs were identified in surface water or sediment in this area including Cu, Fe, Sr, and Zn.
MU 4 (Outer Area)	**Radiological:** No radiological COPC identified. **Non-radiological:** Chloride and Zn concentrations are elevated at a number of areas. Sediment concentrations of B, Br, and Cd are elevated in some locations. Concerns in MU 4 primarily relate to physical disturbances including road mortality and habitat alterations, which are further discussed in [10].
MU 5 (Ottawa River – effluent discharge from the Process Outfall)	**Radiological:** No radiological COPC identified. **Non-radiological:** Elevated mercury concentrations in Ottawa River sediment adjacent to the CRL site were found, and an ongoing sediment verification monitoring program occurs every 5 years in order to monitor conditions [23] (see Section 11.5.1.1).
MU 6 (WMA A, Liquid Dispersal Area, Perch Lake)	**Radiological:** Sr-90 in South Swamp and East Swamp areas and Cs-137 in East Swamp. Co-60 has been identified in sediments and soils as well. **Non-radiological:** Several metals were found at elevated concentrations in surface water and sediment. 2-butanone, acetone, and methylene chloride have been identified in sediment concentrations as they volatilize in the surface environment.
MU 7 (Grey Crescent)	There are various isolated areas of known contamination within MU 7 including the Electrical Yard Landfill, the LDA pipeline route, and the Sanitary Landfill. **Radiological:** No radiological COPC identified. **Non-radiological:** Surface waters contain elevated concentrations of chloride, Hg, total suspended solids (TSS), V, and Zn. Effluent steams, under the EVMP [5], have shown elevated values for some metals,

Location	Hazard Characterization Conclusions
	benzylbutylphthalate, ammonia compounds, anions and phenolics.
MU 8 (WMA C, WMA J and Duke Swamp south)	**Radiological:** No radiological COPC identified. **Non-radiological:** In surface water and sediment at Duke Swamp, chloride and TSS were elevated.
MU 9 (WMA E and Tank Farm)	No radiological or non-radiological COPC identified.
MU 10 (WMA F)	**Radiological:** Ra-226 is elevated in the waste soils brought to WMA F from various locations such as Port Hope and Ottawa. **Non-radiological:** No non-radiological COPC identified.
MU 11 (Nitrate Plant, ACS Pits, Thorium Pit and Duke Swamp north)	**Radiological:** No radiological COPC identified. **Non-radiological:** In surface water, chloride levels were elevated.

6. Need for an Environmental Monitoring Program at CRL

The criteria used to determine the need for an EMP at CRL are based on the requirements in Clause 5 of the CSA N288.4-19 Standard [12] as well as those outlined in the CRL Environmental Monitoring Program document [1] and duplicated in Table 3 below. An EMP is needed if one or more of the criteria is met. As indicated in Table 3, more than one criterion is met at CRL, thus necessitating the establishment of an EMP.

Table 3: Need for an Environmental Monitoring Program at CRL

Criteria	Criteria Met at CRL (Yes/No & Justification)
*The concentration, intensity, or other appropriate characteristics of a contaminant, physical stressor, or an effect on the environment **shall** be measured by CRL if one or more of the following criteria are triggered:*	
(a) Environmental monitoring of that contaminant, physical stressor, or effect is required by Authorities Having Jurisdiction (AHJs).	Yes: • Licence Condition 9.1 of the CNSC-granted CRL Operating License [24] states that the "licensee shall implement and maintain an environmental protection program, which includes a set of action levels." • Licence Condition 9.2 of the CNSC-granted CRL Operating License [24] states that the "licensee shall prepare and submit to CNSC staff […] written reports that cover […] (e) the results of environmental monitoring for nuclear substances and hazardous substances." • REGDOC-2.9.1. [17] states that "the licensee shall use applicable regulatory monitoring requirements and the ERA to identify the need for and complexity of the environmental monitoring." • REGDOC-3.1.2 [25] outlines the reporting components required under the EMP.

Criteria	Criteria Met at CRL (Yes/No & Justification)
(b) The results of the ERA (or equivalent) indicate a reasonable likelihood that the concentration of a contaminant or the intensity of a physical stressor could pose a potential risk.	Yes: The results of the ERA [26] for the CRL site indicate that there is reasonable likelihood that the concentration of some hazardous substances and radioactive contaminants (primarily Sr-90) in localized regions of the CRL site could pose a potential risk.
(c) The effective dose to members of an off-site critical group from all radioactive emissions from the site during normal operations and anticipated transients is estimated to exceed 5×10^{-5} Sv (or 0.05 mSv) per year [23]	No: Since the shutdown of NRU in 2018, the calculated effective dose to off-site members of the public (i.e., critical groups) from all radioactive emissions from CRL has decreased from 0.036 mSv in 2018, to 0.0024 mSv in 2023. The current values are well below the threshold and is not expected to increase substantially based upon current site operations.
(d) The potential effective dose to members of an off-site critical group from all radioactive emissions from the site in the event of an accident is estimated to exceed 1×10^{-3} Sv (or 1 mSv) per year [17]	No: There are no longer any source terms at the CRL site that would result in an off-site dose rate of this magnitude. For any event rated at frequencies greater than 1 in 30 years.
(e) There are uncertainties in environmental transfer parameters such that emissions from the site could potentially cause doses exceeding the levels in c) or d)	No: Based on the levels detailed in criteria (*c)* and the reasoning in *(d)*, any uncertainty associated with the DRL model and effluent/emissions monitoring results will not result in an exceedance as values are too low.
*Note that a few additional criteria were also considered in evaluating the need to establish and Environmental Monitoring Program: An Environmental Monitoring Program **may** also be established if:*	
(a) The level of risk from a potential spill or other unintended release of contaminants from the facility is unknown or has been determined, by an ERA (or equivalent) to be of concern;	Yes: Risk has been extensively assessed in the CRL ERA [15]. Furthermore, the facility has various engineered safety features, programs, or systems to provide protection against- or mitigation of- the release of contaminants to the environment (e.g., surveillance programs such as the EVMP or the various system process monitoring). The EMP parallels a defense-in-depth approach by providing a redundant and independent means of identifying unplanned emissions.

Criteria	Criteria Met at CRL (Yes/No & Justification)
(b) The emission of contaminants is highly variable	No: No variability is anticipated, and past empirical data indicates this as well.
(c) The level of risk from unmonitored releases is unknown or has been determined, by an ERA (or equivalent) to be of concern;	No: Risk has been extensively assessed (see item (a) above) and is known to be minimal.
(d) There are other business reasons, i.e., stakeholder and Indigenous community concerns, due diligence, etc.;	Yes: There is a need to address concerns from local communities and increase the credibility of CNL in the eyes of the public, and the EMP plays a role in this. The program generates data that can be shared with the public, the program ensures monitoring of various environmental compartments such as fish, game and farm animals, such that all monitoring demonstrates due diligence and serves solely to address actual or potential stakeholder concerns.
*The concentration, intensity, or other appropriate characteristics of a contaminant, physical stressor, or an effect on the environment **should** be measured by CRL where multi-stressor effects can be reasonably expected to occur:*	
Multi-stressor effects can reasonably be expected to occur	Yes: Multi-stressor effects can reasonably be expected to occur.

7. Design by Systematic Planning Process

In accordance with Clause 6.2 of the CSA N288.4-19 Standard [13], the EMP is designed using the data quality objectives (DQO) systematic planning process. The DQO process consists of six iterative steps that are documented in Figure 9 below. The main sections of this document follow the steps in the DQO process. Cross-references to the sections of this document that relate to each step in the DQO process are included in Figure 9. While the interaction of these steps is portrayed in Figure 9 in a sequential fashion, the iterative nature of the DQO process means that one or more of these steps will be revisited when making additions or changes to the already existing EMP.

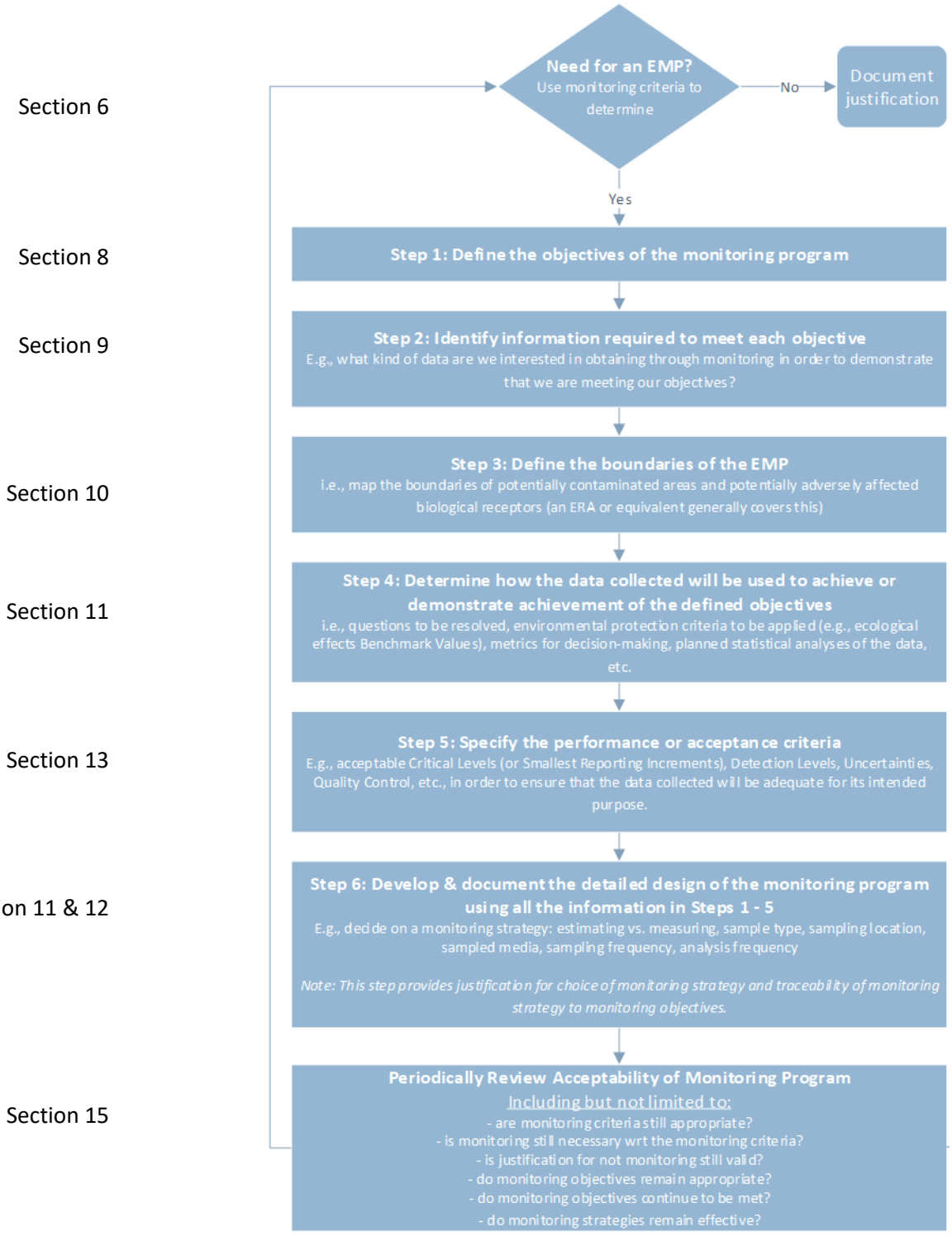


Figure 9: Systematic Planning Process for the Development of the Environmental Monitoring Program at CRL

8. Environmental Monitoring Program Objectives

This Section covers the first step of the Systematic Planning Process (see Figure 9): *Define the Objectives of the Environmental Monitoring Program.*

The objectives to be considered as part of an EMP are outlined in Clause 4 of the CSA N288.4-19 Standard [12] and detailed in the Environmental Monitoring Programs standard [1] and the Framework document [2]. The specific objectives of the CRL EMP are listed below and include primary and secondary objectives.

8.1 Primary Objectives

1. *To assist in collecting the data required to assess the level of risk on human health and safety, and the potential biological effects in the environment of the contaminants and physical stressors of concern arising from the facility.*

The ERA does not suggest any likelihood of human health effects from radionuclides and non-radioactive hazardous substances releases by CRL. However, potential non-human biological effects in the environment and evaluation criteria exceedances are identified in the ERA.

They largely relate to organisms that reside in or near the WMAs that are exposed to trace metal and radionuclide concentrations in surface and groundwater, and sediment. Hence, they will be assessed on a regular basis by comparing measured concentrations in relevant exposure media to evaluation criteria, where available. Such routine monitoring will also serve to confirm exposure conditions, and to provide data in support of the next ERA update.

Potential biological effects that are identified in the ERA and were based on modelled exposure concentrations can be assessed more reliably using measured concentrations in relevant exposure media. EMP components will provide these concentrations.

Detailed monitoring program design to meet this program objective is described in Section 11.1.

2. *To demonstrate compliance with any applicable limits on the concentration and/or intensity of contaminants and physical stressors in the environment or their effect on the environment.*

Regulatory requirements necessitate calculating radiation doses to representative persons for comparison to the public dose limit [25]. Measured radionuclide concentrations in environmental media along relevant exposure pathways are used to confirm the results of effluent/emissions monitoring and its conclusion that all releases are below the DRLs and can be used to calculate realistic doses to the representative person(s). The EMP will provide these measurements.

Detailed monitoring program design to meet this program objective is described in Section 11.2.

3. *To check, independently of effluent monitoring, on the effectiveness of containment and effluent/emissions control, and provide public assurance of the effectiveness of containment and effluent control.*

The control of contaminant releases to the environment is determined by monitoring of significant effluent/emission streams at CRL. An approximate check on the accuracy of this effluent/emission monitoring can be obtained by measuring contaminant concentrations in the environment. For example, weekly tritium emissions monitoring are compared to environmental air monitoring results at stations approximately 1-2 km from the built-up area of CRL.

Containment is assessed by monitoring within close proximity to the points of discharge, and in the likely path of the discharges. For example, deposition is collected at the property boundary in both dominant wind directions. Surface water is collected downgradient of sources as well as any identified groundwater plume discharge areas. The containment of HTO and beta/gamma emitters within the WMAs can be confirmed by weekly monitoring of runoff at these downgradient locations. An increase in concentrations beyond that expected by seasonal effects and rainfall events can be an indication of loss of containment.

Detailed monitoring program design to meet this program objective is described in Section 11.3.

4. *Further to the objective described above, which provides an indication on effectiveness of effluent control, where waste storage facilities and contaminated lands exist, provide an indication of unusual or unforeseen conditions that might require corrective action or additional monitoring such as groundwater monitoring.*

In areas surrounding WMAs, known areas of contamination exist. Surface water monitoring at downgradient discharge locations can serve to provide an indication of unusual or unforeseen surfacing of contaminants from a breach of containment, etc.

Detailed monitoring program design to meet this program objective is described in Section 11.4.

5. *To assist in collecting the data required to provide data to verify the predictions made by the ERA (or equivalent), Derived Release Limit (DRL) model, and/or Environmental Assessment (EA), refine the models used in the ERA (or equivalent), DRL model and/or EA, or reduce the uncertainty in the predictions made by the ERA (or equivalent), DRL model and/or EA.*

Most of the uncertainty associated with the ERA is related to data gaps. The main areas of uncertainty and the monitoring activities that have been implemented in order to address the uncertainties are described in Section 11.5.

8.2 Secondary Objectives

6. *To provide data required to support site restoration programs, site operations or to plan for future stages of the facility lifecycle (e.g., decommissioning).*

Yes: Data collected as part of the EMP is used to support site restoration programs, site operations or to plan for future stages of the facility lifecycle. For example:

- Groundwater and surface water monitoring data in and around the WMAs is used to

support the characterization of these areas to better plan for and prioritize closure and remediation projects.

- Environmental monitoring data was used to support the Environmental Assessment (EA) for the Near Surface Disposal Facility (NSDF).
- Environmental monitoring data was used to support the characterization of the site for a baseline study for siting the Small Modular Reactor (SMR) project.

CRL anticipates similar needs for EMP data in the future.

Detailed monitoring program design to meet this program objective is described in Section 11.6.

7. *To provide resources and data that can be of value during the response to an accident or upset, and in the recovery from such an event.*

Yes: Data generated by the EMP is available for use in response to an accident or upset, and in the recovery from such an event, and part of the province's response to an emergency through the dispatch of monitoring capabilities.

Detailed monitoring program design to meet this program objective is described in Section 11.7.

8. *To demonstrate due diligence.*

Since the ERA has not suggested any likelihood of human health effects from radionuclides and non-radioactive substances released by CRL, and since CNSC Regulatory Reporting Requirement [25] only requires reporting of doses for the most exposed group of people, monitoring at other locations demonstrates due diligence by the station. Similarly, since the monitoring to check on effluent/emission control and continuing containment is precautionary, it serves to demonstrate due diligence.

Detailed monitoring program design to meet this program objective is described in Section 11.8.

9. *To meet the needs and expectations of stakeholders and Indigenous communities, and any other business purposes.*

CRL meets the requirements of the CNSC Regulatory Requirements document 3.2.1 [27], which is documented in the Public Information Program (PIP) document [28] and takes into consideration any public requests for environmental monitoring.

Detailed monitoring program design to meet this program objective is described in Section 11.9.

9. Identify Information Required to Meet Each Objective

This Section covers Step 2 of the Systematic Planning Process (see Figure 9): Identify information required to meet each objective.

Defining the information required to meet each objective of the EMP is a useful pre-cursor to development of the detailed design of the program (i.e., Step 6 of the Systematic Planning

Process). In order to do this, each objective has been translated into clear criteria about receptors, locations, environmental media, contaminants, physical stressors and measures of biological effect to be monitored. These criteria were pulled from a comprehensive review of the guidance provided in Clause 7.2 through Clause 7.8 of the CSA N288.4 Standard [13] and documented in *Environmental Monitoring Programs* [1] as well as in the program overview document [2].

Using these criteria, the information needed to meet each specific objective (e.g., Environmental Pathways Monitoring) was identified and is summarized in Table 4. It should be noted that there are cases where monitoring activities serve the purpose of more than one objective. If this is the case, the details on this monitoring are typically covered under each objective and cross-referenced to other pertinent objectives.

Table 4: Information Required to Meet Each Objective of the Environmental Monitoring Program

Objective	Information Required to Meet the Objective	
Primary Objectives		
1. *To assist in collecting the data required to assess the level of risk on human health and safety, and the potential biological effects in the environment of the contaminants and physical stressors of concern arising from the facility.*	What relevant exposure pathways and receptors of interest are applicable to the contaminants released in CRL effluents and emissions? Are the contaminant concentrations along these pathways below applicable evaluation criteria? Are contaminant concentrations measured in the environment of concern to biological receptors? Are contaminant concentrations measured in the environment of concern to public health and safety?	**Environmental Pathways Monitoring (Section 11.1.1):** Monitor contaminants relevant to the dose/exposure assessments that are part of the ERA (including both HHRA and EcoRA), along exposure pathways relevant to the receptors of interest for the site. **Evaluation Criteria Exceedances (Section 11.1.2):** Generate data to confirm that concentrations in the environment are below evaluation criteria, where the potential for exceedances have been identified by the ERA. Generate data for relevant reference locations to ensure consideration of possible high backgrounds. **Biological Effects Monitoring (BEM)** (**Section 11.1.3):** Based on measures of contaminant concentration, physical stressor intensity, and results of the ERA [29] there are currently several instances where biological effects could be anticipated. BEM is not currently part of the CRL EMP but is being evaluated through non-routine projects (i.e., fish impingement studies in the past).
2. *To demonstrate compliance with any applicable limits on the concentration and/or intensity of contaminants and physical stressors in the environment or their effect on the environment.*	Did the measured contaminant concentrations in the environmental compartments applicable to CRL effluents and emissions result in a dose to an off-site member of the public in excess of the public dose limit?	**Monitoring to assess the dose to public (Section 11.2.1):** Demonstrate that the dose to public does not exceed the CNSC public dose limit of 1 mSv/yr. Monitor tritium in surface water to confirm that it does not exceed Health Canada's drinking water guideline.

Objective	Information Required to Meet the Objective	
3. *To check, independently of effluent monitoring, on the effectiveness of containment and effluent control, and provide public assurance of the effectiveness of containment and effluent control.*	In areas that have the potential to release contaminants to the environment, is there movement of contaminants beyond applicable boundaries? Are there any increasing trends in contaminant concentrations in the environment?	**Monitoring around Waste Management Areas, Affected Lands and Developed Areas (Section 11.3.1):** CRL has numerous operating and legacy waste areas. For many, the point of discharge is groundwater seepage, therefore monitoring needs to be situated at downgradient surface water locations where groundwater discharge occurs. This includes both chemical and radiological contaminant plumes. **Monitoring around Specific Facilities (Section 11.3.2):** Monitoring at 010 Stream, as it could receive low-level radioactive water from the Tritiated Light Water Storage Facility (B217) in the event of a failure of containment. **Monitoring at the Property Boundary (Section 11.3.3):** Understand any movement of contaminants past the property boundary, including ambient air, deposition and surface water. Maintaining property boundary monitoring as an independent check on the effectiveness of containment.
4. *Further to the objective described above, which provides an indication on the effectiveness of effluent control, where waste storage facilities and contaminated lands exist, the objective is to provide an indication of unusual or unforeseen conditions that might require corrective action or additional monitoring such as groundwater monitoring.*	Are there increasing contaminant concentration trends in areas where waste storage facilities and contaminated lands exist? For any increasing trend identified where waste storage facilities and contaminated lands exist, is a corrective action or additional monitoring needed?	**Monitoring surface waters near WMAs or in areas where there is potential for the surfacing of groundwater plumes, etc. (Section 11.4):** Monitoring is done in order to detect any breach of containment of WMA structures. For example, if there something unusual noted in surface water, check source groundwater area, if the issue is not already monitored in groundwater, then this would be the trigger to initiate that monitoring.

Objective	Information Required to Meet the Objective	
5. *To assist in collecting the data required to provide data to verify the predictions made by the ERA (or equivalent), Derived Release Limit (DRL) model, and/or Environmental Assessment (EA), refine the models used in the ERA (or equivalent), DRL model and/or EA, or reduce the uncertainty in the predictions made by the ERA (or equivalent), DRL model and/or EA*	What are the contaminants of potential concern are identified by the ERA or EAs? What parameters are identified in the DRL model as the highest potential contributors to public dose?	**(Section 11.5)** The information required to meet Objective 5 can change quite a bit with each new update or development of the site's ERA, DRL model, or EAs. There are cases where changes are made to the EMP in efforts to verify predictions and/or reduce uncertainties (e.g., addition of sediment monitoring) alternatively, the information gathered is instead considered non-routine or special investigation monitoring and is incorporated into the next version of the ERA, DRL model or EAs. Data collected through the EMP in support of the ERA feeds into the ERA update cycle, creating a continual improvement loop for the program.
Secondary Objectives		
6. *To provide data required to support site restoration programs, site operations or to plan for future stages of the facility lifecycle (e.g., decommissioning).*	Can any of the routine sampling serve as baseline and reference data in project planning?	**Monitoring to support restoration, operations, decommissioning activities (Section 11.6):** In support of numerous proposed and on-going activities at CRL, the need to monitor groundwater, surface water, ambient air and deposition in the vicinity of the built-up area, proposed development areas and WMAs to continually evaluate the potential long-term impacts.
7. *To provide resources and data that can be of value during the response to an accident or upset, and in the recovery from such an event;*	In an emergency situation, can any of the routine sampling we complete serve as a baseline and evidence of the extent of the event?	**(Section 11.7)** In the event of an emergency, routine baseline data collected through the EMP can be shared and monitoring capabilities (i.e., resources and equipment) can be provided. If the routine monitoring can serve as both baseline and evidence of an emergency condition, compare the pre-event results to the post-event result to aid in the determination of the extent of the event.

Objective	Information Required to Meet the Objective	
8. *To demonstrate due diligence;*		**(Section 11.8)** CRL has adopted the approach to maintain a more extensive EMP than the minimum specified in the regulations; this includes monitoring at various locations not because the ERA has suggested any likelihood of public or ecological health effects or because there is a regulatory requirement, but instead to demonstrate due diligence.
9. *To meet the needs and expectations of stakeholders and Indigenous communities, and any other business purposes (e.g., monitoring emissions to support international treaties).*	Are there any contaminants/media/locations that are of particular interest to stakeholders and Indigenous communities?	**(Section 11.9)** If public requests are made requiring additional environmental monitoring to be put in place, these requests would be addressed on a case-by-case basis and may be in the form of special investigation monitoring or an addition to the routine EMP.

Notes: All of the guidance provided in Clause 7.2 through Clause 7.7 of the CSA N288.4 Standard [12], were used in order to define what information was required to meet the specific objective.

10. Boundaries of the Environmental Monitoring Program

The boundaries of the EMP are shown in Figure 10. The boundary starts beyond the final point of control for an airborne or waterborne release and extends out to the spatial boundaries defined in the ERA based on receptor location and range. It includes all natural areas, both on-site and off-site, that may be subject to exposure to stressors originating from site operations. It does not include the developed areas of the site where natural habitat has been largely displaced. This monitoring plan also does not address effluent/emissions monitoring at CRL, nor the exposure of workers or visitors to the CRL site to nuclear substances, which is controlled by CNL's Radiation Protection Program.

A more detailed description of locations where potentially impacted areas intersect with ecological receptor habitat within the site boundary is available in the ERA [26].

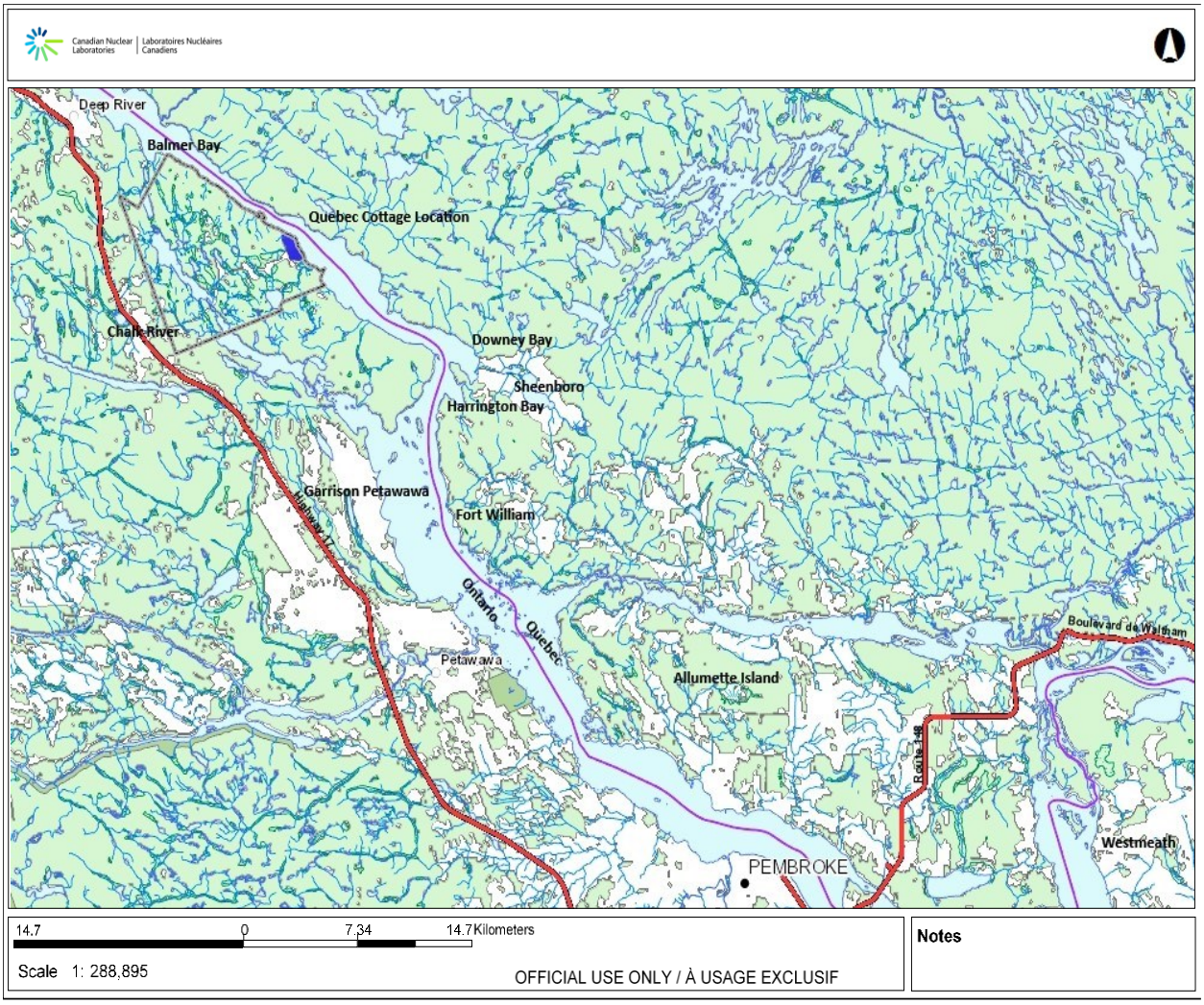


Figure 10: Boundaries of the Environmental Program

11. Design by Objective

This section (in combination with Section 12) covers Step 4 and Step 6 of the Systematic Planning Process (see Figure 9).

Step 4: Determine how the data collected will be used to achieve the defined objectives.

Step 6: Develop the detailed design of the EMP.

This section captures the decisions on the Receptors of interest; Monitoring locations; Environmental media; Contaminants; Physical stressors; and, Measures of biological effect, which are included in the EMP along with a high level description on the process used to decide on what is included.

This Section also outlines how the information collected for each Objective (as identified in Table 4) is used to achieve that objective.

11.1 OBJECTIVE 1: To assist in collecting the data required to assess the level of risk on human health and safety, and the potential biological effects in the environment of the contaminants and physical stressors of concern arising from the facility

The radioactive data obtained from the EMP are used to assess the level of risk to human health and safety by calculating radiation doses to the most exposed off-site members of the public (i.e., critical groups) as identified in the DRL model for CRL [16]. These calculations address the significant exposure pathways and, where available, incorporate local intake fractions based on a site-specific survey of human receptors in the area.

Based on the results of the ERA for the Chalk River site [15], there is reasonable likelihood that the concentration of some hazardous substances could pose a potential risk; therefore, non-radiological data obtained from the EMP are used to assess the level of risk on the environment.

11.1.1 Environmental Pathways Monitoring

A key aspect of environmental monitoring is to assess the level of risk that contaminants can pose to humans and the environment. To accomplish this, it is important to measure contaminant concentrations along pathways that are relevant to the human and ecological receptors of interest, in areas that are potentially impacted by site activities, and compare them to baseline concentrations and to effects-based criteria (i.e., evaluation criteria) to identify areas where there is a potential risk.

In order to assess the level of risk that contaminants may pose to ecological receptors residing on and around the CRL site, and to the public residing in nearby communities, information from the ERA [15] and DRL model [16] for the CRL site (summarized in Section 5) were used to identify the receptors, locations, media, contaminants and physical stressors to be monitored. Details are provided in the following sub-sections.

Table 8, Table 9, Table 10 and Table 11, and Figure 11 (at the end of Section 11.1.1) summarize the monitoring performed as part of the EMP in order to gather the information needed to assess the level of risk that contaminants may pose to human and ecological receptors residing on and around the CRL site.

Note that monitoring to address gaps or uncertainties in the HHRA and the EcoRA for the site is covered under Objective 2 (Section 11.2).

11.1.1.1 Selection of Receptors of Interest

The **human receptors** of interest are the Representative Persons identified in *Derived Release Limits for CNL's Chalk River Laboratories* [16]. The three representative groups associated with radioactive airborne and liquid releases from CRL include:

Local resident (airborne): An adult, child and infant who live at Balmer Bay, obtain their water (for bathing, swimming and drinking) from a shallow well, and consume local fruit, vegetables, potatoes and deer.

Seasonal resident (airborne): An adult, child and infant who live at Québec Cottage Location A on the north shore of the Ottawa River in close proximity to CRL. The cottage properties are generally not accessible by road and are not occupied on a permanent basis, with rare exceptions (Figure 6).

Local resident (liquid): An adult, child and infant who live on the shore of the Ottawa River, and communities that are serviced with water drawn from the Ottawa River, i.e., Petawawa (Figure 7).

The characteristics of each group are described in Section 5.1 and Table 1.

The potential health risks to human receptors were assessed by a HHRA completed as part of the ERA for the CRL site (Section 5.2.1). The results of the HHRA showed that no adverse effects to human receptors are expected as a result of radiological releases from CRL. Similarly, for non-radiological contaminants in air, no undue risk to human receptors is expected. However, because regulatory requirements necessitate calculating annual radiation doses to the public (see Section 0), monitoring along human exposure pathways makes up an important component of the EMP and hence is included under Objective 1. Section 0 (Objective 2) covers in greater detail how the monitoring data are used to assess the dose to public.

The **ecological receptors** of interest are those identified in the ERA and are based upon the types of ecosystems present at CRL and the species that reside in each. In order to effectively assess the risk to ecological receptors, the CRL site is divided into two ecosystems:

- Aquatic: Includes the lakes, wetlands and streams on and surrounding the CRL site.
- Terrestrial: Includes the land on and surrounding the CRL site.

11.1.1.2 Selection of Monitoring Locations

The locations chosen for pathways monitoring in and around CRL include all locations that trigger the environmental monitoring criteria defined to meet Objective 1. The rationale used in

the selection of locations to be monitored in the EMP is discussed below and further detailed in Section 11.1.1.5.

All monitoring activities with the objective of assessing the level of risk to human receptors (i.e., the public) take place off-site. This is because no member of the public is expected to be on the CRL site. Furthermore, all persons working or visiting the site are covered by the site's radiation protection and health and safety programs. A large portion of the off-site locations monitored in the EMP are representative of CRL's critical groups. As part of the DRL calculations, doses were modelled for a number of potential critical groups selected based on lifestyle and proximity to CRL. Monitoring is done near all potential critical groups, with the focus being on the critical groups that are likely to receive the highest radiation doses as a result of CRL operations. In cases where there is public concern regarding emissions, monitoring is established in nearby population centres other than locations of identified or potential critical groups, or identified in the ERA.

All monitoring activities with the objective of assessing the level of risk to ecological receptors take place in the two site-specific ecosystems, with a focus on areas where potential effects were identified in the ERA (note that areas where the ERA identified insufficient data to assess risk are addressed under the separate monitoring Objective 5):

- **Aquatic**: Elevated metals concentrations are found in numerous aquatic systems at CRL (Table 2), which could also pose a risk to ecological receptors.
- **Terrestrial**: Organisms are potentially at risk from exposure to Cs-137 in soil at the Chemical Pit.

Surface hydrology is taken into consideration in the selection of monitoring locations. It is convenient to subdivide the WMAs and associated surface water monitoring locations by drainage basin. The three main drainage basins affected by CRL operations are the Perch Lake basin, the Maskinonge Lake basin, and the Ottawa River basin.

There are two categories of sampling locations: indicator and reference. The indicator locations are those locations within the possible influence of routine releases and are selected to be representative of the receptors of interest identified above. The reference locations are selected to be outside the influence of CRL releases, while still being within a similar influence of radioactive and non-radioactive sources external to CRL. Monitoring of reference and indicator locations allows comparison of activity or concentrations in sample media while minimizing interpretation problems associated with changes not related to facility operation. Generally, the airborne pathway reference locations are greater than 20 km from the site, and in a lesser prevalent wind direction. The reference locations for the liquid pathway are generally located up-gradient of the impacted area.

The monitoring locations selected for the EMP are outlined in further detail provided in Section 11.1.1.5.

11.1.1.3 Selection of Environmental Media

The selection of environmental media to be included in the EMP depends on the exposure routes to the receptors of interest. An understanding of receptor exposure pathways was developed (see Sections 5.1 and 5.2) to facilitate selection of appropriate environmental media (or compartments) along the pathways linking the source to the receptor in which to measure contaminants. For radiological releases from CRL, the selection of environmental media also depends upon the physical forms in which the radionuclides were released. For the airborne pathways, the physical forms are gas (e.g., tritium and carbon dioxide), vapour (e.g., water and iodine), and particulate. For the liquid pathways, all radionuclides for which a DRL has been calculated are assumed to be dispersed readily in water. A description of the exposure pathways for human receptors living near CRL can be found in *Derived Release Limits (DRLs) for CNL's Chalk River Laboratories* [16] and a description of the exposure pathways for non-human receptors living on or near CRL can be found in the ERA [15].

For the critical groups that are subject to annual dose assessments, it is necessary to measure radioactive contaminant concentrations in environmental media along applicable/critical exposure pathways. All monitoring activities with the objective of assessing the level of radiation dose risk to human receptors (i.e., the public) include such media as ambient air, vegetation/produce, game animal and fish, surface water, and sediment/beach sand (Figure 6 and Figure 7).

All monitoring activities with the objective of assessing the level of risk to ecological receptors take place in the two previously mentioned ecosystems and cover as many of the media along the exposure routes shown in the ecological exposure diagrams as practical, focusing on those where potential 'downstream' effects were identified in the ERA (note that areas where the ERA identified insufficient data to assess risk are addressed under the separate monitoring Objective 5).

The following principles are considered in the selection of environmental media for pathways monitoring:

- Where practical, monitoring is done near the end of a pathway (i.e., closer to the receptor) to reduce the uncertainties that arise from inaccuracies in the exposure/pathway models and transfer coefficients.
- The fate and distribution of the radionuclides along the pathway linking the source to the receptor are considered when selecting the media to be sampled.
- The mobility of the receptor relative to the area of contamination is considered when selecting the media to be sampled.

The selection of environmental media to be sampled and of contaminants to be measured in each medium also considers the feasibility of sampling the medium, obtaining quantitative results distinguishable from natural background, and obtaining measurements when estimated concentrations have high uncertainty.

11.1.1.4 Selection of Contaminants

The EMP includes radiological and non-radiological/chemical contaminants that are relevant to the exposure assessments that are part of the ERA for the CRL site (Table 5). The radionuclides and chemicals selected for monitoring are measured in relevant environmental media, depending on the physical forms of the radionuclides and chemicals released from CRL, as shown in Table 7. The contaminants chosen for pathways monitoring in and around CRL include all those that trigger the environmental monitoring criteria relevant to Objective 1. The rationale used in the selection of contaminants to be monitored in the EMP is discussed below and detailed in Section 11.1.1.5.

11.1.1.4.1 Radionuclides

The radionuclides selected for monitoring include fission and activation products that have been produced at CRL in the past and have the potential to be present in the environment, that have a half-life long enough to reach the public through releases, and have been detected routinely by the EVMP, and radionuclides estimated to contribute 1% or more of total radiation dose to a representative person, as listed in Table 6. For airborne releases, tritium, radioiodines, Cs-137, U-233/235/238, Pu-239, Ra-226 and Th-232 can be expected in emissions (although there is no longer an operating reactor on-site, there could still be some minor fission and activation product emissions from the management of legacy waste tanks). In addition, Sr-90 can be expected in the environment based on past releases. Prior to the shutdown of NRU in March 2018, noble gases (Ar-41, in particular) and C-14 were major components of releases and were previously considered in the monitoring program. The liquid releases contain a greater number of radionuclides, including Ac-228, U-238, Ra-226, Th-228, with tritium, Co-60, Cs-134/137, Sr-90 and gross alpha/beta particulates having the greatest impact in terms of percent DRL.

Certain elements have to be present in order for radioactivity to accumulate to measurable levels in the environment. The radioisotope must be released in significant quantity from CRL and must be capable of being efficiently transported through the environment. Also, the radioisotope must have a sufficiently long half-life to allow time for environmental transport, sample collection, sample processing and counting. These factors are considered in the selection of radionuclides for inclusion in the EMP, as well as in the selection of the monitoring (i.e., sample collection and analysis) frequency.

There is no regulatory requirement to monitor the concentration of specific radionuclides in the environment. Also, radionuclides at CRL are not important contaminants as defined in CSA N288.4 [13] since none contribute a dose of 10% or more of the relevant dose benchmark to members of the public (i.e., 1 mSv per year). However, they were deemed important for the EMP because of a regulatory requirement to report the dose to the public from CRL operations. To this end, the radionuclides selected for monitoring include those estimated to contribute 1% or more of total radiation dose to a critical group, based on the results of historical monitoring and dose assessments for the CRL site (Table 6).

11.1.1.4.2 Non-Radiological Parameters

The chemicals/ physical attributes identified as contaminants for the CRL site in the ERA [26] are identified in Table 5.

11.1.1.4.3 Meteorological and Hydrological Patterns

Measurements of meteorological data are used for modelling of contaminant dispersion following atmospheric release and aquatic release, and to produce the triple joint frequency distribution required by the DRL model.

For example, the deposition of particulate radionuclides from air to soil and from air to plant is calculated in IMPACT – the tool used to derive DRLs for the CRL site [16] – based on both wet and dry deposition velocities. The wet deposition velocity is calculated for each wind sector based on the fraction of time the wind blows into that sector during rain events, the washout ratio and the precipitation rate.

At CRL, site-specific meteorological measurements are made. This information is used for input into the DRL model and the model for estimating dose to the public. For atmospheric modelling, hourly measurements of wind direction, wind speed, and atmospheric stability are usually needed. For aquatic modelling, data on water depth, current speed, and current direction are usually needed.

Table 5: Summary of Parameters Selected for Environmental Monitoring at CRL

Radionuclides [a]		General Chemistry	Field Parameters	Metals	Other
Ac-228	Mo-99	Alkalinity (as $CaCO_3$)	Conductivity	Aluminum	Solvent Extractables
Ag-108m	**Nb-94**	Chemical oxygen demand	pH	Antimony	Polychlorinated biphenyls
Ag-110m	Nb-95	Nitrate + Nitrite	Dissolved Oxygen	Arsenic	Phenolics
Am-241	Pa-233	Total Kjedahl Nitrogen		Barium	Volatile Organic Compounds
Ar-41	Pb-212	Sodium		Boron	Dioxins/Furans
Ba-133	Pb-214	Sulphur (sulphate+sulphide)		Cadmium	
Ba-140	**Ra-226**	Total Dissolved Solids		Chromium	
Be-7	**Ra-226P**	Total Suspended Solids		Copper	
Bi-212	Ru-103	Dissolved Organic Carbon		Iron	
Bi-214	Ru-106	Total Organic Carbon		Lead	
Ce-141	Sb-124	Total Phosphorus		Lithium	
Ce-144	Sb-125	Hardness		Mercury	
Co-57	**Sc-46**	Chloride		Nickel	
Co-60	Se-75	Sulphate		Selenium	
Cr-51	**Sr-90**			Strontium	
Cs-134	Ta-182			Uranium	
Cs-137	Tc-99m			Vanadium	
Eu-152	**Th-228**			Zinc	
Eu-154	Th-234				
Eu-155	Tl-208				
Fe-59	U-235				
Hf-175	**U-238**				
Hf-181	Zn-65				
K-40	Zn-95				
Kr-85	**HTO**				
Mn-54					

Notes:

[a] Radionuclides that are in bold are those that are routinely detected in CRL effluents [4], groundwater, or that are estimated to contribute 1% or more of total radiation dose to a representative person, as listed in Table 6

Table 6: Dose Contribution by Radionuclide for the CRL Site

Parameter	2019			2020			2021			2022			2023		
	Adult	Child	Infant	Adult	Child	Infant	Adult	Child	Infant	Adult	Child	Infant	Adult	Child	Infant
Gross Alpha				12.0%	24.2%	20.9%	13.2%	20.2%	16.8%	29.3%	37.1%	35.6%	30.6%	38.8%	37.1%
Cs-137	24.0%	21.3%	29.7%	76.5%	60.7%	60.4%	59.2%	49.2%	52.7%	46.8%	33.4%	36.6%	50.3%	39.0%	42.3%
Sr-90	46.9%	56.2%	38.8%												
Tritium	28.2%	21.4%	30.0%	11.3%	14.6%	17.7%	22.8%	25.5%	26.3%	7.0%	9.1%	10.6%	8.1%	11.8%	12.7%
C-14	0.9%	1.1%	1.4%				0.00%	0.00%	0.00%	4.9%	9.4%	8.7%			
Co-60	0.02%	0.02%	0.05%	0.1%	0.3%	0.6%	0.8%	2.2%	2.5%	1.8%	4.8%	5.2%	1.6%	4.3%	4.5%
Cs-134	0.02%	0.01%	0.01%	0.08%	0.2%	0.4%	4.0%	2.9%	1.8%	10.3%	6.2%	3.2%	9.4%	6.1%	3.3%

Table 7: Radionuclide and Chemical Contaminants Monitored in Environmental Media

Environmental Media	Pathway	Radionuclide/ Chemical Contaminant
Ambient Air	Airborne	- tritium (H-3) - direct radiation: ambient gamma (total dose, thermoluminescent dosimeter (TLD) - radiocarbon (C-14)[a]
Surface Water	Liquid	- gamma emitters (detailed) - tritium (H-3) - alpha/beta emitting particulates (gross) - strontium (Sr-89/90) - general chemistry (and associated calculated parameters) - trace metals - field parameters - PCBs
Sediment	Liquid	- trace metals - VOCs - dioxins and furans
Beach Sand	Liquid	- gamma emitters (detailed), gamma survey
Foodstuff: Farm animal	Airborne	- free-water tritium - organically bound tritium - alpha/beta emitting particulates (gross) - gamma emitters (detailed) - strontium (Sr-89/90)
Foodstuff: Game animal	Airborne	- free-water tritium - organically bound tritium - alpha/beta emitting particulates (gross) - gamma emitters (detailed) - strontium (Sr-89/90)
Foodstuff: Produce/Vegetation	Airborne	- free-water tritium - organically bound tritium - alpha/beta emitting particulates (gross) - gamma emitters (detailed) - strontium (Sr-89/90)

Environmental Media	Pathway	Radionuclide/ Chemical Contaminant
Foodstuff: Fish	Liquid	- free-water tritium - organically bound tritium - alpha/beta emitting particulates (gross) - gamma emitters (detailed) - radiocarbon (C-14)
Deposition	Airborne	- alpha/beta emitting particulates (gross)
Roads	Airborne	- direct radiation: ambient gamma

[a] C-14 monitoring only serves as a baseline for upcoming NSDF, i.e., no current C-14 airborne emissions that require ambient air C-14 monitoring

11.1.1.5 Detailed Selection of Locations and Parameters

11.1.1.5.1 Ambient Air

Ambient air is monitored at CRL under Objective 1 because external exposure to, and inhalation of contaminants in ambient air could contribute to the dose to human (off-site) and non-human (on-site) receptors.

There are a total of 23 ambient air monitoring stations in the EMP that measure one or more of the contaminants given in Table 7. There are five locations on CRL property, seven at the CRL property boundary, and 11 are located off-site. Of these, three locations are identified as potential Critical Groups in the DRL model [16] and one is a reference location: A08 located at Balmer Bay, A13 located across the river from the CRL built-up area, A45 located downriver at Sheenboro, Québec, and background location A42 in Rankin. Therefore, these f locations meet the criteria under Objective 1, while the remaining off-site locations fall under different objectives. Each of these locations is described in Table 8, with associated parameters, showing how the criteria under Objective 1 are met.

In order to assess exposure to radiation via this pathway, tritium in air is monitored with the use of passive diffusion samplers – liquid scintillation vials containing a solution of 50% water and 50% glycol – designed to sample the air at a rate of one litre per day. The samples are collected and analyzed quarterly, with the exception being the locations on the Québec side of the Ottawa River, which are not accessible in winter months. These locations are collected semi-annually.

Thermoluminescent dosimeters (TLDs) measure the external gamma exposures that can result from immersion, largely from cosmic radiation and ground contamination (i.e., groundshine) due to the settling of particulates. They also measure the contribution to dose from natural background radiation. At CRL, there is no significant source of noble gases, therefore the TLDs are capturing these natural forms of radiation.

Table 8: Environmental Pathway Monitoring: Ambient Air at CRL

Code	Location Name	Sample Type	Justification for Sample Type	Criteria for Location	Justification for Location	Parameter	Criteria for Parameter	Justification for Parameter	Cross ref to other objectives
A08 A13 A45	Balmer Bay Québec, Opposite CRL Québec, Sheenboro	CRL Site Boundary; Indicator; Continuous measurement	Continuous monitoring is desirable due to the fleeting nature of the immersion pathway. Air quality is typically subject to meteorological variability over the course of a year (i.e. changes in wind direction, wind speed, and atmospheric stability on hourly time scales). To capture this variability and produce representative annual average contaminant concentrations, continuous monitoring frequencies are used. See Table 21	(shall) If a location is representative of a site's identified critical group(s), then this location shall be included in the EMP. Human Health Pathways Monitoring: Air Inhalation & Immersion	All CRL airborne emissions arising from roof vents and stacks. Located in the prevalent wind direction from the NRU Stack and the built-up area. May be impacted by airborne emissions from the NRU Stack and other stacks/roof vents in the built-up area. Balmer Bay resident, Québec Cottage Location A, and Sheenboro Farm Critical groups identified in the DRL report.	Total Gamma	(should) The radioactive contaminant chosen for monitoring should be those estimated to contribute 1% or more of total radiation dose to members of a critical group	Monitoring results used in public dose calculations prior to NRU and MPF shutdown (Ar-41 and other radioxenon emissions). Now that source is gone, TLD measurements continue to provide a spatial verification of the relative composition of the radioactivity in the air; the external gamma exposures that may be due to immersion in a plume, and from ground contamination due to the settling of particulates based on comparison of locations.	0 11.7 11.8
						Tritium	(should) The radioactive contaminant chosen for monitoring should be those estimated to contribute 1% or more of total radiation dose to members of a critical group	Released in measurable quantities from some stacks and roof vents. Monitoring results used in public dose calculations.	0 11.7 11.8
A42	Rankin (Background)	Off-site; Reference, Continuous measurement	Continuous monitoring is desirable due to the fleeting nature of the immersion pathway. Air quality is typically subject to meteorological variability over the course of a year (i.e. changes in wind direction, wind speed, and atmospheric stability on hourly time scales). To capture this variability and produce representative annual average contaminant concentrations, continuous monitoring frequencies are	(should) In addition to the locations mentioned above, locations with similar environmental conditions but without potential for facility-related effects (i.e. representative of natural background) should be included in the EMP as reference areas.	All CRL airborne emissions arising from roof vents and stacks. Located outside of the prevalent wind direction. Reference site to establish local background.	Total Gamma	(should) The radioactive contaminant chosen for monitoring should be those estimated to contribute 1% or more of total radiation dose to members of a critical group	Monitoring results used in public dose calculations prior to NRU and MPF shutdown (Ar-41 and other radioxenon emissions). Now that source is gone, TLD measurements continue to provide a spatial verification of the relative composition of the radioactivity in the air; the external gamma exposures that may be due to immersion in a plume, and from ground contamination due to the settling of particulates based on	

Code	Location Name	Sample Type	Justification for Sample Type	Criteria for Location	Justification for Location	Parameter	Criteria for Parameter	Justification for Parameter	Cross ref to other objectives
			used. See Table 21					comparison of locations.	

11.1.1.5.2 Surface Water

Surface water is monitored at and around CRL under Objective 1 because it could contribute to the dose to human (off-site) and non-human (on-site). Surface water contributes to human dose through immersion in (e.g., swimming, washing, etc.), and ingestion of contaminated river/lake water.

Monitoring of surface water at locations downgradient of, and within reasonable proximity to, points of groundwater discharge are included in the EMP. Monitoring at these locations is intended to show the movement of contaminants from the groundwater to the surface environment where it becomes available to aquatic receptors. This also provides feedback to the GWMP. The evaluation of the groundwater results together with the surface water results is done at the GWMP's annual Environmental Performance Review, and as part of the annual EMP Report. Locations that fall under this category include:

- East Swamp Weir (ESW), which receives groundwater from the Chemical and Reactor Pits area.
- South Swamp Weir (SSW), which receives groundwater from the Reactor Pit 2 (RP2) compound and WMA A.
- Frog Pond Seepage (FPS), which receives groundwater from Reactor Pit 1 (RP1).
- West Swamp monitoring location (BHL), which receives groundwater from the circular bunkers in the southern portion of WMA B.

Surface waters may be monitored in locations downstream of areas where significant soil contamination exists (or could potentially exist) that could be transported to nearby surface water bodies (e.g., erosion, runoff). Presently, there are no known or suspected areas that meet this requirement for monitoring at CRL.

Surface hydrology is taken into consideration in the selection of monitoring locations. It is convenient to subdivide the waste management areas and associated surface water monitoring locations by drainage basin. The three main drainage basins affected by CRL operations are the Perch Lake basin, the Maskinonge Lake basin, and the Ottawa River basin. Within each basin, surface waters can be further subdivided by sub-basin (Appendix B).

Flow monitoring is not required under CSA N288.4. However, for monitoring locations that also fall under the umbrella of the EVMP, flow is required to calculate an emission (loading) rate for all effluent streams leaving the CRL site. This is described in Table 9, in accordance with the requirements of CSA N288.5 [3].

There are 23 surface water monitoring stations that are included under Objective 1 and measure one or more of the contaminants given in Table 7. There are 16 locations on CRL property, five for the Ottawa River, and two are located off-site. Of these, three locations are identified as potential Critical Groups in the DRL model [15] and six are reference locations. Each of these locations is described in Table 9, with associated parameters, showing how the criteria under Objective 1 are met. A map of surface water monitoring locations is provided in Appendix B.

Table 9: Environmental Pathways Monitoring: Surface Water at and Around CRL

Code	Location Name	Sample Type	Justification for Sample Type	Criteria for Location	Justification for Location	Parameter	Criteria for Parameter	Justification for Parameter	Cross ref to other objectives
Ottawa River Water									
ORD ORR	Deep River, Ottawa River Rolphton, Ottawa River	Off-site, Reference; Daily Grab samples	Water quality is subject to natural hydrological variability over the course of a year (e.g. temperature variations, currents, precipitation, etc.). See Table 21	(should) Locations with similar environmental conditions but without potential for facility-related effects (i.e. representative of natural background) should be included in the EMP as reference areas.	There is a high level of public concern regarding levels of radioactivity in local drinking water. Monitoring at water treatment plants upstream of CRL serves to confirm the absence of impacts. The upstream portion of the Ottawa River is not affected by CRL operations, therefore serves as a reference site for the Ottawa River.	Tritium Gross Alpha/Beta Gamma emitters (detailed)	(shall) The concentration of a contaminant or the intensity of a physical stressor shall be measured if, based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	Monitoring results used to perform background deduction in public dose calculations. Serves as reference monitoring for the Ottawa River, thus monitoring is for the same parameters as downstream locations.	0 11.3 11.8
ORF ORH PET	Fort William, Ottawa River Harrington Bay, Ottawa River Petawawa, Ottawa River	Off-site, Indicator; Semi-Annual Grab samples (ORF, ORH) Off-site, Indicator; Daily Grab samples (PET)	Water quality is subject to natural hydrological variability over the course of a year (e.g. temperature variations, currents, precipitation, etc.). See Table 21	(shall) If a location is representative of a site's identified critical group(s), then this location shall be included in the EMP. Human Health Pathways Monitoring: Ingestion of Water	Downstream residents located at, Harrington (Downey) Bay, Petawawa/Fort William, Critical groups identified in the DRL report.	Tritium Gross Alpha/Beta Gamma Emitters (detailed)	(should) The radioactive contaminant(s) chosen for monitoring should be those estimated to contribute 1% or more of total radiation dose to members of a critical group.	Monitoring results used in public dose calculations. Water ingestion is a relevant pathway for exposure to critical groups that get their drinking water from the river. Serves as a periodic verification of the relative composition of the radionuclides in the Ottawa River.	11.3 (ORF,ORH) 0 11.8
Ottawa River Direct Basin									
010	Storm Outfall 010 (MU7)	On-site; Indicator; Monthly Grab sample (rads)	Water quality is subject to natural hydrological variability over the course of a year (e.g. temperature variations, currents, precipitation, etc.). See Table 21	(may) If a gradient in contaminant concentration is expected over a spatial extent, monitoring locations may be distributed along the gradient.	The 010 Outfall is located down gradient of the inactive landfill site and Grey Crescent site, accepting groundwater discharges from both areas. This location is found at the end of the gradient, a final discharge point before the Ottawa River.	Flow	Essential for determining contaminant loading to watercourses.		11.3
						Tritium Gross Alpha/Beta Gamma Emitters (detailed)	Primarily Effluent Verification Program		

Code	Location Name	Sample Type	Justification for Sample Type	Criteria for Location	Justification for Location	Parameter	Criteria for Parameter	Justification for Parameter	Cross ref to other objectives
		Semi-annual Grab sample (non-rads)	See Section 12.2	(should) If a location represents an area in which contaminants of concern, physical stressors of concern, or potential effects were identified in an ERA (or equivalent), then this location should be included in the EMP.	The ERA [15] identified several COPC, including Al, Cl, Hg, Total Suspended Solids, V, and Zn in the undiluted stream.	Field Parameters General Chemistry Metals	See Appendix A (Table A-1)		11.3 11.8
020	Stream 020 (MU7)	On-site; Indicator; Semi-annual Grab sample (rads)	Water quality is subject to natural hydrological variability over the course of a year (e.g. temperature variations, currents, precipitation, etc.). See Table 21	(should) If a location represents an area in which contaminants of concern, physical stressors of concern, or potential effects were identified in an ERA (or equivalent), then this location should be included in the EMP.	020 Stream receives groundwater and runoff from the Supervised Area below the inactive landfill and Grey Crescent sites before it discharges to the Ottawa River. The 020 Stream does not receive any controlled discharges from CRL. This location is found at the end of the gradient, a final discharge point before the Ottawa River. The ERA [15] identified TSS as a COPC at 020 Stream.	Flow	Essential for determining contaminant loading to watercourses.		11.3 11.8
						Tritium Gross Alpha/Beta	(shall) The concentration of a contaminant or the intensity of a physical stressor shall be measured if based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	Surface waters on CRL property receive groundwater, runoff, and effluent from various facilities and WMAs that are potential sources of radioactive contamination	
		Semi-annual Grab sample (non-rads)	See Section 12.2			Field Parameters General Chemistry Metals	See Appendix A (Table A-2)		
PIS	Pipeline Stream	On-site, Indicator; Semi-Annual Grab sample	See Table 21	(should) Any locations in which contaminant benchmark concentrations have been exceeded or are predicted to be exceeded should be included in the EMP.	Located downgradient of the Salt Storage Shed. May be impacted by leaching of chlorides from the facility.	Anions Metals	(shall) The concentration of a contaminant or the intensity of a physical stressor shall be measured if, based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	Metals and Anions identified in the ERA as being of potential ecological concern at O-3 Swamp. Appendix A (Table A-17)	11.5

Code	Location Name	Sample Type	Justification for Sample Type	Criteria for Location	Justification for Location	Parameter	Criteria for Parameter	Justification for Parameter	Cross ref to other objectives
KMC	Kennedy's Creek at Welsh's Bay	Off-site, Reference; Annual Grab sample (rads) Semi-annual Grab samples	See Section 12 and Table 21	(should) In addition to the locations mentioned above, locations with similar environmental conditions but without potential for facility-related effects (i.e. representative of natural background) should be included in the EMP as reference areas.	Located off-site, west-northwest (WNW) of the Chalk River site. Not subject to the influence of the WMAs	Tritium Gross Alpha/Beta Field Parameters General Chemistry Metals	(should) In addition to the locations mentioned above, locations with similar environmental conditions but without potential for facility-related effects (i.e. representative of natural background) should be included in the EMP as reference areas.	At certain locations where surface waters have not been affected by CRL operations, monitoring serves to confirm the absence of impacts. See Appendix A (Table A-3)	
S07	Spring 7 at Garrison Petawawa	Off-site, Reference; Annual Grab sample	See Table 21	(should) In addition to the locations mentioned above, locations with similar environmental conditions but without potential for facility-related effects (i.e. representative of natural background) should be included in the EMP as reference areas.	Located off-site, east-southeast (ESE) of the Chalk River site. Not subject to the influence of the WMAs.	Tritium Gross Alpha/Beta	(should) In addition to the locations mentioned above, locations with similar environmental conditions but without potential for facility-related effects (i.e. representative of natural background) should be included in the EMP as reference areas.	At certain locations where surface waters have not been affected by CRL operations, monitoring serves to confirm the absence of impacts.	
Perch Lake Basin									
BHL	Swamp at WMA B Hydro Line (MU3)	On-site, Indicator; Quarterly Grab sample	Water quality is subject to natural hydrological variability over the course of a year (e.g. temperature variations, currents, precipitation, etc.). Quarterly data are representative of seasonal variability in hydrological conditions. See Table 21	(should) If a location represents an area in which contaminants of concern, physical stressors of concern, or potential effects were identified in an ERA (or equivalent), then this location should be included in the EMP. (should) Any location in which contaminant evaluation criteria have been exceeded or are predicted to be exceeded should be included in the EMP.	BHL is located in the southeastern (downstream) portion of West Swamp. West Swamp receives groundwater and runoff from WMA B. The main sources of contamination in WMA B are the circular bunkers in the southern portion of WMA B and the unlined sand trenches in the northwest corner of WMA B. There is the potential for Sr-90 concentrations at this location to exceed the evaluation criteria.	Tritium Gross Alpha/Beta Total Strontium Gamma emitters (detailed)	(may) If a gradient in contaminant concentration is expected over a spatial extent, monitoring locations may be distributed along the gradient. (shall) The concentration of a contaminant or the intensity of a physical stressor shall be measured if, based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	Concentrations in surface waters at several locations within the Perch Lake basin are relevant to dose assessments that are part of the ERA. BHL is downgradient of the Spring B discharge at WMA B.	11.3

Code	Location Name	Sample Type	Justification for Sample Type	Criteria for Location	Justification for Location	Parameter	Criteria for Parameter	Justification for Parameter	Cross ref to other objectives
ESW	East Swamp Weir (MU6)	On-site, Indicator; Weekly Grab sample (rads and non-rads) Semi-annual Grab Sample (non-rads)	Water quality is subject to natural hydrological variability over the course of a year (e.g. temperature variations, currents, precipitation, etc.). Samples are collected weekly from surface water that are subject to drainage from potentially contaminated areas. See Table 21 See Section 12.2	(should) If a location represents an area in which contaminants of concern, physical stressors of concern, or potential effects were identified in an ERA (or equivalent), then this location should be included in the EMP. (should) Any location in which contaminant evaluation criteria have been exceeded or are predicted to be exceeded should be included in the EMP. (may) If a gradient in contaminant concentration is expected over a spatial extent, monitoring locations may be distributed along the gradient.	ESW is located along East Swamp Stream, which receives groundwater and runoff from the Laundry Pit, the east side of RP2, and the Chemical Pit within the LDA. Sr-90 concentrations at this location have exceeded the evaluation criteria. The ERA [15] identified Fe and Sr as COPC in East Swamp.	Flow	Essential for determining contaminant loading to watercourses.		11.3
						Tritium Gross Alpha/Beta Total Strontium Gamma emitters (detailed)	(shall) The concentration of a contaminant or the intensity of a physical stressor shall be measured if, based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	Concentrations in surface waters at several locations within the Perch Lake basin are relevant to dose assessments that are part of the ERA.	
						Field Parameters General Chemistry Metals PCBs	Appendix A (Table A-12)		
FPS	Frog Pond Seepage (MU6)	On-site, Indicator; Quarterly Grab sample	Water quality is subject to natural hydrological variability over the course of a year (e.g. temperature variations, currents, precipitation, etc.). Quarterly data are representative of seasonal variability in hydrological conditions. See Table 21	(should) If a location represents an area in which contaminants of concern, physical stressors of concern, or potential effects were identified in an ERA (or equivalent), then this location should be included in the EMP. (should) Any location in which contaminant evaluation have been exceeded or are predicted to be exceeded should be included in the EMP.	FPS receives groundwater from RP1 within the LDA. Sr-90/gross beta concentrations at this location have exceeded the evaluation.	Gross Alpha/Beta	(shall) The concentration of a contaminant or the intensity of a physical stressor shall be measured if, based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	Concentrations in surface waters at several locations within the Perch Lake basin are relevant to dose assessments that are part of the ERA. Gross beta is assumed to be primarily Sr-90.	11.3
MAR	Main Stream	On-site, Indicator;	See Section 12	(may) If a gradient in contaminant	MAR is located along the upper reach of Main Stream	Tritium	(may) If a gradient in contaminant	Surface waters on CRL property receive	11.3

Code	Location Name	Sample Type	Justification for Sample Type	Criteria for Location	Justification for Location	Parameter	Criteria for Parameter	Justification for Parameter	Cross ref to other objectives
	Above Plant Road (MU2,9)	Semi-annual Grab sample		concentration is expected over a spatial extent, monitoring locations may be distributed along the gradient. (should) If a location represents an area in which contaminants of concern, physical stressors of concern, or potential effects were identified in an ERA (or equivalent), then this location should be included in the EMP.	(fed by No Name Swamp), which receives groundwater and surface runoff from WMAs D, E, G and H, the Salt Storage Facility, and the Waste Tank Farm. Also, being upgradient from WMA A and B, this location provides a gradient perspective with MSC. The ERA [15] identified Cl and Zn as COPCs at MAR.	Gross Alpha/Beta	concentration is expected over a spatial extent, monitoring locations may be distributed along the gradient.	groundwater, runoff, and effluent from various facilities and WMAs that are potential sources of radioactive contamination.	
						Field Parameters General Chemistry Metals	Appendix A (Table A-10)		
MSC	Main Stream Culvert (MU3,6)	On-site, Indicator; Weekly Grab sample (rads and non-rads)	Water quality is subject to natural hydrological variability over the course of a year (e.g. temperature variations, currents, precipitation, etc.). Samples are collected weekly from surface water that are subject to drainage from potentially contaminated areas. See Table 21. See Section 12.2	(should) If a location represents an area in which contaminants of concern, physical stressors of concern, or potential effects were identified in an ERA (or equivalent), then this location should be included in the EMP.	MSC is located along Main Stream downstream of where the stream intercepts the groundwater and surface runoff from WMA B. The main source of radioactivity to Main Stream from WMA B is the circular bunkers in the southern portion of the WMA. The ERA [15] identified chloride as a COPC at MSC	Flow	Essential for determining contaminant loading to watercourses.		11.3
						Tritium Gross Alpha/Beta Gamma emitters (detailed)	(shall) The concentration of a contaminant or the intensity of a physical stressor shall be measured if, based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	Concentrations in surface waters at several locations within the Perch Lake basin are relevant to dose assessments that are part of the ERA.	
						Field Parameters General Chemistry Metals	Appendix A (Table A-11)		
PCW	Perch Creek Weir (MU3,6)	On-site, Indicator; Weekly Grab sample (rads and non-rads) Semi-annual	Water quality is subject to natural hydrological variability over the course of a year (e.g. temperature variations, currents, precipitation, etc.). Samples are collected weekly from	(should) If a location represents an area in which contaminants of concern, physical stressors of concern, or potential effects were identified in an ERA (or equivalent), then this location should	PCW is located along Perch Creek, downstream of the Perch Lake outlet, and receives groundwater and surface runoff from WMAs A, B, D, E, G, H, the LDAs (Laundry Pit, RP1, RP2, and the Chemical Pit), the Waste	Flow	Essential for determining contaminant loading to watercourses.		11.3 11.8
						Tritium Gross Alpha/Beta Total	Primarily Effluent Verification Program: Concentrations in surface waters at several locations within the Perch Lake basin are relevant to dose assessments that are part of the ERA. According to the results of the ERA, gross beta (primarily Sr-90) in surface waters of the Perch Lake basin has the		

Code	Location Name	Sample Type	Justification for Sample Type	Criteria for Location	Justification for Location	Parameter	Criteria for Parameter	Justification for Parameter	Cross ref to other objectives
		Grab Sample (non-rads)	surface water that are subject to drainage from potentially contaminated areas. See Table 21.	be included in the EMP. (should) Any location in which contaminant evaluation criteria have been exceeded or are predicted to be exceeded should be included in the EMP. (may) If a gradient in contaminant concentration is expected over a spatial extent, monitoring locations may be distributed along the gradient.	Tank Farm, the Salt Storage Shed and the rest of the Perch Lake basin. There are no sources of contamination entering Perch Creek below this location, so that measurements at PCW can be used to assess total releases. There is the potential for Sr-90 concentrations at this location to exceed the evaluation criteria.	Strontium Gamma emitters (detailed)	potential to have an effect on non-human receptors		
						Field Parameters General Chemistry Metals PCBs	Appendix A (Table A-7)		
PL1	Perch Lake Inlet 1 (MU3)	On-site, Indicator; Weekly Grab sample (rads) Semi-annual Grab Sample (non-rads)	Water quality is subject to natural hydrological variability over the course of a year (e.g. temperature variations, currents, precipitation, etc.). Samples are collected weekly from surface water that are subject to drainage from potentially contaminated areas. See Table 21 See Section 12.2	(should) If a location represents an area in which contaminants of concern, physical stressors of concern, or potential effects were identified in an ERA (or equivalent), then this location should be included in the EMP. (should) Any location in which contaminant evaluation criteria have been exceeded or are predicted to be exceeded should be included in the EMP. (may) If a gradient in contaminant concentration is expected over a spatial extent, monitoring locations may be distributed along the gradient.	PL1 is an inlet of Perch Lake, located downstream of West Swamp, which receives groundwater and runoff from WMA B. The main sources of contamination in WMA B are the circular bunkers in the southern portion of WMA B and the unlined sand trenches in the northwest corner of WMA B. There is the potential for Sr-90 concentrations at this location to exceed the evaluation criteria. The ERA [15] identified TSS as a COPCs at PL1	Flow	Essential for determining contaminant loading to watercourses.		11.3
						Tritium Gross Alpha/Beta	(shall) The concentration of a contaminant or the intensity of a physical stressor shall be measured if, based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	Concentrations in surface waters at several locations within the Perch Lake basin are relevant to dose assessments that are part of the ERA.	
						Field Parameters General Chemistry Metals	Appendix A (Table A-8)		

Code	Location Name	Sample Type	Justification for Sample Type	Criteria for Location	Justification for Location	Parameter	Criteria for Parameter	Justification for Parameter	Cross ref to other objectives
PL2	Perch Lake Inlet 2 (MU6)	On-site, Indicator; Weekly Grab sample (rads and non-rads) Semi-annual Grab Sample (non-rads)	Water quality is subject to natural hydrological variability over the course of a year (e.g. temperature variations, currents, precipitation, etc.). Samples are collected weekly from surface water that are subject to drainage from potentially contaminated areas. See Table 21 See Section 12.2	(should) If a location represents an area in which contaminants of concern, physical stressors of concern, or potential effects were identified in an ERA (or equivalent), then this location should be included in the EMP. (should) Any location in which contaminant evaluation criteria have been exceeded or are predicted to be exceeded should be included in the EMP. (may) If a gradient in contaminant concentration is expected over a spatial extent, monitoring locations may be distributed along the gradient.	PL2 is an inlet of Perch Lake that receives groundwater and surface water runoff from WMAs A and the LDAs (Laundry Pit, RP2, RP2, and Chemical Pit) via South Swamp and East Swamp, and from WMAs B (east side), E, G, and H, and the Waste Tank Farm via Main Stream. There is the potential for Sr-90 concentrations at this location to exceed the evaluation criteria. The ERA [15] identified Cl as a COPC at PL2.	Flow	Essential for determining contaminant loading to watercourses.		
						Tritium Gross Alpha/Beta Gamma emitters (detailed)	(shall) The concentration of a contaminant or the intensity of a physical stressor shall be measured if, based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	Concentrations in surface waters at several locations within the Perch Lake basin are relevant to dose assessments that are part of the ERA.	11.3
						Field Parameters General Chemistry Metals PCBs	Appendix A (Table A-9)		
PL4	Perch Lake Inlet 4	On-site, Reference; Annual Grab sample (rads) Semi-annual Grab sample (non-rads)	See Section 12 and Table 21	(should) In addition to the locations mentioned above, locations with similar environmental conditions but without potential for facility-related effects (i.e. representative of natural background) should be included in the EMP as reference areas.	PL4 is an inlet of Perch Lake. It is not subject to the influence of the WMAS. It serves as a reference site for surface waters of the Perch Lake basin. The only potential contamination would be from atmospheric deposition.	Tritium Gross Alpha/Beta	(should) In addition to the locations mentioned above, locations with similar environmental conditions but without potential for facility-related effects (i.e. representative of natural background) should be included in the EMP as reference areas.	At certain locations where surface waters have not been affected by CRL operations, monitoring serves to confirm the absence of impacts. See Appendix A (Table A-16)	
						Field Parameters General Chemistry Metals			

Code	Location Name	Sample Type	Justification for Sample Type	Criteria for Location	Justification for Location	Parameter	Criteria for Parameter	Justification for Parameter	Cross ref to other objectives
PLO	Perch Lake Outlet (MU3,6)	On-site, Indicator; Weekly Grab sample (rads and non-rads) Semi-annual Grab Sample (non-rads)	Water quality is subject to natural hydrological variability over the course of a year (e.g. temperature variations, currents, precipitation, etc.). Quarterly data are representative of seasonal variability in hydrological conditions. See Table 21	(should) If a location represents an area in which contaminants of concern, physical stressors of concern, or potential effects were identified in an ERA (or equivalent), then this location should be included in the EMP. (should) Any location in which contaminant evaluation criteria have been exceeded or are predicted to be exceeded should be included in the EMP.	PLO is an outlet of Perch Lake, located approximately 1 km upstream of the Perch Creek Weir monitoring location, and receives groundwater and surface runoff from WMAs A, B, D, E, G, H, the LDAs (Laundry Pit, RP1, RP2, and the Chemical Pit), the Waste Tank Farm, the Salt Storage Shed and the rest of the Perch Lake basin. There is the potential for Sr-90 concentrations at this location to exceed the evaluation criteria. The ERA [15] identified several COPC in Perch Lake including Pb, Ag and Zn.	Tritium Gross Alpha/Beta	(shall) The concentration of a contaminant or the intensity of a physical stressor shall be measured if, based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	Concentrations in surface waters at several locations within the Perch Lake basin are relevant to dose assessments that are part of the ERA.	11.3
						Field Parameters General Chemistry Metals PCBs	Appendix A (Table A-15)		
SBD	Spring B Discharge (MU 3)	On-site, Indicator; Monthly Grab sample (rads) Semi-annual Grab Sample (non-rads)	Water quality is subject to natural hydrological variability over the course of a year (e.g. temperature variations, currents, precipitation, etc.). Samples are collected monthly from surface water that are subject to drainage from potentially contaminated areas. See Table 21 See Section 12.2	(should) If a location represents an area in which contaminants of concern, physical stressors of concern, or potential effects were identified in an ERA (or equivalent), then this location should be included in the EMP. (should) Any location in which contaminant evaluation criteria have been exceeded or are predicted to be exceeded should be included in the EMP.	SBD receives groundwater and runoff from WMA B. The main sources of contamination are the unlined sand trenches in the northwest corner of WMA B. The SBD monitoring point is located directly behind the system of intake wells for the new Spring B treatment system. Sr-90 concentrations at this location have exceeded the evaluation criteria. The ERA [15] identified several COPC, including Cl, Fe and Zn.	Tritium Gross Alpha/Beta	(shall) The concentration of a contaminant or the intensity of a physical stressor shall be measured if, based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	Concentrations in surface waters at several locations within the Perch Lake basin are relevant to dose assessments that are part of the ERA.	11.3
						Field Parameters General Chemistry Metals		Appendix A (Table A-14)	

Code	Location Name	Sample Type	Justification for Sample Type	Criteria for Location	Justification for Location	Parameter	Criteria for Parameter	Justification for Parameter	Cross ref to other objectives
SSW	South Swamp Weir (MU6)	On-site, Indicator; Monthly Grab sample (rads) Annual Grab Sample (non-rads)	Water quality is subject to natural hydrological variability over the course of a year (e.g. temperature variations, currents, precipitation, etc.). Samples are collected monthly from surface water that are subject to drainage from potentially contaminated areas. See Table 21 See Section 12.2	(should) If a location represents an area in which contaminants of concern, physical stressors of concern, or potential effects were identified in an ERA (or equivalent), then this location should be included in the EMP. (should) Any location in which contaminant evaluation criteria have been exceeded or are predicted to be exceeded should be included in the EMP. (may) If a gradient in contaminant concentration is expected over a spatial extent, monitoring locations may be distributed along the gradient.	SSW is located along South Swamp Stream, which receives groundwater and runoff from WMA A and RP2 within the LDA Sr-90 concentrations at this location have exceeded the evaluation criteria. The ERA [15] identified Phenolics as a COPC at SSW and Sr in South Swamp.	Tritium Gross Alpha/Beta Total Strontium	(shall) The concentration of a contaminant or the intensity of a physical stressor shall be measured if, based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	Concentrations in surface waters at several locations within the Perch Lake basin are relevant to dose assessments that are part of the ERA.	11.3
						Field Parameters General Chemistry Metals	Appendix A (Table A-13)		
Maskinonge Lake Basin									
DBS	Duke and Bulk Streams	On-site, Indicator; Semi-annual Grab sample	Water quality is subject to natural hydrological variability over the course of a year (e.g. temperature variations, currents, precipitation, etc.). See Section 12 and Table 21	(should) If a location represents an area in which contaminants of concern, physical stressors of concern, or potential effects were identified in an ERA (or equivalent), then this location should be included in the EMP. (should) Any location in which contaminant evaluation criteria have been exceeded or are predicted to be exceeded should be included in the EMP.	It is fed by groundwater and run-off from the watershed that includes WMAs C (low level radioactive), F (Port Hope historic waste) and the Bulk Material Landfill. Sampling is completed just after Duke Stream and Bulk Stream meet and before they discharge into Maskinonge Lake. The ERA [15] identified Cl and Total Suspended Solids as COPCs at DBS.	Field Parameters General Chemistry Metals	Appendix A (Table A-4)		

Code	Location Name	Sample Type	Justification for Sample Type	Criteria for Location	Justification for Location	Parameter	Criteria for Parameter	Justification for Parameter	Cross ref to other objectives
UBI	Upper Bass Lake Inlet	On-site, Reference; Annual Grab sample	See Section 12 and Table 21	(should) In addition to the locations mentioned above, locations with similar environmental conditions but without potential for facility-related effects (i.e. representative of natural background) should be included in the EMP as reference areas.	This inlet is not subject to the influence of the WMAs. It serves as a reference site for surface waters of the Maskinonge Lake basin.	Tritium Gross Alpha/Beta	(should) In addition to the locations mentioned above, locations with similar environmental conditions but without potential for facility-related effects (i.e. representative of natural background) should be included in the EMP as reference areas.	At certain locations where surface waters have not been affected by CRL operations, monitoring serves to confirm the absence of impacts.	
						Field Parameters General Chemistry Metals		Appendix A (Table A-6)	

11.1.1.5.3 Foodstuff: Garden, Produce, Game, Farm and Wild Animal, Fish

Monitoring for radioactivity in garden vegetables is relevant for off-site locations only (Table 10). Garden Produce is monitored because ingestion of contaminated terrestrial plants (e.g., garden vegetables) could contribute to human dose. There are summer vegetable gardens located on-site at the Mattawa Road Gate (MRG) and off-site in Deep River (DRG), Balmer Bay (BBG), Chalk River (CRG), Petawawa (PLG), Pembroke (PMG) and Sheenboro (SLG) that are located at the main population centres in the dominant wind directions from CRL, from which samples of root vegetables, leafy vegetables and fruits are either purchased or obtained at the generosity of garden owners. The reference location for garden samples is Killaloe, from which samples were obtained annually from 2003 to 2018 and is now on a triannual schedule (every three year confirmatory collection) and is currently represented by a long-term average concentration for free-water tritium, organically bound tritium, gross beta, gross alpha, Cs-137, Co-60 and K-40.

Large game animals are monitored because ingestion of contaminated meat (e.g., local game) could contribute to human dose. While different types of animals are hunted (e.g., bear, moose, deer, rabbit, upland birds, migratory game birds, etc.), deer is one of the most popular and has among the highest yields in terms of the quantity of game meat consumed. Deer were, therefore, considered the bounding game animal in the assessment in terms of uptake of radioactivity from ingesting game meat [16]. Efforts are made to collect annual venison samples off-site within 25 km of CRL property boundary, with reference samples from location(s) farther than 50 km from the property boundary. Although hunting is not permitted on CRL property, the home range of the white-tailed deer and moose is such that it is possible for local hunters to catch deer that spend a portion of their time on the CRL site. Some opportunistic samples on the CRL site are available on occasion (i.e., vehicle interaction). On-site animals can serve to verify the effectiveness of containment (i.e., fences around WMAs), however these animals are also included in the dose assessment as it is assumed that their home range would include areas outside of CRL property.

It is important to note that although the DRL model [16] includes ingestion of game animal meat as an environmental exposure pathway to human dose, it does so with certain assumptions. The game animal pathway is considered an airborne emission exposure pathway, with animals becoming contaminated by air inhalation and immersion, as well as ingestion of vegetation potentially affected by deposition of contaminants. This is not necessarily reflective of the on-site game animals that could be exposed to contamination unrelated to air emissions or liquid effluents; rather contamination is likely related to the site's WMAs and resulting on-site contaminated surface water or vegetation.

Small wild animals are monitored on-site when available (i.e., turkeys, beavers) as they could be potentially at risk from ingesting radioactive contaminants (primarily Sr-90) in surface waters of the CRL site. These samples are often collected because of vehicle interaction on CRL roadways, or in the case of nuisance beavers that are trapped.

Ingestion of contaminated terrestrial farm animals could contribute to human dose. However, local meat production is not a big industry in the area, therefore samples directly from critical group locations is not always available. When needed, meat can be purchased from local meat vendors.

Fish are monitored because they are potentially at risk from radioactive contaminants (including tritium, C-14, Cs-134, Cs-137) in surface waters off-site in the Ottawa River, as ingestion of contaminated fish from the Ottawa River could contribute to human dose.

Table 10: Environmental Pathways Monitoring: Foodstuff at CRL

Code	Location Name	Sample Type	Justification for Sample Type	Criteria for Location	Justification for Location	Parameter	Criteria for Parameter	Justification for Parameter	Cross Ref to other Objectives
Garden Produce									
MRG	Mattawa Road Garden	On-site, Indicator; Annual Grab samples of Garden Produce: a) Above-ground fruits; b) Leaf vegetables; c) Root vegetables	See Table 21	(shall) If a location is representative of a site's identified critical group(s), then this location shall be included in the EMP. Human Health Pathways Monitoring: Fruit/Vegetable Ingestion Pathway	Critical Groups: Balmer Bay, identified in the DRL model.	Free-Water Tritium Organically bound Tritium Gross Alpha/Beta Gamma emitters (detailed)	(should) The radioactive contaminant(s) chosen for monitoring should be those estimated to contribute 1% or more of total radiation dose to members of a critical group.	Monitoring results used in public dose calculations. Garden produce ingestion is a relevant pathway for exposure to critical groups that are in the dominant wind directions for airborne emission streams. The accumulated dose due to ingestion of tritium in foods may depend on the chemical form of the tritium (i.e. OBT vs. free-water tritium). Reports have shown that the specific activity of OBT was higher than that of the tritium oxide (HTO) in most food items at environmental levels. The difference in metabolic pathways and turnover rates of HTO and OBT in foods may result in a contribution to dose by OBT significantly higher than of that estimated by simply considering all tritium intake to be in the form of HTO.	0
BBG PLG SLG	Balmer Bay, Local Garden Petawawa, Local Garden Sheenboro, Local Garden	Off-site, Indicator; Annual Grab samples of Garden Produce: a) Above-ground fruits; b) Leaf vegetables; c) Root vegetables	See Table 21	(shall) If a location is representative of a site's identified critical group(s), then this location shall be included in the EMP. Human Health Pathways Monitoring: Fruit/Vegetable Ingestion Pathway	Critical Groups: Balmer Bay, Petawawa, Sheenboro identified in the DRL model.	Free-Water Tritium Organically bound Tritium Gross Alpha/Beta Gamma emitters (detailed)	(should) The radioactive contaminant(s) chosen for monitoring should be those estimated to contribute 1% or more of total radiation dose to members of a critical group.		0
KLG	Killaloe, Farmer's Market	Off-site, Reference; Estimated based on historical average with 3-yr confirmatory samples	See Table 21	(should) Locations with similar environmental conditions but without potential for facility-related effects (i.e. representative of natural background) should be included in the EMP as reference areas. Human Health Pathways Monitoring: Fruit/Vegetable Ingestion Pathway	Garden produce Reference Location: 56 km south of the CRL site out of the prevailing wind direction	Free-Water Tritium Organically bound Tritium Gross Alpha/Beta Gamma emitters (detailed)	(should) The radioactive contaminant(s) chosen for monitoring should be those estimated to contribute 1% or more of total radiation dose to members of a critical group.	The same parameters that are monitored at indicator locations are chosen for reference locations. Monitoring results used to perform background deduction in public dose calculations	0
Game and Farm Animal									

Code	Location Name	Sample Type	Justification for Sample Type	Criteria for Location	Justification for Location	Parameter	Criteria for Parameter	Justification for Parameter	Cross Ref to other Objectives
CRLG R25G	On CRL Property Within 25 km from CRL property	On-site, Indicator; Opportunistic Grab samples of Game Animal: (a) Bone, and (b) Flesh Off-site, Indicator; Donated Grab samples of Game Animal: (a) Bone, and (b) Flesh	See Table 21	(shall) If a location is representative of a site's identified critical group(s), then this location shall be included in the EMP. Human Health Pathways Monitoring: Game/Farm Animal Ingestion	Critical Groups: Sheenboro, Chapeau, Petawawa, Pembroke identified in the DRL model	Free-Water Tritium Organically bound Tritium Gross Alpha/Beta Strontium-90 Gamma emitters (detailed)	(should) The radioactive contaminant(s) chosen for monitoring should be those estimated to contribute 1% or more of total radiation dose to members of a critical group.	Tritium and gross beta are released to the air in measurable quantities from roof vents and stacks at CRL. Sr-90 and other long-lived radionuclides may still be present in the receiving environment from past emissions. Areas on-site with known contamination in surface waters may be contributing an ingestion dose. For on-site and off-site animals, monitoring results used in public dose calculations.	0
R50G	> 50 km away from CRL property	Off-site, Reference; Donated Grab samples of Game Animal: (a) Bone, and (b) Flesh	See Table 21	(should) Locations with similar environmental conditions but without potential for facility-related effects (i.e. representative of natural background) should be included in the EMP as reference areas. Human Health Pathways Monitoring: Game/Farm Animal Ingestion	Game animal reference location: Animal collected from greater than 50 km from the CRL site	Free-Water Tritium Organically bound Tritium Gross Alpha/Beta Strontium-90 Gamma emitters (detailed)	(should) The radioactive contaminant(s) chosen for monitoring should be those estimated to contribute 1% or more of total radiation dose to members of a critical group.	The same parameters that are monitored at indicator locations are chosen for reference locations. Monitoring results used to perform background deduction in public dose calculations	0
LFRM	Off-site (Local Farm)	Off-site, Indicator; Annual Purchased Grab samples of Farm Animal: (a) Bone, and (b) Flesh	See Table 21	(shall) If a location is representative of a site's identified critical group(s), then this location shall be included in the EMP. Human Health Pathways Monitoring: Ingestion of Animal Produce	Critical Groups: Balmer Bay, Laurentian Valley, Quebec Cottage A, Sheenboro Farm. Represented by beef from local meat vendor.	Free-Water Tritium Organically bound Tritium Gross Alpha/Beta Strontium-90 Gamma emitters	(should) The radioactive contaminant(s) chosen for monitoring should be those estimated to contribute 1% or more of total radiation dose to members of a critical group	Tritium and gross beta are released to the air in measurable quantities from roof vents and stacks at CRL. Sr-90 and other long-lived radionuclides may still be present in the receiving environment from past emissions. For on-site and off-site animals, monitoring results used in public dose calculations.	0

Code	Location Name	Sample Type	Justification for Sample Type	Criteria for Location	Justification for Location	Parameter	Criteria for Parameter	Justification for Parameter	Cross Ref to other Objectives
						(detailed)			
Small Wild Animal									
CRL	On CRL Property	On-site, Indicator; Opportunistic Grab samples of Small Wild animal (turkey, beaver, etc.)	See Table 21	(should) Any environmental media in which contaminant evaluation criteria have been exceeded or are predicted to be exceeded should be considered for inclusion in the EMP for measurement of those same contaminants.	Small animals could be potentially at risk from ingesting radioactive contaminants (primarily Sr-90) in surface waters of the Chalk River site	Free-Water Tritium Organically bound Tritium Gross Alpha/Beta Strontium-90 Gamma emitters (detailed)	(shall) The concentration of a contaminant or the intensity of a physical stressor shall be measured if, based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	Tritium and gross beta are released to the air in measurable quantities from roof vents and stacks at CRL, although airborne pathway likely not a significant source. Sr-90 and other long-lived radionuclides may still be present in the receiving environment from past emissions. Areas on-site with known legacy contamination in surface waters may be contributing an ingestion dose. For on-site animals, monitoring results can be used to assess any potential for biological effects.	0
Fish									
HF WF	Highview (Ottawa River Downstream) Westmeath/ Waltham Station (Ottawa River Downstream)	Off-site, Indicator; Grab samples of Ottawa River Fish	See Table 21	(shall) If a location is representative of a site's identified critical group(s), then this location shall be included in the EMP. Human Health Pathways Monitoring: Fish Ingestion	Critical Groups: Downey Bay, Petawawa,	Free-Water Tritium Organically bound Tritium Gross Alpha/Beta Carbon-14 Gamma emitters (detailed)	(should) The radioactive contaminant(s) chosen for monitoring should be those estimated to contribute 1% or more of total radiation dose to members of a critical group.	Released to the Ottawa River in measurable quantities from effluent streams and groundwater contaminant plumes at CRL, either in the past or presently. Some radionuclides (i.e., Cs-137) may not be released but still measurable in fish due to long biological half-life. Monitoring results used in public dose calculations.	0

Code	Location Name	Sample Type	Justification for Sample Type	Criteria for Location	Justification for Location	Parameter	Criteria for Parameter	Justification for Parameter	Cross Ref to other Objectives
MF	Mackey (Upstream of Rolphton Dam)	Off-site, Reference; Grab samples of Ottawa River Fish	See Table 21	(should) Locations with similar environmental conditions but without potential for facility-related effects (i.e. representative of natural background) should be included in the EMP as reference areas. Human Health Pathways Monitoring: Fish Ingestion	Ottawa River Fish reference site, located 36 km upriver from the CRL site.	Free-Water Tritium Organically Bound Tritium Gross Alpha/Beta Carbon-14 Gamma Emitters	(should) The radioactive contaminant(s) chosen for monitoring should be those estimated to contribute 1% or more of total radiation dose to members of a critical group.	The same parameters that are monitored at indicator locations are chosen for reference locations. Monitoring results used to perform background deduction in public dose calculations	0

11.1.1.5.4 Sediment and Beach Sand

Sediment is monitored at and around CRL under Objective 1 because it can contribute to the dose or exposure of a non-human receptor that is anticipated to experience an effect, and contaminant evaluation criteria have been exceeded or are predicted to be exceeded. Beach sand is monitored at and around CRL under Objective 1 because it can contribute to the dose or exposure of a human receptor (i.e., beach shine).

Sediments can represent a sink for many radioactive and non-radioactive contaminants. There are a total of 15 on-site sediment monitoring locations that measure one or more of the non-radioactive contaminants given in Table 7 as well as radiological parameters at four on-site locations in the Perch Lake Basin on an annual basis. Each of these locations is described in Table 11, with associated parameters, showing how the criteria under Objective 1 are met.

Beach sand is monitored at nine locations along the Ottawa River; two found up-river from the CRL built-up area at Deep River (B01) and Cook's Cove (B04), two located near the CRL property boundary (B05A and B05B at Point au Baptême), and five located down-river at increasing distances from CRL which includes critical group locations.

Table 11: Environmental Pathways Monitoring: Sediment and Beach Sand at CRL

Code	Location Name	Sample Type	Justification for Sample Type	Criteria for Location	Justification for Location	Parameter	Criteria for Parameter	Justification for Parameter	Cross Ref to other Objectives
Sediment									
KMC UBI	Kennedy Creek Upper Bass Lake Inlet	Reference; Annual Sediment Grab sample	See Table 21	(should) Locations with similar environmental conditions but without potential for facility-related effects (i.e. representative of natural background) should be included in the EMP as reference areas.	Not subject to the influence of the WMAs.	Metals	(shall) The concentration of a contaminant or the intensity of a physical stressor shall be measured if, based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	Reference location monitoring is for the same parameters as indicator locations.	
PL4	Perch Lake Inlet 4	Reference; Annual Sediment Grab sample	See Table 21			Metals Volatile Organics Dioxins/Furans Gross Alpha/Beta Tritium		Reference location monitoring is for the same parameters as indicator locations in the Perch Lake Basin.	
DSW	Duke Stream Weir	On-site (Maskinonge Lake Basin), Indicator; Annual Sediment Grab sample	See Table 21	(should) If a location represents an area in which contaminants of concern, physical stressors of concern, or potential effects were identified in an ERA (or equivalent), then this location should be included in the EMP. (should) Any locations in which contaminant benchmark concentrations have been exceeded or are predicted to be exceeded should be included in the EMP.	Located downgradient of WMA C, at the south outlet of Duke Swamp. The ERA [15] identified Cl as a sediment COPC in Duke Swamp.	Metals	(shall) The concentration of a contaminant or the intensity of a physical stressor shall be measured if, based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	See Appendix A (Table A-4).	11.5.2.1
LBL	Lower Bass Lake				Located downgradient of Nitrate, Thorium and ACS pits, at the north outlet of Duke Swamp.	Metals	(shall) The concentration of a contaminant or the intensity of a physical stressor shall be measured if, based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	See Appendix A (Table A-5).	11.5.2.1

Code	Location Name	Sample Type	Justification for Sample Type	Criteria for Location	Justification for Location	Parameter	Criteria for Parameter	Justification for Parameter	Cross Ref to other Objectives
PIS	Pipeline Stream	On-site (Ottawa River Direct Basin), Indicator; Annual Sediment Grab sample	See Table 21	(should) Any locations in which contaminant benchmark concentrations have been exceeded or are predicted to be exceeded should be included in the EMP.	Located downgradient of the Salt Storage Shed. May be impacted by leaching of chlorides from the facility. The ERA [15] identified Bromide and Cd as sediment COPCs in O-3 Swamp.	Anions Metals	(shall) The concentration of a contaminant or the intensity of a physical stressor shall be measured if, based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	Metals and Anions identified in the ERA as being of potential ecological concern at O-3 Swamp.	11.5.2.1
BHL	WMA B at Hydro Line	On-site (Perch Lake Basin), Indicator; Annual Sediment Grab sample	See Table 21	(should) If a location represents an area in which contaminants of concern, physical stressors of concern, or potential effects were identified in an ERA (or equivalent), then this location should be included in the EMP. (should) Any locations in which contaminant benchmark concentrations have been exceeded or are predicted to be exceeded should be included in the EMP	BHL is located in the southeastern (downstream) portion of West Swamp. West Swamp receives groundwater and runoff from WMA B. The ERA [15] identified Bromide and Chloride as sediment COPCs in West Swamp.	Anions Metals	(shall) The concentration of a contaminant or the intensity of a physical stressor shall be measured if, based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	Anions identified in the ERA as being of potential ecological concern at this location.	11.5.2.1
ESW	East Swamp Weir	On-site (Perch Lake Basin), Indicator; Annual Sediment Grab sample	See Table 21		ESW is located along East Swamp Stream, which receives groundwater and runoff from the Laundry Pit, the east side of RP2, and the Chemical Pit within the LDA. The ERA [15] identified Al, Ba, and Organics (acetone, 2-butanone) as sediment COPCs in East Swamp.	Gross Alpha/Beta Tritium	(should) The EMP should include contaminants relevant to the dose/exposure assessments that are normally part of an ERA (or equivalent)	Several of the COPCs that may be present in the contact surface water or leachate are tritium and alpha/beta/gamma emitting radionuclides and the analysis can be used to assess ecological risk.	
						Metals Volatile Organics Dioxins & Furans	(shall) The concentration of a contaminant or the intensity of a physical stressor shall be measured if, based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	See Appendix A. Dioxins and Furans monitored in sediment instead of surface water due to hydrophobic nature.	11.5.2.1

Code	Location Name	Sample Type	Justification for Sample Type	Criteria for Location	Justification for Location	Parameter	Criteria for Parameter	Justification for Parameter	Cross Ref to other Objectives
MAR	Main Stream at Plant Road	On-site (Perch Lake Basin), Indicator; Annual Sediment Grab sample	See Table 21	(should) If a location represents an area in which contaminants of concern, physical stressors of concern, or potential effects were identified in an ERA (or equivalent), then this location should be included in the EMP. (should) Any locations in which contaminant benchmark concentrations have been exceeded or are predicted to be exceeded should be included in the EMP	MAR is located along the upper reach of Main Stream (fed by No Name Swamp), which receives groundwater and surface runoff from WMAs D, E, G and H, the Salt Storage Facility, and the Waste Tank Farm. The ERA [15] identified B as a sediment COPC in Main Stream.	Metals	(shall) The concentration of a contaminant or the intensity of a physical stressor shall be measured if, based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	See Appendix A.	11.5.2.1
PL1	Perch Lake Inlet 1	On-site (Perch Lake Basin), Indicator; Annual Sediment Grab sample	See Table 21		PL1 is an inlet of Perch Lake, located downstream of West Swamp, which receives groundwater and runoff from WMA B. The ERA [15] identified Cu as a sediment COPC at Perch Lake Inlet 1.	Gross Alpha/Beta Tritium	(should) The EMP should include contaminants relevant to the dose/exposure assessments that are normally part of an ERA (or equivalent)	Several of the COPCs that may be present in the contact surface water or leachate are tritium and alpha/beta/gamma emitting radionuclides and the analysis can be used to assess ecological risk.	
						Metals	(shall) The concentration of a contaminant or the intensity of a physical stressor shall be measured if, based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	See Appendix A.	11.5.2.1
PL2	Perch Lake Inlet 2	On-site (Perch Lake Basin), Indicator; Annual Sediment Grab sample	See Table 21	(should) If a location represents an area in which contaminants of concern, physical stressors of concern, or potential effects were identified in an ERA (or equivalent), then this location should be	PL2 is an inlet of Perch Lake that receives groundwater and surface water runoff from WMAs A and the LDAs (Laundry Pit, RP2, RP2, and Chemical Pit) via South Swamp and East Swamp, and from	Gross Alpha/Beta Tritium	(should) The EMP should include contaminants relevant to the dose/exposure assessments that are normally part of an ERA (or equivalent)	Several of the COPCs that may be present in the contact surface water or leachate are tritium and alpha/beta/gamma emitting radionuclides and	

Code	Location Name	Sample Type	Justification for Sample Type	Criteria for Location	Justification for Location	Parameter	Criteria for Parameter	Justification for Parameter	Cross Ref to other Objectives
				included in the EMP. (should) Any locations in which contaminant benchmark concentrations have been exceeded or are predicted to be exceeded should be included in the EMP.	WMAs B (east side), E, G, and H, and the Waste Tank Farm via Main Stream.			the analysis can be used to assess ecological risk.	
						Dioxins & Furans	(shall) The concentration of a contaminant or the intensity of a physical stressor shall be measured if, based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	See Appendix A. Dioxins and Furans monitored in sediment instead of surface water due to hydrophobic nature.	11.5.2.1
PCW	Perch Creek Weir	On-site (Perch Lake Basin), Indicator; Annual Sediment Grab sample	See Table 21		PCW is located along Perch Creek, downstream of the Perch Lake outlet, and receives groundwater and surface runoff from WMAs A, B, D, E, G, H, the LDAs (Laundry Pit, RP1, RP2, and the Chemical Pit), the Waste Tank Farm, the Salt Storage Shed and the rest of the Perch Lake basin.	Gross Alpha/Beta Tritium	(should) The EMP should include contaminants relevant to the dose/exposure assessments that are normally part of an ERA (or equivalent)	Several of the COPCs that may be present in the contact surface water or leachate are tritium and alpha/beta/gamma emitting radionuclides and the analysis can be used to assess ecological risk.	
						Metals	(shall) The concentration of a contaminant or the intensity of a physical stressor shall be measured if, based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	See Appendix A.	11.5.2.1

Code	Location Name	Sample Type	Justification for Sample Type	Criteria for Location	Justification for Location	Parameter	Criteria for Parameter	Justification for Parameter	Cross Ref to other Objectives
SSW	South Swamp Weir	On-site (Perch Lake Basin), Indicator; Annual Sediment Grab sample	See Table 21		SSW is located along South Swamp Stream, which receives groundwater and runoff from WMA A and RP2 within the LDA. The ERA [15] identified Al, Ba, Sr, Zn, Cl, Fluoride and Organics as sediment COPCs in South Swamp.	Metals Volatile Organic Compounds	(shall) The concentration of a contaminant or the intensity of a physical stressor shall be measured if, based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	See Appendix A.	11.5.2.1
Beach Sand									
B01 B04	Pine Point, Deep River Cook's Cove, Québec	Off-site, Reference; Beach Sand Annual Grab sample	See Table 21	(should) Locations with similar environmental conditions but without potential for facility-related effects (i.e. representative of natural background) should be included in the EMP as reference areas. Human Health Pathways Monitoring: Beach Shine	Ottawa River Beach Sand reference sites: upgradient from the CRL liquid effluent points	Gamma Emitters (detailed)	(should) In addition to the locations mentioned above, locations with similar environmental conditions but without potential for facility-related effects (i.e. representative of natural background) should be included in the EMP as reference areas.	Monitoring results used in public dose calculations.	11.2
B05A B05B	Pointe au Baptême, Upstream side Pointe au Baptême, Downstream side	Property Boundary, Indicator; Beach Sand Annual Grab sample	See Table 21	(shall) If a location is representative of a site's identified critical group(s), then this location shall be included in the EMP. Human Health Pathways Monitoring: Beach Shine	Ottawa River Beach Sand Critical group: Cottage B, seasonal residential	Gamma Emitters (detailed)	(should) The radioactive contaminant(s) chosen for monitoring should be those estimated to contribute 1% or more of total radiation dose to members of a critical group	Monitoring results used in public dose calculations.	11.2

Code	Location Name	Sample Type	Justification for Sample Type	Criteria for Location	Justification for Location	Parameter	Criteria for Parameter	Justification for Parameter	Cross Ref to other Objectives
B06 B08 B09	Oiseau Point, Québec Fort William, Québec Petawawa Point, Petawawa	Off-site, Indicator; Annual Grab sample	See Table 21	(shall) If a location is representative of a site's identified critical group(s), then this location shall be included in the EMP. Human Health Pathways Monitoring: Beach Shine	Ottawa River Beach Sand Critical Groups: Downey Bay, Petawawa	Gamma Emitters (detailed)	(should) The radioactive contaminant(s) chosen for monitoring should be those estimated to contribute 1% or more of total radiation dose to members of a critical group	Monitoring results used in public dose calculations.	11.8

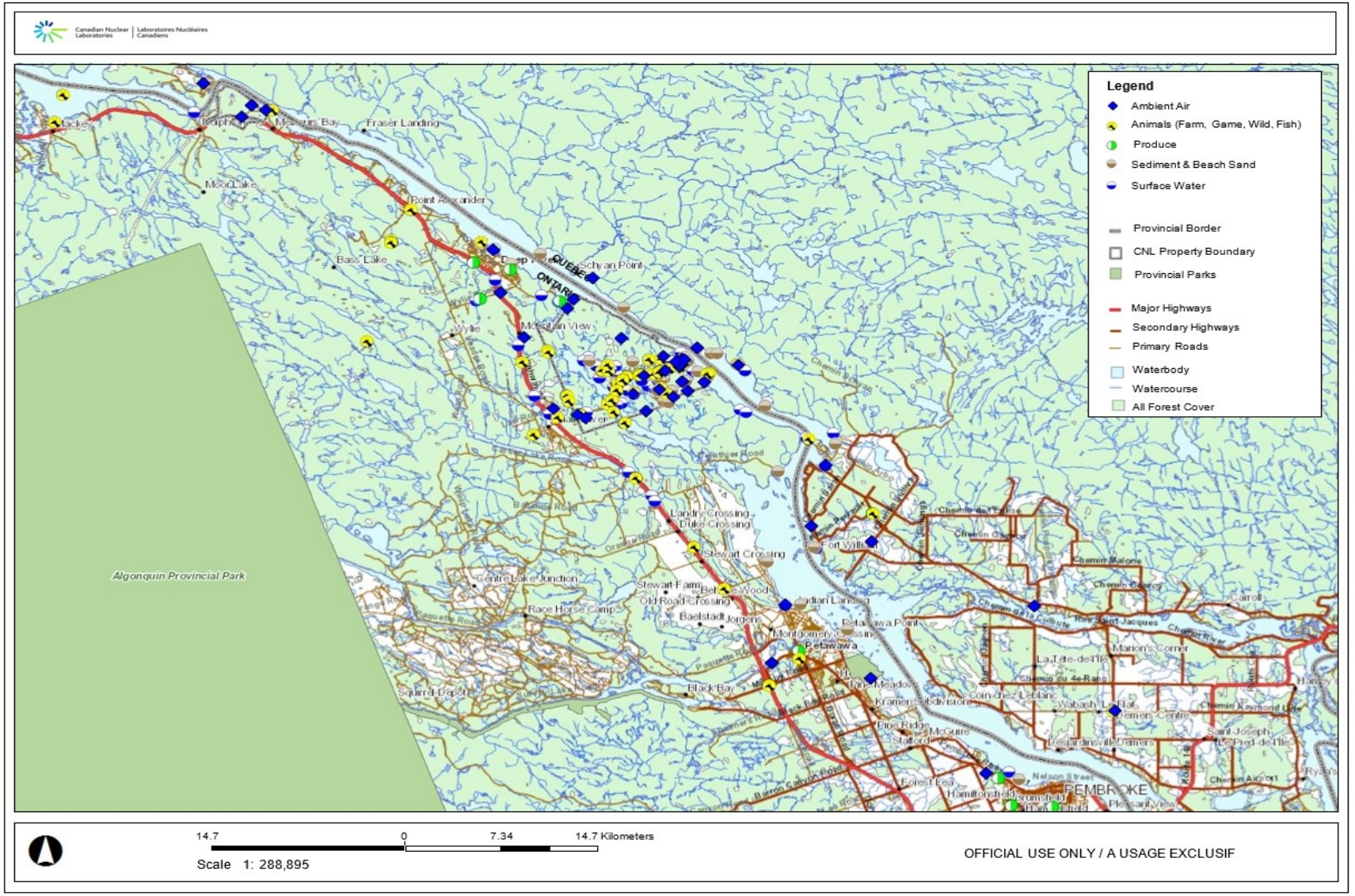


Figure 11: Environmental Monitoring Stations in the Chalk River Region

11.1.2 Evaluation Criteria Exceedances

Certain on-site locations are included in the EMP because evaluation criteria have been exceeded or are predicted to be exceeded there.

In order to identify locations where surface water evaluation criteria are predicted to be exceeded, surface water and sediment concentrations at all monitored locations (with the exception of those locations that have already been found to exceed the evaluation criteria) were compared to a set of screening criteria used in the ERA for CRL to identify COPCs. Exceedance of a screening criterion does not necessarily indicate that an evaluation criterion will be exceeded. However, it is used as a conservative means to indicate where there is the potential for an evaluation criterion to be exceeded. The surface water screening criteria and evaluation criteria for CRL are listed in Table 12 and the sediment screening criteria and evaluation criteria are in Table 13.

In addition to comparison of measured concentrations to the screening criteria given in Table 12 and Table 13 (which are largely federal and provincial water and sediment quality guidelines), data are also compared to a statistically-derived screening value specifically for that location and parameter. The screening value is calculated based on a ten-year mean plus three standard deviations (M+3SD), and is meant to identify potential increasing trends. Exceedance of the statistically based screening value results in an ImpAct being raised for trending purposes.

11.1.3 Biological Effects Monitoring

The CRL ERA [15] identified a number of areas on the CRL property where biological effects could be anticipated due to elevated contaminant concentrations. These areas are well defined and well characterized being downgradient of legacy waste areas, namely the wetlands surrounding WMA A and WMA B (West Swamp, East Swamp and South Swamp). As part of follow-up work from the ERA, any biological effects monitoring, for example, benthic invertebrate community studies and toxicity testing, would be performed as supplementary studies and reported separately. Therefore, biological effects monitoring is not currently part of the routine CRL EMP.

11.1.4 Using the Data to Achieve the Desired Objective

The radiological data obtained from the EMP are used to assess the level of risk to human health and safety by calculating radiation doses to the most exposed off-site members of the public (i.e., critic groups) as identified in the DRL model for CRL [16].

These calculations address the significant exposure pathways and, where available, incorporate local intake fractions based on a site-specific survey of human receptors in the area. Calculations are based on the CSA N288.1 guidelines and when available, site-specific data on use of local food and water sources are used and are performed using spreadsheets.

Annual average contaminant concentrations are used to calculate annual average dose to the public. Human exposure concentrations are corrected for natural background using the results

of monitoring at reference locations so that the dose contribution from CRL can be compared to the public dose limit (Section 0). Radionuclides present below the detection level (L_D) are included in the dose calculations, and the as measured value is used. Radionuclides present below the critical level (L_C) are not included in the dose calculations.

The CRL ERA [15] concludes that, based on available characterization information, there is the potential for negative impacts on biota populations or Species at Risk in areas outside of operational facilities due to current operations. Ongoing protection requires assessment of measured concentrations at the locations listed in Table 8, Table 9, Table 10, Table 11 and Figure 11 against ecological effects-based criteria, i.e. evaluation criteria to evaluate risk on a routine basis. Unacceptable risk identified through this evaluation should be followed up with field investigations assessing for impact to receptors. This occurs before any risk management decisions are made.

To this end, a set of Screening Criteria (SC) and evaluation criteria have been established for the CRL site and are listed in Section 11.1.4.1(non-radiological) and Section 11.1.4.2 (radiological). They are reviewed periodically and updated as more recent information becomes available.

Note: Not all parameters measured under this program have an associated SC or evaluation criteria, in fact, there are a number which do not; these generally consist of measures of environmental indicators (e.g., alkalinity) instead of pollutants; or they could be pollutants but have not had guidelines developed yet as they have not been federally identified as federal priority pollutants requiring the development of a guideline.

11.1.4.1 Non-Radiological Screening Criteria and Benchmark Levels

Screening Criteria (SC) and evaluation criteria for those parameters which are routinely monitored under the EMP (i.e., surface water and sediment) are outlined in this section. The surface water and sediment SC and evaluation criteria developed are for comparison for ecological receptors only and not human receptors as no members of the public are expected to be on the CRL property and all NEW (Nuclear Energy Worker) or non-NEW workers are covered by the site's Occupational Health and Safety program.

Non-radiological surface water SCs and evaluation criteria are listed in Table 12, and those for sediment are given in Table 13. These tables also list the current detection limits provided by the Analytical Chemistry Branch (ACB) at CRL. There are no instances where the detection limits are above the associated evaluation criteria.

The SC used for ecological receptors consist primarily of federal or provincial guidelines for environmental quality and are the same levels that are used in the selection of COPCs in the ERA [15]. These values represent no observed effects concentrations. If federal or provincial guidelines are not available, the most relevant values from the literature are used. Exceedance of SC does not necessarily indicate that an evaluation criterion will be exceeded and does not indicate the potential for effects. It is used as a conservative means to indicate where there is the potential for an evaluation criterion to be exceeded.

The majority of SC consist of Canadian Council of Ministers of the Environment (CCME) Water Quality Guidelines for the Protection of Aquatic Life. Several of the guidelines are not single values, but are site-specific calculated values based on factors such as hardness and pH. In these cases, site-specific levels of hardness or pH can be applied [17]. In calculating the guideline values for screening, the hardness or pH values resulting in the more conservative guideline were selected.

Evaluation criteria are intended to identify potential risk from elevated concentrations of contaminants at the monitoring locations. Site-specific evaluation criteria developed as part of the ERA process are used, if available. An exceedance of an evaluation criterion does not necessarily indicate that ecological impacts would occur, but instead indicates that there is some potential for ecological impacts that may trigger follow-up actions. As per *Environmental Monitoring* Programs [1], an exceedance of an evaluation criterion should constitute an Improvement Action (ImpAct) and if biological effects are anticipated, appropriate action should be taken to better understand the magnitude of potential impact in the receiving environment.

The evaluation criteria used for ecological receptors are selected from scientific literature, databases, and guidance documents, which serve to assess whether contaminant concentrations in the environment may potentially have an adverse effect on ecological species at the community level (as opposed to individual members of the species). These are the same levels that are used to characterise risk in the ERA and recommended by CSA N288.6 [30].

In addition to comparison of measured concentrations to the screening criteria given here, data are also compared to a statistically derived screening value specifically for that location and parameter. The statistical screening value is calculated based on a ten-year mean plus three standard deviations (M+3SD), and is meant to identify changes and potential increasing trends.

Table 12: Surface Water Non-Radiological Screening Criteria and Evaluation Criteria for Ecological Receptors

Parameter	Detection Limits		Screening Criteria (SC)			Evaluation Criteria (EC) [1]			Notes
			Value	Unit	Ref	Value	Unit	Ref	
General Chemistry									
Ammonia (total)	0.025	mg/L	5.74	mg/L	[31]	630	µg/L	[32]	SC: CWQG for the protection of aquatic life. Calculated based on surface water field temperature (15°C) and pH (7.0) [2]. EC: Lowest chronic value for the protection of Daphnids.
Chloride	0.09	mg/L	120	mg/L	[31]	*			SC: CWQG for the protection of aquatic life (long-term/ chronic). Used in ERA COPC screening.
Sulphate	0.08	mg/L	*			*			
Hardness ($CaCO_3$)	0.06	mg/L	*			*			
Nitrate + Nitrite (as N)	0.034	mg/L	*			14 (nitrate) 0.197 (nitrite)	g/L	[32]	EC: Lowest chronic value for the protection of all organisms.
Phosphorus (Total)	0.025	mg/L	0.01	mg/L	[33]				SC: PWQO for the protection of aquatic life (long-term). Used in ERA COPC screening.
Phenolics	1.9	µg/L	1	µg/L	[33]	70	µg/L	[32]	SC: CWQG for the protection of aquatic life. Used in ERA COPC screening. EC: Lowest chronic value for the protection of all organisms.
Total Dissolved Solids (TDS)	10	mg/L	*			*			
Total Suspended Solids (TSS)	3	mg/L	Clear flow: Maximum increase of 25 mg/L from background levels for any short-term exposure (e.g. 24-h period). Maximum average increase of 5 mg/L from background levels for longer term exposures (e.g. inputs lasting between 24 h and 30 d). High flow: Maximum increase of 25 mg/L from background levels at any time when background levels are between 25 and 250 mg/L and should not increase more than 10% of background levels when background is ≥ 250 mg/L.						
Total Kjeldahl Nitrogen (TKN)	0.05	mg/L	*			*			
Solvent Extractables (Oil & Grease)	1	mg/L	(see note)						Oil or petrochemicals should not be present in concentrations that: can be detected as a visible film, sheen, or discolouration on the surface; can be detected by odour; can cause tainting of edible aquatic organisms; can form deposits on shorelines and bottom sediments that are detectable by sight or odour or are deleterious to resident aquatic organisms.

Parameter	Detection Limits		Screening Criteria (SC)			Evaluation Criteria (EC) [1]			Notes
			Value	Unit	Ref	Value	Unit	Ref	
Field Parameters									
Dissolved Oxygen (DO)	NA		4000	mg/L	[33]	*			SC: PWQO for the protection of aquatic life (long-term). Used in ERA COPC screening.
pH	-	-	6.5 – 8.5	-	[33]	*			SC: PWQO for the protection of aquatic life (long-term). Used in ERA COPC screening.
Trace Metals									
Aluminum	6	µg/L	213	µg/L	[18]	460	µg/L	[32]	SC: The Water Quality Objective for a substance may be set at the upper limit of background (i.e., 90th percentile, or mean + 2 standard deviations), or a level which is slightly above the background level, i.e., aquatic life would be protected if concentrations were elevated by no more than 10% above background levels [35]. Site-wide average calculated. EC: Lowest chronic value for the protection of all organisms.
Antimony	0.2	µg/L	20	µg/L	[33]	610	µg/L	[32]	SC: PWQO (lowest NOEC of aquatic toxicity, mutagenicity or bioaccumulation endpoints). Used in ERA COPC screening. EC: Lowest chronic value for the protection of all organisms.
Arsenic	0.2	µg/L	5	µg/L	[33]	48	µg/L	[32]	SC: PWQO (lowest NOEC of aquatic toxicity, mutagenicity or bioaccumulation endpoints). Used in ERA COPC screening. EC: Lowest chronic value for the protection of all organisms.
Barium	1	µg/L	*			1000	µg/L	[34]	EC: British Columbia Ministry of the Environment (BCMOE) water quality guideline
Boron	5	µg/L	200	µg/L	[33]	1800	µg/L	[32]	SC: PWQO for the protection of aquatic life (long-term). Used in ERA COPC screening. EC: Lowest chronic value for the protection of all organisms.
Cadmium	0.09	µg/L	0.04	µg/L	[31]	0.12	µg/L	[32]	SC: CWQG for the protection of aquatic life. Used in ERA COPC screening EC: Lowest chronic value for the protection of all organisms.
Chromium (total)	2	µg/L	8.9	µg/L	[31]	44	µg/L	[32]	SC: CWQG for the protection of aquatic life. Used in ERA COPC screening EC: Lowest chronic value for the protection of all organisms.
Copper	3	µg/L	17.2	µg/L	[18]	12	µg/L	[32]	SC: The Water Quality Objective for a substance may be set at the upper limit of background (i.e., 90th percentile, or mean + 2 standard deviations), or a level which is slightly above the background level, i.e., aquatic life would be protected if concentrations were elevated by no more than 10% above background levels [35]. Site wide average calculated. EC: NAWQ chronic effects criteria.

Parameter	Detection Limits		Screening Criteria (SC)			Evaluation Criteria (EC) [1]			Notes
			Value	Unit	Ref	Value	Unit	Ref	
Iron	4	µg/L	2442	µg/L	[18]	NA			SC: The Water Quality Objective for a substance may be set at the upper limit of background (i.e., 90th percentile, or mean + 2 standard deviations), or a level which is slightly above the background level, i.e., aquatic life would be protected if concentrations were elevated by no more than 10% above background levels [35]. Site wide average calculated. EC: Documented benchmarks is lower than the upper limit of background at the CRL site. Risk-based evaluation criteria not available at this time.
Lead	0.1	µg/L	1.0	µg/L	[31]	12.3	µg/L	[32]	SC: CWQG for the protection of aquatic life (long-term). When hardness (CaCO3) is 30 to 80 mg/L. Used in ERA COPC screening. EC: Lowest chronic value for the protection of all organisms.
Lithium	0.5	µg/L	14	µg/L	[36]	440	µg/L	[37]	SC: US EPA Region 3 freshwater screening value. Used in ERA COPC screening EC: Oregon Dept of Ecology. Used in ERA.
Mercury	0.006	µg/L	0.026	µg/L	[31]	0.23	µg/L	[32]	SC: CWQG for the protection of aquatic life (long-term). Used in ERA COPC screening. EC: Lowest chronic value for the protection of all organisms.
Nickel	3	µg/L	25	µg/L	[31]	160	µg/L	[32]	SC: CWQG for the protection of aquatic life (long-term). Used in ERA COPC screening. EC: NAWQ chronic criteria.
Selenium	0.5	µg/L	1.0	µg/L	[31]	88.32	µg/L	[32]	SC: CWQG for the protection of aquatic life (long-term). Used in ERA COPC screening. EC: Lowest chronic value for the protection of all organisms.
Strontium	2	µg/L	*			5300	µg/L	[37]	EC: Oregon Dept of Ecology. Used in ERA.
Uranium	0.2	µg/L	5	µg/L	[33]	142	µg/L	[32]	SC: PWQO for the protection of aquatic life (long-term). Used in ERA COPC screening. EC: Lowest chronic value for the protection of all organisms.
Vanadium	0.9	µg/L	6	µg/L	[33]	27	µg/L	[37]	SC: PWQO for the protection of aquatic life (long-term). Used in ERA COPC screening. EC: Oregon Dept of Ecology. Used in ERA.

Parameter	Detection Limits		Screening Criteria (SC)			Evaluation Criteria (EC) [1]			Notes
			Value	Unit	Ref	Value	Unit	Ref	
Zinc	2	µg/L	9.3	µg/L	[18]	30	µg/L	[32]	SC: The Water Quality Objective for a substance may be set at the upper limit of background (i.e., 90th percentile, or mean + 2 standard deviations), or a level which is slightly above the background level, i.e., aquatic life would be protected if concentrations were elevated by no more than 10% above background levels [34]. Site wide average calculated. EC: Lowest chronic value for the protection of all organisms.

Notes:

NA - Not Available, CWQG: Canadian Water Quality Guideline, NOEC: No Observed Effect Concentration

NAWQ: National Ambient Water Quality

* Not all parameters measured under this program have an associated Screening Level or Evaluation Criteria, in fact, there are a number which do not; these generally consist of measures of environmental indicators (e.g. alkalinity) instead of pollutants; or they could be pollutants but have not had guidelines developed yet as they have not been federally identified as federal priority pollutants requiring the development of a guideline.

[1] Most restrictive value for Aquatic Freshwater Lower Trophic Biota

[2] Screening Level is based on field measured pH and temperature; calculated according to following table:

		pH							
		6.0	6.5	7.0	7.5	8.0	8.5	9.0	10.0
Temp (°C)	0	231	73.0	23.1	7.32	2.33	0.749	0.25	0.042
	5	153	48.3	15.3	4.84	1.54	0.502	0.172	0.034
	10	102	32.4	10.3	3.26	1.04	0.343	0.121	0.029
	15	69.7	22.0	6.98	2.22	0.715	0.239	0.089	0.026
	20	48.0	15.2	4.82	1.54	0.499	0.171	0.067	0.024
	25	33.5	10.6	3.37	1.08	0.354	0.125	0.053	0.022
	30	23.7	7.50	2.39	0.767	0.256	0.094	0.043	0.021

Table 13: Sediment Non-Radiological Screening Levels and Evaluation Criteria for Ecological Receptors

Parameter	Detection Limits		Screening Criteria (SC)			Evaluation Criteria (EC) [1]			Notes
			Value	Unit	Reference	Value	Unit	Reference	
Trace Metals									
Aluminium	75	µg/g	*			58030	µg/g	[38]	EC: Representative Probable Effects Concentration
Antimony	0.6	µg/g	*			25	µg/g	[39]	EC: Expected effects level.
Arsenic	0.5	µg/g	5.9	µg/g	[31]	57	µg/g	[38]	SC: CCME ISQG. EC: Representative Probable Effects Concentration
Barium	8	µg/g	*			7200	µg/g	[40]	EC: Netherlands risk concentration
Boron	20	µg/g	*			*			
Cadmium	0.4	µg/g	0.6	µg/g	[31]	11.7	µg/g	[38]	SC: ISQG for the protection of aquatic life (long-term). EC: Representative Probable Effects Concentration.
Chromium (total)	5	µg/g	26	µg/g	[41]	159	µg/g	[38]	SC: PSQG for the protection of aquatic life. EC: Representative Probable Effects Concentration.
Copper	2.5	µg/g	16	µg/g	[41]	77.7	µg/g	[38]	SC: PSQG for the protection of aquatic life. EC: Representative Probable Effects Concentration.
Iron	50	µg/g	20,000	µg/g	[41]	*			SC: PSQG for the protection of aquatic life.
Lead	0.2	µg/g	31	µg/g	[41]	396	µg/g	[38]	SC: PSQG for the protection of aquatic life. EC: Representative Probable Effects Concentration.
Lithium	2.5	µg/g	*			*			
Mercury	0.01	µg/g	0.17	µg/g	[31]	1.0	µg/g	[39]	SC: CCME ISQG. EC: Expected effects level.
Nickel	2.5	µg/g	16	µg/g	[41]	38.5	µg/g	[38]	SC: PSQG for the protection of aquatic life. EC: Representative Probable Effects Concentration.
Selenium	1.5	µg/g	*			*			
Strontium	15	µg/g	*			*			
Uranium	0.2	µg/g	*			*			
Vanadium	5	µg/g	*			*			
Zinc	10	µg/g	120	µg/g	[41]	1532	µg/g	[38]	SC: PSQG for the protection of aquatic life (long-term). EC: Representative Probable Effects Concentration.

Parameter	Detection Limits		Screening Criteria (SC)			Evaluation Criteria (EC) [1]			Notes
			Value	Unit	Reference	Value	Unit	Reference	
Volatile Organic Compounds									
1,1,2,2-Tetrachloroethane	0.04	µg/g	0.54	µg/g	[42]	2.8	µg/g	[42]	SC: threshold concentration based on 2% TOC EC: low risk to aquatic life based on 2% TOC
1,1,2-Trichloroethane	0.03	µg/g	0.52	µg/g	[42]	*			SC: US EPA screening criteria
1,1-Dichloroethane	0.04	µg/g	0.0006	µg/g	[42]	0.027	µg/g	[38]	SC: Protective of benthic biota EC: Oak Ridge (protect aquatic life to same degree as Water Quality Guideline)
1,1-Dichloroethylene	0.03	µg/g	4	µg/g	[42]	*			SC: threshold concentration based on 2% TOC
1,2-Dichlorobenzene	0.04	µg/g	0.85	µg/g	[42]	*			SC: threshold concentration based on 2% TOC
1,3-Dichlorobenzene	0.03	µg/g	2.1	µg/g	[42]	*			SC: threshold concentration based on 2% TOC
1,4-Dichlorobenzene	0.03	µg/g	1.2	µg/g	[42]	*			SC: threshold concentration based on 2% TOC
Bromodichloromethane	0.05	µg/g	*			*			
Bromoform	0.23	µg/g	*			*			
Bromomethane	0.14	µg/g	0.0014	µg/g	[42]	*			SC: US EPA screening level
Carbon tetrachloride	0.05	µg/g	1.07	µg/g	[42]	1.45	µg/g	[42]	SC: threshold concentration based on 2% TOC EC: US EPA minimal effects to benthic biota
Chloroform	0.04	µg/g	0.022	µg/g	[43]	*			SC: protect aquatic life to same degree as Water Quality Guideline
cis-1,3-Dichloropropylene	0.04	µg/g	*			*			
Dibromochloromethane	0.08	µg/g	*			*			
Ethylene dibromide	0.04	µg/g	*			*			
Hexane	0.19	µg/g	0.04	µg/g	[42]	*			SC: US EPA protective of aquatic life.
Methylene chloride	0.07	µg/g	0.16	µg/g	[42]	*			SC: US EPA protective of aquatic life.
Tetrachloroethylene	0.04	µg/g	0.468	µg/g	[42]	*			SC: US EPA protective of aquatic life.
Trans-1,3-Dichloropropylene	0.04	µg/g	0.00005	µg/g	[42]	*			SC: US EPA protective of aquatic life.
Trichloroethylene	0.05	µg/g	0.22	µg/g	[43]	*			SC: protect aquatic life to same degree as Water Quality Guideline
Trichlorofluoromethane	0.04	µg/g	*			*			

Parameter	Detection Limits		Screening Criteria (SC)			Evaluation Criteria (EC) [1]			Notes
			Value	Unit	Reference	Value	Unit	Reference	
1,2-Dichloroethane	0.05	µg/g	0.26	µg/g	[42]	1.7	µg/g	[38]	SC: US EPA screening level EC: low risk to aquatic life based on 2% TOC
1,2-Dichloropropane	0.05	µg/g	0.33	µg/g	[42]	*			SC: US EPA screening level
Chlorobenzene	0.04	µg/g	0.2	µg/g	[42]	0.66	µg/g	[38]	SC: threshold concentration based on 2% TOC EC: low risk to aquatic life based on 2% TOC
Trans-1,2-Dichloroethylene	0.04	µg/g	0.65	µg/g	[42]	1.2	µg/g	[38]	SC: US EPA screening level EC: low risk to aquatic life based on 2% TOC
Vinyl chloride	0.05	µg/g	0.20	µg/g	[42]	1.8	µg/g	[40]	SC: US EPA screening level EC: Netherlands minimal effects concentration
1,1,1-Trichloroethane	0.03	µg/g	0.21	µg/g	[42]	*			SC: US EPA protective of aquatic life.
Total Dioxin/Furan			0.2	µg/g	[43]	0.68	µg/g	[43]	SC: Washington State sediment quality standard – protective of benthic community EC: Washington State cleanup criteria – protective of ecological receptors

Notes:

NA - Not Available, CCME: Canadian Council of Ministers of the Environment, ISQG: Interim Sediment Quality Guideline, PSQG: Provincial Sediment Quality Guideline

US EPA: United States Environmental Protection Agency, TOC: Total Organic Carbon

* Not all parameters measured under this program have an associated Screening Level or Evaluation Criteria, in fact, there are a number which do not; these generally consist of measures of environmental indicators (e.g. alkalinity) instead of pollutants; or they could be pollutants but have not had guidelines developed yet as they have not been federally identified as federal priority pollutants requiring the development of a guideline.

[1] Represents a Lowest Observed Effects Level, protective of the most sensitive receptor.

11.1.4.2 Radiological Screening Criteria and Evaluation Criteria

The surface water SC outlined in Table 14 include those available in literature for the list of radiological contaminants selected to be monitored under the EMP (Table 5). These represent no-observed effects levels to receptors.

The radiological dose criteria used for ecological receptors are Estimated No-Effect Values (ENEVs), which serve as benchmarks for population-level impacts on non-human biota. The ENEVs used in the EMP are based on United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) [44], as recommended by CSA N288.6 [25] and are the same as those used in the ERA [15]. They are shown below in

Table 15. The use of these evaluation criteria is a conservative approach; a dose rate at these levels, given to the most highly exposed individuals, would be unlikely to have significant effects on most terrestrial communities.

The radiological evaluation criteria used for human receptors (i.e., Representative Person) are based on the dose limit to members of the public in the NSCA Radiation Protection Regulations [17]. This benchmark is compared to station releases, and to the estimated public dose.

Table 14: Radiological Surface Water Screening Criteria for Human Receptors and Ecological Evaluation Criteria at CRL

Receptor	Media	Parameter	Unit	Screening Criteria	Source
Human	Potable surface water	Cesium-137	Bq/L	10	[45]
		Gross Alpha [a]	Bq/L	0.5	[45]
		Gross Beta [b]	Bq/L	1	[45]
		Strontium-90	Bq/L	5	[45]
		Tritium	Bq/L	7,000	[45]
Ecological	Surface water	Tritium [e]	Bq/L	1.74E+07	[15]
		Gross Beta [d, e]	Bq/L	366	[15]
		Caesium-137 [d]	Bq/L	72.7	[15]
		Carbon-14 [c, d]	Bq/L	164	[15]
		Cobalt-60 [d]	Bq/L	135	[15]
		Strontium-90 [d]	Bq/L	183	[15]

Notes:

[a] Based on the strictest Maximum Acceptable Concentration for alpha activity (Ra-226) expected to be present.

[b] Protective of all beta-emitting species that can be expected to be found in drinking water, including iodine species and Sr-90.

[c] Unit is Bq/g dissolved inorganic carbon in water for C-14

[d] Ecological Effects Concentration Level for Wetland and Aquatic sites [15]

[e] Gross beta limit where Sr-90 is the dominant beta emitter. Sr-90 is in secular equilibrium with Y-90 also a beta emitter. The gross beta limit is therefore two times the CRL ecological risk benchmark for Sr-90.

Table 15:Radiological Dose Benchmarks for Human and Ecological Receptors at CRL

Receptor	Parameter	Unit	Dose Benchmark	Notes	Source
Ecological (aquatic)	Total dose	mGy/day	9.6	An exceedance occurs if the concentration of one radionuclide multiplied by the applicable dose conversion factor (DCF) exceeds the benchmark.	[41]
Ecological (terrestrial)	Total dose	mGy/day	2.4		
Human	Total dose	mSv/a	1	Station releases at 100% of the DRL for a year would result in a dose to the Representative Person of 1 mSv. DCFs are given in the DRL document [15].	[16]

11.1.4.3 Benchmark Evaluation Process

The benchmark evaluation is a stepwise process that should take into consideration the SC, evaluation criteria, as well as background levels and detection limits.

Background levels: The use of guidelines without consideration of other information (e.g., background concentrations of naturally occurring substances) can lead to erroneous conclusions about the likelihood of biological effects. The naturally occurring background concentrations of some contaminants may exceed the applicable guidelines (e.g., Fe at CRL). In this case, the upper limit of background is used to determine whether the contaminant will be defined as a High Background COPC (i.e., concentration higher than guidelines, but less than local background upper limit). The upper limit of background is calculated according to the method prescribed by the CCME [31] and cited in CSA N288.6-22 [30], unless otherwise documented. If no background measurements are available from these areas, site-specific background measurements will need to be obtained when contaminant concentrations in areas of concern are found to be above the applicable guidelines.

Detection limits: In an effort to ensure comparisons to the evaluation criteria and background values compiled in this report are achievable, the analytical detection limits must be below the evaluation and background values.

Stepwise benchmark evaluation process:

1. Unless otherwise documented, measured values are used to calculate an annual average concentration for use in the benchmark evaluation process.
2. Compare the measured values against the respective statistical and ecological SC. It is possible that the generic CWQGs and PWQOs are over or under-protective at sites with unique conditions. For example, at the CRL site, certain substances are naturally present in the environment at concentrations above the guidelines. Therefore, CNL needs to take this background information into consideration when interpreting results
3. If it is found to be above this level, confirm whether it is above the Laboratory Detection Limit and the Upper Limit of Background.

4. If it is found to be above the Screening Level, Detection Limit and Upper Limit of Background, compare the measured value against the respective evaluation criteria.

Contaminants that are found to be above the SC and Detection Limit, but below the Upper Limit of Background and evaluation criteria are considered High Background COPCs. Those contaminants that are above the SC, Detection Limit and Upper Background Limits, but below the evaluation criteria should be maintained or added as a component of the routine EMP. If contaminants are found to be above the evaluation criteria, it indicates potential for ecological effects. This is an indication that BEM may be needed, or that additional information is required to further assess risk for these contaminants (see Figure 12).

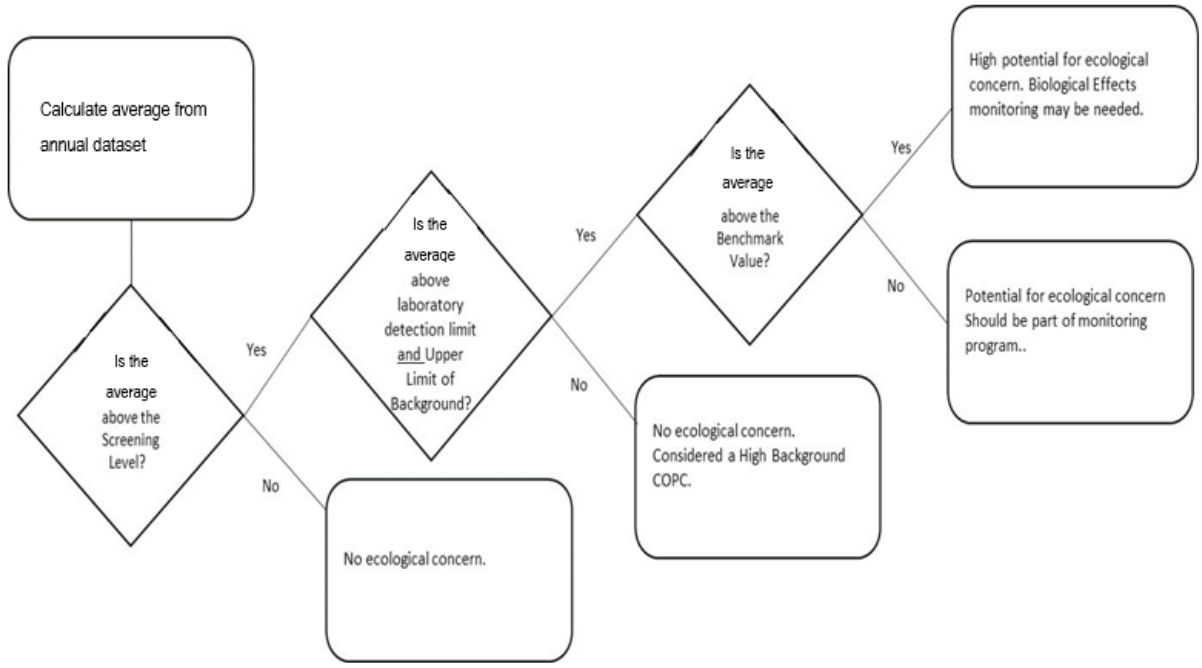


Figure 12: Stepwise Benchmark Evaluation Process

The background screening criteria in Table 16 consist of a combination of generic background concentrations (e.g., background concentrations from the literature, or regionally applicable data on natural background concentrations) and site-specific background concentrations. The site-specific background concentrations are determined by monitoring conditions at one or more reference areas, which are located on or near the CRL site but have not been adversely affected by CRL operations. The site-specific values usually consist of the upper limit (e.g., mean plus two standard deviations) of the average for the reference location(s).

Table 16: Background Screening Criteria

Environmental Medium	Parameter	Unit	Background Screening Criteria [a]	Basis
Surface water – Perch Lake Basin	All measured radionuclides	Bq/L	Calculated	Site-specific background (mean plus two standard deviations for surface waters at PL4)
	All measured non-radiological parameters	µg/L	Calculated	
Surface water – Maskinonge Lake Basin	All measured radionuclides	Bq/L	Calculated	Site-specific background (mean plus two standard deviations for surface waters at UBI)
	All measured non-radiological parameters	µg/L	Calculated	
Surface water – Ottawa River Direct Basin	All measured radionuclides	Bq/L	Calculated	Site-specific background (mean plus two standard deviations for at KMC and S07)
	All measured non-radiological parameters	µg/L	Calculated	
Ambient air	Tritium	Bq/m^3	0.09 – 0.26	Regional background in Ontario [46]
	Direct radiation	µGy/a	145 – 515	Terrestrial gamma background in Canada [46]
Garden produce	All measured radionuclides	Bq/L	Calculated	Site-specific background (average for Killaloe produce)
Large game animals	All measured radionuclides	Bq/kg f.w.	Calculated	Site-specific background (average for all animals >50 km from CRL)
Fish	All measured radionuclides	Bq/kg f.w.	Calculated	Site specific background (average for Mackey fish)

[a]Site-specific background criteria are calculated annually using the most recent available data.

11.2 OBJECTIVE 2: To demonstrate compliance with any applicable limits on the concentration and/or intensity of contaminants and physical stressors in the environment or their effect on the environment

The discussion in the EMP ACMR will mostly be focused on the most significant data observed during the monitoring year, as determined by elevated contaminant concentrations or deviations in contaminant trends. Significant data are identified using different types of limits.

Three types of limits are applied in the EMP:

- Regulatory limits;
- Screening criteria (i.e., statistically based and ecological) to detect changes in contaminant concentrations, as well as those present above natural background; and
- Ecological effects-based criteria (i.e., evaluation criteria) to identify areas where there is a potential for ecological risk.

11.2.1 Monitoring to Assess Dose to the Public

Regulatory requirements necessitate calculating radiation doses to representative persons for comparison to the public dose limit of 1 mSv/a [47], CRL site licence dose constraint of 0.3 mSv to members of the public in any period of 12 consecutive months [12], and the dose trigger for As Low As Reasonably Achievable (ALARA) [48] of 50 µSv/a to individual members of the public, and 1 person-Sv annual collective dose (both occupational and public) [49]. A subset of the data generated to meet Objective 1 (Section 11.1.1 on Environmental Pathways Monitoring) is used confirm the results of effluent/emission monitoring and its conclusions that all releases are below the DRLs.

While human exposures (i.e., doses to CRL critical groups) do not approach regulatory dose limits, routine monitoring near critical group locations is required in order to meet the regulatory requirement for an annual public dose assessment. It also contributes to identification of the most-exposed group(s) and important exposure pathways, to ensure that these receptors and pathways are considered in calculating DRLs for CRL according to CSA N288.1 [23].

Monitoring locations that are detailed in Section 11.1.1.5 that are cross-referenced to this section are those that are intended for use in calculating (or estimating) the dose to the public. These specific locations were selected according to the criteria in Table 4, to ensure that the calculated (or estimated) dose is representative of the Representative Persons for the CRL site. The following sections provide a justification for the selection of monitoring locations along each of the relevant airborne (Section 11.2.1.1) and liquid (Section 11.2.1.2) exposure pathways.

11.2.1.1 Airborne Pathways

As identified by the DRL model, the representative persons for airborne pathways are those living in Balmer Bay (stack releases) and seasonal cottage dwellers on the Québec side of the Ottawa River, adjacent to CRL (roof vent/fan releases). The representative groups consist of adult, ten-year-old child and one-year-old infant receptors. This section outlines the specific locations and environmental media that are sampled in order to demonstrate that the radiation doses to these receptor groups are below the public dose limit. All characteristics listed in Table 1 and all pathways shown in Figure 6 are taken into consideration in the selection of media and locations.

The airborne exposure pathways from CRL to the public, as identified in Figure 6 include:

- Inhalation of and immersion in ambient air (Section 11.2.1.1.1)
- Ingestion of and immersion in well water (Section 11.2.1.1.2)
- Ingestion of vegetation and meat (Section 11.2.1.1.3)
- Soil external exposure and incidental ingestion (Section 11.2.1.1.4)

Radionuclides are measured along each of these pathways, where feasible. The justification for the monitoring performed along each of these pathways is given in more detail in the following sub-sections.

Any pathways not discussed here have been determined by the DRL model for the CRL site to be negligible in terms of contribution to public dose. A detailed discussion of these pathways may be found in *Derived Release Limits for CNL's Chalk River Laboratories* [16].

11.2.1.1.1 Inhalation of and Immersion in Ambient Air

Balmer Bay (stack releases) and Québec Cottage Location A (roof vent/fan releases) were selected as the locations for the representative groups for airborne releases. An ambient air monitoring station located at Balmer Bay (A08) approximately 7 km northwest of the CRL built-up area in the prevailing wind direction assesses exposure to the stack releases representative person. This location measures tritium in air and is equipped with a TLD to measure ambient radiation. A similar station is located directly across the Ottawa River from the built-up area (A13), approximately 1 km east of the CRL built-up area, representing a cottager location. Reference stations are located at the Outer Gate of CRL property, B560 (A43), approximately 6.5 km south west, and an off-site TLD is situated in Rankin (A42), approximately 43 km south. Details are given in Section 11.1.1.5.1.

11.2.1.1.2 Ingestion of and Immersion in Well Water

Airborne critical group locations are assumed to get their water from wells and springs. Well water can become contaminated by deposition from the atmosphere to the soil, followed by infiltration and transport to the well with groundwater circulations. In the DRL document, a spring is considered equivalent to a well 7.5 m deep, as these springs are discharge zones of aquifer flow systems [16]. Groundwater well monitoring is not completed at off-site locations, although numerous off-site springs are included in the EMP. These include Kennedy's Creek (KMC), Downey's Bay Creek (DBC), Oiseau Creek at Hilborn (HIL), and Spring 7 at Petawawa (S07).

Groundwater on-site is not for human consumption but is monitored as part of the GWMP, the details of which are documented in program specific documentation [8].

11.2.1.1.3 Ingestion of Vegetation and Meat

Ingestion of vegetation and meat is the dominant exposure route in the DRL calculation for several radionuclides. The DRL model assumes that the representative person at Balmer Bay grows 26.8% of their vegetables and 18.6% of their potatoes, and obtains 13.3% of their fruit from wild berries in the area [16]. In order to evaluate this pathway, produce from either a local, residential garden at Balmer Bay is generously donated (BBG) and/or produce from the on-site garden at the Mattawa Road gate (MRG) is collected. The garden produce reference location in Killaloe (KLG) is monitored on a confirmatory basis of every three years, and otherwise uses long-term estimates.

Efforts are made to collect annual large game samples off-site within 25 km of CRL property boundary (within 25 km), with reference samples from locations farther than 50 km from the property boundary. As these collections rely on donations from local hunters, there is not a consistent and reliable source. Therefore, on-site animals (obtained by opportunistic means, i.e., vehicle interactions) are also considered in the large game portion of the dose assessment.

Beef from local farmers directly in the area of critical groups is often difficult to obtain, so a local meat vendor supplying locally raised meat from the Beachburg or Cobden areas may be used when no other source is available. Beachburg is located approximately 55 km south east of the CRL site and Cobden is approximately 60 km south east.

Details are given in Section 11.1.1.5.3.

11.2.1.1.4 Soil External Exposure

Airborne critical group members may be exposed to contaminated soil. Soil can become contaminated by deposition from the atmosphere to the soil. Soil is not monitored under the routine EMP, however atmospheric deposition is collected at Balmer Bay on a monthly basis (F08) and analyzed for gross alpha and gross beta. Results from this location are not elevated compared to other locations. Further, non-routine characterization samples of soil at the Mattawa Road gate, along the property boundary at Balmer Bay, are categorized as background.

11.2.1.2 Liquid Pathways

As identified by the DRL model, the representative persons for liquid pathways are those living downgradient of CRL on the shores of the Ottawa River consisting of adults, ten-year-old child and one-year-old infant. This section outlines the locations and environmental media that are sampled in order to demonstrate that the radiation doses to this receptor group are below the public dose limit. All characteristics listed in Table 1 and all pathways shown in Figure 7 are taken into consideration in the selection of media and locations.

The liquid exposure pathways from CRL to the public, as identified in Figure 7, are:

- Exposure to sediment/sand (Section 11.2.1.2.1)
- Exposure from ingestion of fish (Section 11.2.1.2.2)
- Ingestion of and immersion in river water (Section 11.2.1.2.3)

Radionuclides are measured along each of these pathways, where feasible. The justification for the monitoring performed along each pathway is given in more detail in the following sub-sections.

Any pathways not discussed here have been determined by the DRL model for the CRL site to be negligible in terms of contribution to public dose. A detailed discussion of these pathways may be found in *Derived Release Limits for CNL's Chalk River Laboratories* [16].

11.2.1.2.1 Exposure to Sediment/Sand

The DRL model assumes that a member of the critical group would receive external exposure from beach sand/sediment while visiting public beaches and spending time walking along the Ottawa River shoreline. In order to assess this pathway, beach sand is collected at the Point au Baptême location and two upriver locations (as a background correction) at Pine Point Beach in Deep River (B01) and Cook's Cove (B04). Point au Baptême is a sandy beach, publicly accessible by boat, located at the CRL property boundary, downriver of the built-up area. Both the

upstream (B05A) and downstream (B05B) sides of the point are sampled, and the average results are used in the dose assessment. Details are given in Section 11.1.1.5.4.

11.2.1.2.2 Exposure from Ingestion of Fish

Ingestion of Ottawa River fish is a major exposure route in the DRL model for several radionuclides. The DRL assumes that the representative person consumes fish caught in the Ottawa River downstream of the CRL site on a regular basis. In order to evaluate this pathway, samples of locally caught fish are harvested from the Ottawa River at two locations downstream from CRL, Highview (HF) and Waltham (WF), and average results are calculated. The reference fish are caught upstream at Mackey (MF), and serves as a background correction in the dose assessment. Fish typically caught for sampling include walleye and pike. Details are given in Section 11.1.1.5.3.

11.2.1.2.3 Ingestion of and Immersion in River Water

The effective dose to residents of the Town of Petawawa from consumption of Ottawa River water is estimated based on annual average concentrations of tritium, gross alpha and gross beta at Petawawa (PET). The DRL model assumes that these are the closest population centers that obtain drinking and bathing water from the Ottawa River. The reference location upriver at Rolphton (ORR) serves as a background correction. Immersion in Ottawa River water is not a dominant pathway identified in the CRL DRL [16] and therefore, not included in the dose assessment. Details are given in Section 11.1.1.5.2.

11.2.1.3 Using the Data to Achieve the Desired Objective

If radionuclide activities in the environment (airborne or liquid pathways) are less than the detection limits (<Ld), doses are still estimated using the result value from the analysis and accompanied by a “<” symbol. If all measured activities are less than the critical level (<Lc), these radionuclides are not included in the overall dose assessment. For a data set that includes a mix of <Lc, <Ld and detected results, the value of the critical level will be used in calculations. Furthermore, if a result at the critical group location is lower than that measured at a reference location (i.e., lower than the local background level), that radionuclide is excluded from the dose assessment.

If radionuclide activities in the environment are greater than the detection limit and the background level, doses are calculated (Section 11.2.1.3.1).

11.2.1.3.1 Calculating Dose to Public based on Environmental Monitoring Data

The data collected along each of the airborne and liquid pathways described above can be used to calculate doses to the most exposed off-site members of the public, i.e. representative person(s), using the models and equations provided in CSA N288.1 [23].

Parameters such as food intake rates and dose coefficients (DCs) that convert environmental concentrations or intakes into doses are taken from the DRL document [16]. These parameters are based on CSA N288.1 models [23], and in some cases have been adjusted to be site-specific.

Public exposure concentrations are corrected for natural background using the results of monitoring at reference locations.

Using these methods, conservative dose estimates to members of the representative groups are calculated and compared to the public dose limit of 1 mSv/y.

11.3 OBJECTIVE 3: To check, independently of effluent monitoring, on the effectiveness of containment and effluent control, and provide public assurance of the effectiveness of containment and effluent control

Monitoring of surface water, ambient air, direct radiation, and deposition on CRL property serves to verify the effectiveness of containment and effluent controls. Emissions data based on effluent monitoring are compared to those inferred from the results of environmental monitoring to see how well they agree. Where monitoring is being done for this purpose, the basic design aspects of the monitoring locations (i.e., specific monitoring location, parameter(s) to be monitored, and the frequency of monitoring) take into consideration several principles, as described below.

If there is a discrepancy between the results of effluent monitoring and environmental monitoring, for example if certain radionuclides begin showing up in environmental samples that were not there previously, this is an indication that the present effluent monitoring and/or control measures are lacking. As new measures are instituted, progress is monitored by watching for those nuclides in future environmental samples.

At locations where environmental monitoring is being done to verify the effectiveness of containment and effluent controls, monitoring is for radionuclides that could potentially be present in effluent/emission discharges. These radionuclides were identified using various sources of information, including:

- The results of other monitoring activities (e.g., routine effluent and groundwater monitoring, non-routine monitoring including special investigations, etc.);
- A review of radionuclide inventories and usage on site;
- Process knowledge derived from historical assessment, waste records and staff knowledge; and
- The Significant Environmental Aspects (SEA) database for CRL

Where there is limited knowledge of contaminants of potential concern, a wide array of parameters are targeted, and as monitoring data become available the suite of parameters can be reduced as appropriate.

11.3.1 Monitoring Around Waste Management Areas, Affected Lands and Developed Areas

Surface waters are monitored at strategic locations within the watershed to evaluate the general environmental performance of WMAs, affected lands, and developed regions of the CRL site (where nuclear facilities are located). The general strategy for the selection of monitoring locations is to monitor surface waters downstream of the locations of potential

contaminant inputs (e.g., locations downgradient of, and within reasonable proximity to, points of groundwater discharge). Flow rate measurements are taken at the same locations to facilitate the calculation of contaminant loading throughout the watershed.

Where monitoring of direct radiation (e.g., TLDs and GammaTracers), ambient air (e.g., tritium) and wet and dry deposition rates is being undertaken in areas affected by airborne effluents from the CRL site, monitoring at locations within reasonable proximity to the site and in the prevailing wind direction are included in the EMP. Monitoring at these locations is intended to provide feedback to the EVMP.

Where contamination could be spread by vehicles that travel between the controlled area and the supervised areas (e.g. WMAs), and by vehicles leaving the CRL site, monitoring of Plant Road is done between the Main Gate and the C-2 Fire Trail.

Monitoring to verify wet and dry deposition rates, ambient air concentrations, and direct radiation resulting from CRL airborne releases is achieved through a network of samplers and monitors located at the site boundary. Monitoring locations established for this purpose, in most cases, are selected to be within the main upriver and downriver wind rose sectors.

Details are provided in Table 17.

Table 17: Monitoring Around WMAs, Affected Lands and Developed Areas

Code	Location Name	Sample Type	Justification for Sample Type	Criteria for Location	Justification for Location	Parameter	Criteria for Parameter	Justification for Parameter	Cross ref to other objectives
Ambient Air									
A09 A568	Main Gate (B449J) Sewage Treatment Facility	On-site; Indicator; Continuous measurement	Continuous monitoring is desirable due to the fleeting nature of the immersion pathway. See Table 21	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be in locations within reasonable proximity to the points of discharge and in the likely path of the discharges.	All CRL airborne effluents arising from roof vents and stacks. Located in the prevalent wind direction from the NRU Stack and the built-up area. May be impacted by airborne effluents from the NRU Stack and other stacks/roof vents in the built-up area.	Total Gamma Tritium	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be for those contaminants that could potentially be present in effluent discharges.	Radionuclide is released to the air in measurable quantities from roof vents and stacks at CRL.	11.4
A34	C-2 Fire Trail at Hydro Line	On-site; Indicator; Continuous measurement	Continuous monitoring is desirable due to the fleeting nature of the immersion pathway. See Table 21	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be in locations within reasonable proximity to the points of discharge and in the likely path of the discharges.	All CRL airborne effluents arising from roof vents and stacks. Located in the prevalent wind direction from WMA B. May be impacted by airborne effluent from WMA B.	Total Gamma	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be for those contaminants that could potentially be present in effluent discharges.	Radionuclide is released to the air in measurable quantities from roof vents and stacks at CRL.	11.4
A33 A44	Perch Lake Main Gate at WMA B	On-site; Indicator; Continuous measurement	Continuous monitoring is desirable due to the fleeting nature of the immersion pathway. See Table 21	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be in locations within reasonable proximity to the points of discharge and in the likely path of the discharges.	All CRL airborne effluents arising from roof vents and stacks. Located in the prevalent wind direction from WMA B. May be impacted by airborne effluent from WMA B.	Total Gamma Tritium	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be for those contaminants that could potentially be present in effluent discharges.	Radionuclide is released to the air in measurable quantities from roof vents and stacks at CRL.	11.4
Surface Water									
010	010 Storm Outfall	On-site; Indicator;	Samples are collected at least monthly from surface	(should) If environmental monitoring is being done to	010 Outfall, which flows into the Ottawa River,	Flow	Essential for determining contaminant loading to watercourses.		11.1 11.4

Code	Location Name	Sample Type	Justification for Sample Type	Criteria for Location	Justification for Location	Parameter	Criteria for Parameter	Justification for Parameter	Cross ref to other objectives
	(MU1)	Monthly Grab Sample (rads), Semi-Annual Grab Sample (non-rads)	water crossing the site boundary and off-site stream or rivers that are subject to drainage from potentially contaminated areas. See Table 21 See Section 12.2	verify the effectiveness of containment and effluent controls, then monitoring should be in locations within reasonable proximity to the points of discharge and in the likely path of the discharges.	receives runoff and groundwater from the Southeast portion of the built-up area, and is located down gradient of the inactive landfill site and Grey Crescent site, accepting groundwater discharges from both areas.	Tritium Gross Alpha/Beta Gamma emitters (detailed)	Primarily Effluent Verification Program		11.8
						Field Parameters General Chemistry Metals	See Appendix A Table A-1		
020	020 Stream (MU7)	On-site; Indicator; Semi-Annual Grab Sample (rads and non-rads)	See Section 12 and Table 21	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be in locations within reasonable proximity to the points of discharge and in the likely path of the discharges.	020 Stream receives groundwater and runoff from the Supervised Area downgradient of the inactive landfill and Grey Crescent sites before it discharges to the Ottawa River. The 020 Stream does not receive any controlled discharges from CRL.	Flow	Essential for determining contaminant loading to watercourses.		11.1 11.4 11.8
						Tritium Gross Alpha/Beta	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be for those contaminants that could potentially be present in effluent discharges.	Surface waters on CRL property receive groundwater, runoff, and effluent from various facilities and WMAs that are potential sources of radioactive contamination.	
						Field Parameters General Chemistry Metals	See Appendix A Table A-2		
BHL	Swamp at WMA B Hydro Line (MU3)	On-site; Indicator; Quarterly Grab Sample	Water quality is subject to natural hydrological variability over the course of a year (e.g. temperature variations, currents, precipitation, etc.). See Table 21	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be in locations within reasonable proximity to the points of discharge and in the likely path of the discharges.	BHL is located in the southeastern (downstream) portion of West Swamp in MU3. West Swamp receives groundwater and runoff from WMA B.	Tritium Gross Alpha/Beta Gamma emitters (detailed) Total Strontium	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be for those contaminants that could potentially be present in effluent discharges.	Surface waters on CRL property receive groundwater, runoff, and effluent from various facilities and WMAs that are potential sources of radioactive contamination.	11.1 11.4
ESW	East Swamp Weir (MU6)	On-site; Indicator; Weekly Grab	Samples are collected at least monthly from surface water crossing the site	(should) If environmental monitoring is being done to verify the effectiveness of	ESW is located along East Swamp Stream, which receives groundwater and	Flow	Essential for determining contaminant loading to watercourses.		

Code	Location Name	Sample Type	Justification for Sample Type	Criteria for Location	Justification for Location	Parameter	Criteria for Parameter	Justification for Parameter	Cross ref to other objectives
		Sample	boundary and off-site stream or rivers that are subject to drainage from potentially contaminated areas. See Table 21	containment and effluent controls, then monitoring should be in locations within reasonable proximity to the points of discharge and in the likely path of the discharges.	runoff from the Laundry Pit, the east side of RP2, and the Chemical Pit within the LDA.	Tritium Gross Alpha/Beta Gamma emitters (detailed) Total Strontium	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be for those contaminants that could potentially be present in effluent discharges.	Surface waters on CRL property receive groundwater, runoff, and effluent from various facilities and WMAs that are potential sources of radioactive contamination.	11.10 11.4
FPS	Frog Pond Seepage (MU6)	On-site; Indicator; Quarterly Grab Sample	Water quality is subject to natural hydrological variability over the course of a year (e.g. temperature variations, currents, precipitation, etc.). See Table 21	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be in locations within reasonable proximity to the points of discharge and in the likely path of the discharges.	FPS receives groundwater from RP1 within the LDA.	Gross Alpha/Beta	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be for those contaminants that could potentially be present in effluent discharges.	Surface waters on CRL property receive groundwater, runoff, and effluent from various facilities and WMAs that are potential sources of radioactive contamination.	11.111.4
MAR	Main Stream Above Plant Road	On-site; Indicator; Semi-annual Grab Sample	Semi-annual collection is considered adequate at this location as inputs from groundwater are slow and consistent. See Table 21	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be in locations within reasonable proximity to the points of discharge and in the likely path of the discharges.	MAR is located along the upper reach of Main Stream (fed by No Name Swamp), which receives groundwater and surface runoff from WMAs D, E, G and H, the Salt Storage Facility, and the Waste Tank Farm.	Tritium Gross Alpha/Beta	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be for those contaminants that could potentially be present in effluent discharges.	Surface waters on CRL property receive groundwater, runoff, and effluent from various facilities and WMAs that are potential sources of radioactive contamination.	11.10 11.4
MSC	Main Stream Culvert	On-site; Indicator; Weekly Grab Sample	Samples are collected at least monthly from surface water crossing the site boundary and off-site stream or rivers that are subject to drainage from potentially contaminated areas. See Table 21	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be in locations within reasonable proximity to the points of discharge and in the likely path of the discharges.	MSC is located along Main Stream downstream of where the stream intercepts the groundwater and surface runoff from WMA B. The main source of radioactivity to Main Stream from WMA B is the circular bunkers in the southern portion of the	Flow Tritium Gross Alpha/Beta Gamma emitters (detailed)	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be for those contaminants that could potentially be present in effluent discharges.	Surface waters on CRL property receive groundwater, runoff, and effluent from various facilities and WMAs that are potential sources of radioactive contamination.	11.10

Code	Location Name	Sample Type	Justification for Sample Type	Criteria for Location	Justification for Location	Parameter	Criteria for Parameter	Justification for Parameter	Cross ref to other objectives
					WMA.				
PCW	Perch Creek Weir	On-site; Indicator; Weekly Grab Sample	Samples are collected at least monthly from surface water crossing the site boundary and off-site stream or rivers that are subject to drainage from potentially contaminated areas. See Table 21	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be in locations within reasonable proximity to the points of discharge and in the likely path of the discharges.	PCW is located along Perch Creek, downstream of the Perch Lake outlet, and is the last monitoring point of the Perch Lake basin before entering the Ottawa River. There are no sources of contamination entering Perch Creek downstream of this location, so that measurements at PCW can be used to assess total releases.	Flow	Essential for determining contaminant loading to watercourses.		
						Tritium Gross Alpha/Beta Gamma emitters (detailed) Total Strontium	Primarily Effluent Verification Program		11.1 11.4 11.8
PL1	Perch Lake Inlet 1	On-site; Indicator; Weekly Grab Sample (Monthly composite)	Samples are collected at least monthly from surface water crossing the site boundary and off-site stream or rivers that are subject to drainage from potentially contaminated areas. See Table 21	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be in locations within reasonable proximity to the points of discharge and in the likely path of the discharges.	PL1 is an inlet of Perch Lake, located downstream of West Swamp, which receives groundwater and runoff from WMA B. The main sources of contamination in WMA B are the circular bunkers in the southern portion of WMA B and the unlined sand trenches in the northwest corner of WMA B.	Flow Tritium Gross Alpha/Beta	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be for those contaminants that could potentially be present in effluent discharges.	Surface waters on CRL property receive groundwater, runoff, and effluent from various facilities and WMAs that are potential sources of radioactive contamination.	11.1 11.4
PL2	Perch Lake Inlet 2	On-site; Indicator; Weekly Grab Sample	Samples are collected at least monthly from surface water crossing the site boundary and off-site stream or rivers that are subject to drainage from potentially contaminated areas. See Table 21	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be in locations within reasonable proximity to the points of discharge and in the likely path of the discharges.	PL2 is an inlet of Perch Lake that receives groundwater and surface water runoff from WMAs A and the LDAs (Laundry Pit, RP2, RP2, and Chemical Pit) via South Swamp and East Swamp, and from WMAs B (east side), E, G, and H, and the Waste Tank Farm via Main	Flow Tritium Gross Alpha/Beta Gamma emitters (detailed)	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be for those contaminants that could potentially be present in effluent discharges.	Surface waters on CRL property receive groundwater, runoff, and effluent from various facilities and WMAs that are potential sources of radioactive contamination.	11.1 11.4

Code	Location Name	Sample Type	Justification for Sample Type	Criteria for Location	Justification for Location	Parameter	Criteria for Parameter	Justification for Parameter	Cross ref to other objectives
					Stream.				
PLO	Perch Lake Outlet	On-site, Indicator; Weekly Grab sample	Samples are collected at least weekly from surface water crossing the site boundary and off-site stream or rivers that are subject to drainage from potentially contaminated areas. See Table 21	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be in locations within reasonable proximity to the points of discharge and in the likely path of the discharges.	PLO is an outlet of Perch Lake, located approximately 1 km upstream of the Perch Creek Weir monitoring location, and receives groundwater and surface runoff from WMAs A, B, D, E, G, H, the LDAs (Laundry Pit, RP1, RP2, and the Chemical Pit), the Waste Tank Farm, the Salt Storage Shed and the rest of the Perch Lake basin.	Tritium Gross Alpha/Beta	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be for those contaminants that could potentially be present in effluent discharges.	Surface waters on CRL property receive groundwater, runoff, and effluent from various facilities and WMAs that are potential sources of radioactive contamination.	11.1 11.4
SBD	Spring B Discharge (MU 3)	On-site, Indicator; Monthly Grab sample	Samples are collected at least monthly from surface water crossing the site boundary and off-site stream or rivers that are subject to drainage from potentially contaminated areas. See Table 21	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be in locations within reasonable proximity to the points of discharge and in the likely path of the discharges.	SBD receives groundwater and runoff from WMA B. The main sources of contamination are the unlined sand trenches in the northwest corner of WMA B. The SBD monitoring point is located directly behind the system of intake wells for the new Spring B treatment system.	Tritium Gross Alpha/Beta	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be for those contaminants that could potentially be present in effluent discharges.	Surface waters on CRL property receive groundwater, runoff, and effluent from various facilities and WMAs that are potential sources of radioactive contamination.	11.1 11.4
SSW	South Swamp Weir (MU 3)	On-site, Indicator; Monthly Grab sample	Samples are collected at least monthly from surface water crossing the site boundary and off-site stream or rivers that are subject to drainage from potentially contaminated areas. See Table 21	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be in locations within reasonable proximity to the points of discharge and in the likely path of the discharges.	SSW is located along South Swamp Stream, which receives groundwater and runoff from WMA A and RP2 within the LDA.	Tritium Gross Alpha/Beta Total Strontium	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be for those contaminants that could potentially be present in effluent discharges.	Surface waters on CRL property receive groundwater, runoff, and effluent from various facilities and WMAs that are potential sources of radioactive contamination.	11.1 11.4
23L	Lake 233	On-site, Indicator; Annual Grab	Samples are collected annually at water bodies on-site expected to be not	(should) If environmental monitoring is being done to verify the effectiveness of	Lake 233 is located east of the ridge that hosts the Nitrate Plant, Thorium Pit,	Tritium Gross Alpha/Beta	(should) If environmental monitoring is being done to verify the effectiveness	Concentrations in surface waters at several locations within the	11.4

Code	Location Name	Sample Type	Justification for Sample Type	Criteria for Location	Justification for Location	Parameter	Criteria for Parameter	Justification for Parameter	Cross ref to other objectives
		sample	impacted by operations. There is no need to capture variability at these locations as there is no relevance to human exposure. See Table 21	containment and effluent controls, then monitoring should be in locations within reasonable proximity to the points of discharge and in the likely path of the discharges.	and WMA C. It is the origin of the groundwater flow system that underlies these WMAs. Lake 233 is not subject to the influence of the WMAs because it is upgradient of the contaminant plumes originating from the WMAs. Due to the close proximity of this lake to the facilities, this serves as confirmatory sampling that no impact is occurring.		of containment and effluent controls, then monitoring should be for those contaminants that could potentially be present in effluent discharges.	Maskinonge Lake basin are relevant to dose assessments that are part of the ERA. At certain locations where surface waters have not been affected by CRL operations, monitoring serves to confirm the absence of impacts.	
BSW DSW LBL	Bulk Storage Stream Weir Duke Swamp Weir Lower Bass Lake	On-site, Indicator; Weekly Grab sample	Samples are collected weekly from surface water that are subject to drainage from potentially contaminated areas. The weekly frequency is considered adequate to represent the variability in hydrological conditions to produce a representative annual average concentration. See Table 21	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be in locations within reasonable proximity to the points of discharge and in the likely path of the discharges.	BSW is located along Bulk Storage Stream, which receives groundwater and runoff from the WMA C Extension, WMA F, and the Bulk Material Landfill. DSW receives groundwater and runoff from WMA C. LBL receives groundwater and runoff from the Nitrate Plant, ACS Compound, Thorium Pit, and WMA C. This stream enters Lower Bass Lake	Flow Tritium Gross Alpha/Beta Gamma emitters (detailed)	Primarily Effluent Verification Program		11.1 11.4
CHL	C-2 Fire Trail at Hydro Line (MU10)	On-site, Indicator; Semi-Annual Grab sample	Semi-annual collection is considered adequate at this location as inputs from groundwater are slow and consistent. See Table 21	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be in locations within reasonable proximity to the points of discharge and in the likely path of the discharges.	CHL could receive groundwater and runoff from WMA B (via West Swamp).	Tritium Gross Alpha/Beta Gamma emitters (detailed)	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be for those contaminants that could potentially be present in effluent discharges.	Surface waters on CRL property receive groundwater, runoff, and effluent from various facilities and WMAs that are potential sources of radioactive contamination.	11.4

Code	Location Name	Sample Type	Justification for Sample Type	Criteria for Location	Justification for Location	Parameter	Criteria for Parameter	Justification for Parameter	Cross ref to other objectives
CL	Chalk Lake	On-site, Indicator; Semi-Annual Grab sample	Semi-annual collection is considered adequate at this location as inputs from groundwater are slow and consistent. See Table 21	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be in locations within reasonable proximity to the points of discharge and in the likely path of the discharges.	CL receives groundwater and runoff from all of the WMAs in the Maskinonge Lake basin and the Chalk Lake basin.	Tritium Gross Alpha/Beta Gamma emitters (detailed)	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be for those contaminants that could potentially be present in effluent discharges.	Surface waters on CRL property receive groundwater, runoff, and effluent from various facilities and WMAs that are potential sources of radioactive contamination.	11.4
DEL	Dewdrop Lake	On-site, Indicator; Annual Grab sample	Samples are collected annually at water bodies on-site expected to be not impacted by operations. There is no need to capture variability at these locations as there is no relevance to human exposure. See Table 21	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be in locations within reasonable proximity to the points of discharge and in the likely path of the discharges.	DEL receives groundwater and runoff from the Nitrate Plant.	Tritium Gross Alpha/Beta	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be for those contaminants that could potentially be present in effluent discharges.	Surface waters on CRL property receive groundwater, runoff, and effluent from various facilities and WMAs that are potential sources of radioactive contamination.	11.4
LBO	Lower Bass Lake Outlet	On-site, Indicator; Annual Grab sample	Samples are collected annually at water bodies on-site expected to be not impacted by operations. There is no need to capture variability at these locations as there is no relevance to human exposure. See Table 21	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be in locations within reasonable proximity to the points of discharge and in the likely path of the discharges.	LBO receives groundwater and runoff from the Nitrate Plant, ACS Compound, Thorium Pit, and WMA C. This stream links Lower Bass Lake to Maskinonge Lake.	Tritium Gross Alpha/Beta	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be for those contaminants that could potentially be present in effluent discharges.	Surface waters on CRL property receive groundwater, runoff, and effluent from various facilities and WMAs that are potential sources of radioactive contamination.	11.4
MLO	Maskinonge Lake Outlet	On-site, Indicator; Weekly Grab sample	Water quality is subject to natural hydrological variability over the course of a year (e.g. temperature variations, currents, precipitation, etc.). See Table 21	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be in locations within reasonable proximity to the points of discharge and in the likely path of the discharges.	MLO receives groundwater and runoff from all of the WMAs in the Maskinonge Lake basin, notably WMA C, F, J, ACS Pits, Nitrate Plant and Thorium Pit.	Tritium Gross Alpha/Beta Gamma emitters (detailed)	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be for those contaminants that could potentially be present in effluent discharges.	Surface waters on CRL property receive groundwater, runoff, and effluent from various facilities and WMAs that are potential sources of radioactive contamination.	0 11.4

Code	Location Name	Sample Type	Justification for Sample Type	Criteria for Location	Justification for Location	Parameter	Criteria for Parameter	Justification for Parameter	Cross ref to other objectives
TOL	Toussaint Lake	On-site, Indicator; Semi-Annual Grab sample	Semi-annual collection is considered adequate at this location as inputs from groundwater are slow and consistent. See Table 21	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be in locations within reasonable proximity to the points of discharge and in the likely path of the discharges.	Water from this lake enters Lower Bass Lake. It could receive groundwater and runoff from WMA B.	Tritium Gross Alpha/Beta Gamma emitters (detailed)	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be for those contaminants that could potentially be present in effluent discharges.	Surface waters on CRL property receive groundwater, runoff, and effluent from various facilities and WMAs that are potential sources of radioactive contamination.	11.4
TWL	Twin Lakes	On-site, Indicator; Annual Grab sample	Samples are collected annually at water bodies on-site expected to be not impacted by operations. There is no need to capture variability at these locations as there is no relevance to human exposure. See Table 21	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be in locations within reasonable proximity to the points of discharge and in the likely path of the discharges.	TWL could receive groundwater and runoff from the Nitrate Plant.	Tritium Gross Alpha/Beta	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be for those contaminants that could potentially be present in effluent discharges.	Surface waters on CRL property receive groundwater, runoff, and effluent from various facilities and WMAs that are potential sources of radioactive contamination.	11.4
Roads									
R13	Gate 12 to Plant Road at C-2 Fire Trail	On-site, Indicator; Annual Run	Annual verification that contamination is not being spread by vehicles travelling on Plant Road.	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be in locations within reasonable proximity to the points of discharge and in the likely path of the discharges.	Located near the WMAs and the built-up area. May be impacted by airborne effluents from these sources. Located along major throughway for CRL traffic leaving the site.	Total Gamma	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be for those contaminants that could potentially be present in effluent discharges.	Released to the air in measurable quantities from roof vents and stacks at CRL.	11.4
Wet and Dry Deposition									
F13	B 227	On-site, Indicator; Monthly Collection	Wet and dry deposition samples are collected monthly as an indication of concentrations being deposited on, and entering, the soil compartment. They represent deposition over the previous month.	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be in locations within reasonable proximity to the points of discharge and in the likely path of the discharges.	Located near the WMAs and the built-up area. May be impacted by airborne effluents from these sources.	Gross Alpha/Beta	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be for those contaminants that could potentially be present in effluent	Released to the air in measurable quantities from roof vents and stacks at CRL. Measurement of Sr-90 in wet and dry deposition (i.e. fallout) provides an estimate of the deposition from air	

Code	Location Name	Sample Type	Justification for Sample Type	Criteria for Location	Justification for Location	Parameter	Criteria for Parameter	Justification for Parameter	Cross ref to other objectives
							discharges.	effluents from CRL and verification of the effectiveness of containment and effluent controls for airborne releases.	

11.3.2 Monitoring Around Specific Facilities

Monitoring to evaluate the environmental performance of specific facilities that contain significant quantities of hazardous materials in dispersible form (i.e., monitoring for leak detection), where releases could escape detection by other monitoring means (e.g., facility-specific monitoring, groundwater monitoring), is included in the EMP where needed. Monitoring to meet this purpose is done in locations within reasonable proximity to the points of discharge and in the likely path of the discharges.

An example of a surface water location that falls under this category is:

- 010 Stream, which could receive low-level radioactive water from the Tritiated Light Water Storage Facility (B217) in the event of a failure of containment.

Road monitoring is completed as part of the EMP along Plant Road as it is in close proximity to many operating and non-operating WMAs. In addition, contamination could be spread by vehicles that travel between the controlled area and the supervised areas (e.g., WMAs), and by vehicles leaving the CRL site.

11.3.3 Monitoring at the Property Boundary

The control of radionuclide releases to the Ottawa River is determined by monitoring radionuclides in the effluent streams (e.g., Process Outfall and Perch Creek) that discharge to the river. An approximate check on the accuracy of this effluent monitoring can be obtained by concurrent measurements of radionuclide concentrations in the river downstream of the discharges.

Monitoring to verify wet and dry deposition rates, ambient air concentrations, and direct radiation resulting from CRL airborne releases is achieved through a network of samplers and monitors located at the site boundary. Monitoring locations established for this purpose, in most cases, are selected to be within the main upriver and downriver wind rose sectors.

Details of monitoring at the CRL property boundary are given in Table 18.

Table 18: Monitoring at the CRL Property Boundary

Code	Location Name	Sample Type	Justification for Sample Type	Criteria for Location	Justification for Location	Parameter	Criteria for Parameter	Justification for Parameter	Cross ref to other objectives
Ambient Air									
A01 A03 A08 A32	Point au Baptême C-2 Fire Trail Balmer Bay Road East Mattawa Road	Property Boundary; Indicator; Continuous measurement	Continuous monitoring is desirable due to the fleeting nature of the immersion pathway. See Table 21	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be in locations within reasonable proximity to the points of discharge and in the likely path of the discharges.	All CRL airborne effluents arising from roof vents and stacks. Located in the prevalent wind direction from the NRU Stack and the built-up area. May be impacted by airborne effluents from the NRU Stack and other stacks/roof vents in the built-up area.	Total Gamma Tritium	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be for those contaminants that could potentially be present in effluent discharges.	TLD and GammaTRACER measurements continue to provide verification of the level of radioactivity in the air; the external gamma exposures that may be due to immersion in a plume, and from ground contamination due to the settling of particulates. Radionuclide is released to the air in measurable quantities from roof vents and stacks at CRL. Monitoring is to verify the effectiveness of containment and effluent controls for airborne releases	11.1 (A08)
A43	B560 (Low Background Bldg)	Property Boundary; Reference; Continuous measurement	Continuous monitoring is desirable due to the fleeting nature of the immersion pathway. See Table 21	(should) In addition to the locations mentioned above, locations with similar environmental conditions but without potential for facility-related effects (i.e. representative of natural background) should be included in the EMP as reference areas.	All CRL airborne effluents arising from roof vents and stacks. Located outside of the prevalent wind direction. Reference site to establish site-specific background.	Total Gamma Tritium	(should) In addition to the locations mentioned above, locations with similar environmental conditions but without potential for facility-related effects (i.e. representative of natural background) should be included in the EMP as reference areas.	Monitoring at reference locations measures concentrations of the same parameters that are of interest at indicator locations.	
Surface Water									
PAB	Point au Baptême	Property Boundary; Indicator; Weekly Grab Sample	Water quality is subject to natural hydrological variability over the course of a year (e.g. temperature variations, currents, precipitation, etc.). See Table 21	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be in locations within reasonable proximity to the points of discharge and in the likely path of the discharges.	Located at the property boundary directly downstream of all liquid effluent releases at CRL	Tritium Gross Alpha/Beta	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be for those contaminants that could potentially be present in effluent discharges	Radionuclide is released to the water in measurable quantities from Process (including WTC effluent) and other outfalls at CRL. Monitoring is to verify the effectiveness of containment and effluent controls for liquid releases	

Code	Location Name	Sample Type	Justification for Sample Type	Criteria for Location	Justification for Location	Parameter	Criteria for Parameter	Justification for Parameter	Cross ref to other objectives
ORC	Ottawa River at CRL	Upgradient Property Boundary; Reference; Weekly Grab Sample	Water quality is subject to natural hydrological variability over the course of a year (e.g. temperature variations, currents, precipitation, etc.). See Table 21	(should) In addition to the locations mentioned above, locations with similar environmental conditions but without potential for facility-related effects (i.e. representative of natural background) should be included in the EMP as reference areas.	CRL water intake location. Located upgradient of all liquid effluent release points.	Tritium Gross Alpha/Beta	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be for those contaminants that could potentially be present in effluent discharges	Monitoring at reference locations is to be for same parameters as indicator locations.	
OR5 ORF ORH	Ottawa River Highview Fort William, Ottawa River Harrington Bay, Ottawa River	Downgradient Indicator; Semi-Annual Grab Sample	Minimal variability expected over the course of the year. See Table 21	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be in locations within reasonable proximity to the points of discharge and in the likely path of the discharges.	Monitoring close to the source, where discharges from Maskinonge Lake Basin enter the Ottawa River; Located in the likely path of discharges, directly downstream of all liquid effluent releases at CRL	Tritium Gross Alpha/Beta	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be for those contaminants that could potentially be present in effluent discharges	Radionuclide is released to the water in measurable quantities from Process (including WTC effluent) and other outfalls at CRL. Monitoring is to verify the effectiveness of containment and effluent controls for liquid releases	
Wet/Dry Deposition									
F01 F08	Pointe au Baptême Balmer Bay Road	Property Boundary; Indicator; Monthly Grab Sample	Wet and dry deposition samples are collected monthly as an indication of concentrations being deposited on, and entering, the soil compartment. They represent deposition over the previous month.	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be in locations within reasonable proximity to the points of discharge and in the likely path of the discharges.	Located in the prevalent wind direction from the NRU Stack and the built-up area. May be impacted by airborne effluents from the NRU Stack and other stacks/roof vents in the built-up area.	Gross Alpha/Beta	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be for those contaminants that could potentially be present in effluent discharges.	Released to the air in measurable quantities from roof vents and stacks at CRL. Measurement of wet and dry deposition (i.e. fallout) provides an estimate of the deposition from air effluents from CRL and verification of the effectiveness of containment and effluent controls for airborne releases.	
F04	B560 (Low Background Bldg)	Property Boundary; Reference; Grab Sample	Wet and dry deposition samples are collected monthly as an indication of concentrations being deposited on, and	(should) In addition to the locations mentioned above, locations with similar environmental conditions but without	Located outside of the prevalent wind direction. Reference site to establish site-specific background	Gross Alpha/Beta	(should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then	Measurement in reference locations provides an estimate of the deposition due to weapons fallout.	

Code	Location Name	Sample Type	Justification for Sample Type	Criteria for Location	Justification for Location	Parameter	Criteria for Parameter	Justification for Parameter	Cross ref to other objectives
			entering, the soil compartment. They represent deposition over the previous month.	potential for facility-related effects (i.e. representative of natural background) should be included in the EMP as reference areas.			monitoring should be for those contaminants that could potentially be present in effluent discharges		

11.4 OBJECTIVE 4: Further to the objective described above, which provides an indication on effectiveness of effluent control, where waste storage facilities and contaminated lands exist, provide an indication of unusual or unforeseen conditions that might require corrective action or additional monitoring such as groundwater monitoring

The EMP serves as a second line of defence by detecting unusual levels in the environment in the event of an unknown release of activity that was not detected by other early warning systems (e.g., leak detection, groundwater monitoring).

The detection of significant deterioration in the quality of surface water while tracking the environmental performance of facilities leads to follow-up investigations of the cause of that deterioration.

As the monitoring criteria pertaining to this objective are the same as Objective 3, activities are not repeated here.

11.5 OBJECTIVE 5: To assist in collecting the data required to provide data to verify the predictions made by the ERA (or equivalent), Derived Release Limit (DRL) model, and/or Environmental Assessment (EA), refine the models used in the ERA (or equivalent), DRL model and/or EA, or reduce the uncertainty in the predictions made by the ERA (or equivalent), DRL model and/or EA

Objective 5 is dynamic in that it changes with the development of the site's ERA, DRL model and EAs. There are cases where changes are made to the EMP as a result, but more often, the information gathered is instead incorporated into the next version of the ERA, DRL model or EA. As such, although the information is current at the time of the writing of this Environmental Monitoring Plan, this information should be considered to be examples only.

Statistical analysis of the monitoring data collected under this Objective can be completed in some cases, and not in others. This is dependent on the desired use of the data being collected.

11.5.1 Verify Predictions Made by an ERA or DRL Model

11.5.1.1 Ottawa Riverbed Remediation – Sediment Verification

Sediments in the vicinity of the Process Outfall were characterized and assessed by the Ottawa Riverbed Remediation (ORR) Project in 2016 [50], and recommendations were made to continue a confirmatory sampling campaign as part of the EMP.

A sediment verification monitoring plan was developed to validate the ORR risk assessment assumptions. This sediment verification monitoring will take place on a five-year schedule. The work involves three main parts: (1) taking sediment cores from the area of the Ottawa River around the Process Outfall and sectioning the cores to 0.5 cm intervals, then performing a gamma spectrometry analysis using Cs-137 as a marker, (2) using a dredge sampler to sample sediment in transects across the river and scan for active particles, and (3) a tabletop review of the data.

To date, the work has been completed in 2016 and the most recent collection was in 2021. A summary of the work is provided in the ACMR when data are available.

11.5.1.2 Ottawa Riverbed Remediation – Shoreline Surveys

As a follow-up to the ORR project [50], routine shoreline gamma scan surveys were incorporated into the EMP in 2015 and serve as verification monitoring that the findings of the ORR are maintained. This was a specific recommendation made by the ORR to the EMP [51] to confirm the continuing absence of active particles. A portable gamma spectrometer is used at one upstream location (Pine Point Beach), five locations at CRL (Gray Dock, two CRL shoreline areas, and both sides of Pointe au Baptême Beach), and three downstream locations (Ells Beach, Shield Beach, and Hilborn Beach) on an annual basis. Six other downstream beaches are scanned on a tri-annual basis. See Table 19 for all location details.

Scans are completed during periods of relatively low water level in summer or fall. Data are collected by walking "lines" at about 0.7 m/s while collecting simultaneous GPS and spectral radiation data at a rate of one per second. Total counts are reported, expressed in counts per minute (cpm).

Table 19: Shoreline Survey Locations

Environmental Media	Station Type	Location Code	Location Name	Location Justification	Survey Frequency	Frequency Justification
Beach Sand; Shoreline Survey	Reference; Upriver	B01	Pine Point, Deep River	Background	Annual	During summer months
	Indicator: Site Boundary	B11	Gray Dock	Directly along CRL shoreline	Annual	During summer months
	Indicator; Site Boundary	B12	CRL Shoreline 1	Directly along CRL shoreline	Annual	During summer months
	Indicator: Site Boundary	B13	CRL Shoreline 2	Directly along CRL shoreline	Annual	During summer months
	Indicator; Site Boundary	B05A	Pointe au Baptême, Upstream	Closest publicly accessible beach	Annual	During summer months
	Indicator; Site Boundary	B05B	Pointe au Baptême, Downstream	Closest publicly accessible beach	Annual	During summer months
	Indicator, Downriver	B14	Ells Beach	Address public concern over activity levels at public beaches	Annual	During summer months
	Indicator, Downriver	B15	Shield Beach, Québec	Address public concern over activity levels at public beaches	Annual	During summer months
	Indicator, Downriver	B16	Hilborn Beach, Québec	Address public concern over activity levels at public beaches	Annual	During summer months
	Indicator, Downriver	B06	Oiseau Point, Québec	Address public concern over activity levels at public beaches	3 years	No change expected, verification of no impact

Environmental Media	Station Type	Location Code	Location Name	Location Justification	Survey Frequency	Frequency Justification
	Indicator, Downriver	B17	Downey Bay, Québec	Address public concern over activity levels at public beaches	3 years	No change expected, verification of no impact
	Indicator, Downriver	B08	Fort William, Québec	Address public concern over activity levels at public beaches	3 years	No change expected, verification of no impact
	Indicator, Downriver	B20	Kiska Beach, Petawawa	Address public concern over activity levels at public beaches	3 years	No change expected, verification of no impact
	Indicator, Downriver	B21	Black Bear Beach, Petawawa	Address public concern over activity levels at public beaches	3 years	No change expected, verification of no impact
	Indicator, Downriver	B10	Riverside Park, Pembroke	Address public concern over activity levels at public beaches	3 years	No change expected, verification of no impact

11.5.1.3 DRL Model Predictions: Pathway Contributions to Airborne and Liquid DRL's

The data collected as part of the EMP can at times (when needed) be used to confirm the predictions of the DRL model in terms of percentage contributions of the main pathways to the calculated DRL for each radionuclide. Monitoring at potential critical group locations generates results that can be used to verify the predictions and reduce the uncertainty made by the DRL model, as well as to refine the DRL model.

11.5.2 Reduce Uncertainty in the ERA

Most of the uncertainty associated with the ERA is related to data gaps, including lack of monitoring data for specific pathways and study areas. The main areas of uncertainty are listed in this section, along with the monitoring activities that have been implemented in order to address the uncertainties. This information can be included in the next ERA update, as appropriate.

11.5.2.1 ERA Recommendations to Update the EMP

The ERA [15] noted several metals in the Perch Lake basin that were measured during non-routine sampling, but do not have screening criteria or background concentrations for comparison. The ERA recommends adding additional non-radiological parameters to the current Perch Lake reference location (PL4) to allow for screening of beryllium, bismuth, silver, tellurium, thallium, titanium and zirconium in sediment, and silver in surface water. Any additional data collected as a result of the implementation of these recommendations will be considered in the next iteration of the ERA.

11.5.2.2 Biological Effects Monitoring

Biological effects monitoring at CRL is carried out through non-routine investigations in support of the ERA and has not been incorporated into the routine EMP. Examples of the studies recently completed include assessments of benthic macroinvertebrate community structures,

toxicity tests and assessment of the bioavailability of the COPC. These are specifically designed and carried out to address the uncertainties identified in the previous ERA, including locations and parameters that were determined to be of potential ecological concern. Uncertainties can be further reduced by using more realistic effect values when screening for potential effects than conservative effect values such as guidelines and the upper level of background where possible.

11.5.2.3 Small On-Site Wild Animals

Small game and wild animals are collected on-site through opportunistic means (e.g., vehicle interaction, or trapping of nuisance beavers) to better understand how CRL operations affect non-human biota. When available, small wild animals would have flesh, bone, and organs (liver and kidney) analyzed for gross alpha and beta, total strontium, gamma emitters and tritium (flesh only). Analysis for metals could also be performed given enough sample is available.

Due to smaller home ranges compared to the large game animals, it is assumed that small animals found on-site have spent all their time on CRL property and exposed to both air and liquid pathways. The resulting radiological data will support the findings of the ERA and better establish CRL's operational effect on non-human biota. Details provided in Section 11.1.1.5.3.

11.5.2.4 Detection Limits

During the development of this Environmental Monitoring Plan, attention was paid to the appropriateness of measurement sensitivity levels used in both the EVMP and in the EMP. Within this Environmental Monitoring Plan, detection limits of the program are compared to SC and/or evaluation criteria, again providing justification for any instances of excursions (Section 13).

11.6 OBJECTIVE 6: Provide Data Required to Support Site Restoration Programs, Site Operations or to Plan for Future Stages of the Facility (e.g., Decommissioning)

This objective looks at the role that the EMP plays in the lifecycle of the facility. For example, the EMP at CRL provides data that could eventually be used as baseline data for future decommissioning stages of the facility. Some of the data generated by the program have been used to support current remediation activities. Restoration, operational, or decommissioning needs do influence the EMP as these needs arise.

In support of numerous proposed and on-going activities at CRL, including the NSDF and the SMR project, monitoring groundwater, surface water, ambient air and deposition in the vicinity of the built-up area, proposed development areas and WMAs is needed to continually evaluate the potential long-term impacts. For example, both the NSDF and SMR projects used EMP data as a baseline for the site selection and characterization phases.

11.7 OBJECTIVE 7: Provide Resources and Data that can be of Value during the Response to an Accident or Upset, and in the Recovery from such an Event

The EMP at CRL provides standby monitoring capability for rapid assessment of risk to the general public in the event of unanticipated or accidental releases of radioactive material. All data provided by the monitoring program can contribute to this objective and are covered elsewhere in this document. Statistical analysis of the monitoring data collected under this objective is not typically completed as it is simply to establish baseline monitoring.

11.8 OBJECTIVE 8: Demonstrate Due Diligence

This objective serves to increase the credibility of CRL in the eyes of the public. CNL has adopted the approach that they will maintain a more extensive EMP than the minimum specified in the regulations.

Since the ERA has not suggested any likelihood of human health effects from radionuclides released from CRL, and the CNSC [25] only requires reporting of doses for the most exposed group of people, monitoring at other locations demonstrates due diligence. Similarly, since the monitoring to check on effluent control and continuing containment is precautionary, it also serves to demonstrate due diligence.

In cases where there is public concern regarding emissions, monitoring is established in nearby population centres other than locations of identified or potential critical groups or identified in the ERA.

Monitoring that falls under this objective is given in Table 20.

Table 20: Monitoring to Demonstrate Due Diligence

Code	Location Name	Sample Type	Justification for Sample Type	Criteria for Location	Justification for Location	Parameter	Criteria for Parameter	Justification for Parameter	Cross ref to other objectives
Ambient Air									
A05 A06 A12 A15 A35	Chalk River; Ottawa Street Mountain-view Subdivision Deep River Water Treatment Facility Québec, Harrington Bay Petawawa Water Filtration Facility	Off-Site; Indicator; Continuous measurement	Continuous monitoring is desirable due to the fleeting nature of the immersion pathway. Air quality is typically subject to meteorological variability over the course of a year (i.e. changes in wind direction, wind speed, and atmospheric stability on hourly time scales). See Table 21	(should) Consideration should be given to establishing monitoring locations in nearby population centres (other than locations of identified or potential critical groups or locations identified in an ERA or equivalent) for the most dominant contaminants and environmental pathways where there is public concern regarding emissions.	To address public concern over ambient air levels in nearby population centres (Deep River and area, cottager locations, Petawawa).	Total Gamma	(may) The choice of contaminants to monitor in the environment may also be based on the fact that there are business reasons, i.e., stakeholder concerns, due diligence, etc.	Monitoring also serves to support atmospheric dispersion models, confirm the absence of effects (i.e. due diligence), and provide information during an emergency.	
						Tritium	(may) The choice of contaminants to monitor in the environment may also be based on the fact that there are business reasons, i.e., stakeholder concerns, due diligence, etc.	Monitoring also serves to support atmospheric dispersion models, confirm the absence of effects (i.e. due diligence), and provide information during an emergency.	
A19 A22 A40	Québec, Hilborn at Oiseau Point Pembroke, Golf Course Road Québec, Demers Centre	Off-Site; Indicator; Continuous measurement	Continuous monitoring is desirable due to the fleeting nature of the immersion pathway. Air quality is typically subject to meteorological variability over the course of a year (i.e. changes in wind direction, wind speed, and atmospheric stability on hourly time scales). See Table 21	(should) Consideration should be given to establishing monitoring locations in nearby population centres (other than locations of identified or potential critical groups or locations identified in an ERA or equivalent) for the most dominant contaminants and environmental pathways where there is public concern regarding emissions.	To address public concern over ambient air levels in nearby population centres (Deep River and area, cottager locations, Petawawa).	Total Gamma	(may) The choice of contaminants to monitor in the environment may also be based on the fact that there are business reasons, i.e., stakeholder concerns, due diligence, etc.	Monitoring also serves to support atmospheric dispersion models, confirm the absence of effects (i.e. due diligence), and provide information during an emergency.	
Surface Water									
BDO	Black Duck Creek at Highway 17	Off-site, Indicator; Annual Grab Sample	See Table 21	(should) Consideration should be given to establishing monitoring locations in nearby population centres (other than locations of identified or	Located off-site, southwest of the CRL property, in the village of Chalk River. Verification of no	Tritium Gross Alpha/Beta	(may) The choice of contaminants to monitor in the environment may also be based on the following:	Aside from the Ottawa River, off-site surface water bodies do not receive any direct inputs from CRL. Serve as	

Code	Location Name	Sample Type	Justification for Sample Type	Criteria for Location	Justification for Location	Parameter	Criteria for Parameter	Justification for Parameter	Cross ref to other objectives
				potential critical groups or locations identified in an ERA or equivalent) for the most dominant contaminants and environmental pathways where there is public concern regarding emissions.	impact from CRL.		there are other business reasons, i.e., stakeholder concerns, due diligence, etc.	reference monitoring for on-site surface waters, thus are monitored for the same parameters.	
CRH	Chalk River at Highway 17	Off-site, Indicator; Annual Grab Sample	See Table 21		Located off-site, south-southwest of the CRL property, at the Petawawa Research Forest. Verification of no impact from CRL.	Tritium Gross Alpha/Beta			
SHC	Spring Creek at Highway 17	Off-site, Indicator; Annual Grab Sample	See Table 21		Located off-site, west-northwest of the Chalk River site, near Mountainview Subdivision. Verification of no impact from CRL.	Tritium Gross Alpha/Beta			
DBC	Downey's Bay Creek	Off-site, Indicator; Annual Grab Sample	See Table 21	(should) Consideration should be given to establishing monitoring locations in nearby population centres (other than locations of identified or potential critical groups or locations identified in an ERA or equivalent) for the most dominant contaminants and environmental pathways where there is public concern regarding emissions.	Located off-site, east-southeast of the Chalk River site, near a group of Québec cottage locations. Verification of no impact from CRL.	Tritium Gross Alpha/Beta	(may) The choice of contaminants to monitor in the environment may also be based on the following: there are other business reasons, i.e., stakeholder concerns, due diligence, etc.	Aside from the Ottawa River, off-site surface water bodies do not receive any direct inputs from CRL. Serve as reference monitoring for on-site surface waters, thus are monitored for the same parameters.	
HIL	Oiseau Creek at Hilborn's	Off-site, Indicator; Annual Grab Sample	See Table 21		Located off-site, southeast of the Chalk River site, directly across the Ottawa River near a Québec cottage location. Verification of no impact from CRL.	Tritium Gross Alpha/Beta			
ORD PET ORP	Deep River, Ottawa River Petawawa, Ottawa River Pembroke, Ottawa River	Off-site, Reference; Daily Grab samples	Water quality is subject to natural hydrological variability over the course of a year (e.g. temperature variations, currents, precipitation, etc.). See Table 21	(should) Consideration should be given to establishing monitoring locations in nearby population centres (other than locations of identified or potential critical groups or locations identified in an ERA or equivalent) for the most dominant contaminants and environmental pathways where there is public concern	The upstream portion of the Ottawa River is not affected by CRL operations, therefore serves as a reference site for the Ottawa River. There is a high level of public concern regarding levels of	Tritium Gross Alpha/Beta Gamma emitters (detailed)	(may) The choice of contaminants to monitor in the environment may also be based on the following: there are other business reasons, i.e., stakeholder concerns, due diligence, etc.	There is a high level of public concern regarding levels of tritium in local drinking water.	11.1 0

Code	Location Name	Sample Type	Justification for Sample Type	Criteria for Location	Justification for Location	Parameter	Criteria for Parameter	Justification for Parameter	Cross ref to other objectives
				regarding emissions.	radioactivity in local drinking water. Monitoring at water treatment plants upstream of CRL serves to confirm the absence of impacts.				
010 020	Storm Outfall 010 Stream 020	On-site; Indicator; Semi-annual Grab sample (non-rads)	Water quality is subject to natural hydrological variability over the course of a year (e.g. temperature variations, currents, precipitation, etc.). See Section 12.2	(should) If environmental monitoring at a location is triggered by the Municipal/Industrial Strategy for Abatement (MISA) protocol, then this location should be included in the EMP.	The 010 and 020 Streams are located down gradient of the inactive landfill site and Grey Crescent site, accepting groundwater discharges from both areas.	Field Parameters General Chemistry Metals	See Appendix A Table A-1 (010) and Table A-2 (020)		11.1 11.3
PCW	Perch Creek Weir	On-site; Indicator; Semi-annual Grab sample (non-rads)	Water quality is subject to natural hydrological variability over the course of a year (e.g. temperature variations, currents, precipitation, etc.). See Section 12.2	(should) If environmental monitoring at a location is triggered by the MISA protocol, then this location should be included in the EMP.	PCW is located along Perch Creek, downstream of the Perch Lake outlet, and receives groundwater and surface runoff from WMAs A, B, D, E, G, H, the LDAs and the rest of the Perch Lake basin such that measurements at PCW can be used to assess total releases.	Field Parameters General Chemistry Metals	See Appendix A Table A-7		11.1 11.3
Fish									
SF	Sturgeon (Chalk) Lake	Off-site, Indicator; Grab sample	See Table 21	(should) Consideration should be given to establishing monitoring locations in nearby population centres (other than locations of identified or potential critical groups or locations identified in an ERA or equivalent) for the most dominant contaminants and environmental pathways where there is public concern regarding emissions.	To address public concern over levels in fish from Chalk Lake (Chalk Lake extends across CRL property onto CFB Petawawa, thus may be accessible to the public)	Free-Water Tritium Organically Bound Tritium Gross Alpha/Beta Carbon-14 Gamma Emitters	(may) The choice of contaminants to monitor in the environment may also be based on the following: there are other business reasons, i.e., stakeholder concerns, due diligence, etc.	Released in measurable quantities from effluent streams and groundwater contaminant plumes at CRL.	

Code	Location Name	Sample Type	Justification for Sample Type	Criteria for Location	Justification for Location	Parameter	Criteria for Parameter	Justification for Parameter	Cross ref to other objectives
Garden Produce									
DRG CRG PMG	Deep River, Local Garden Chalk River, Local Garden Pembroke, Market Garden	Off-site, Indicator; Annual Grab samples of Garden Produce: a) Above-ground fruits; b) Leaf vegetables; c) Root vegetables	See Table 21	(should) Consideration should be given to establishing monitoring locations in nearby population centres (other than locations of identified or potential critical groups or locations identified in an ERA or equivalent) for the most dominant contaminants and environmental pathways where there is public concern regarding emissions.	To address public concern over levels in produce from private vegetables gardens in local communities.	Free-Water Tritium Organically bound Tritium Gross Alpha/Beta Gamma emitters (detailed)	(may) The choice of contaminants to monitor in the environment may also be based on the following: there are other business reasons, i.e., stakeholder concerns, due diligence, etc.	Released in measurable quantities from effluent streams and groundwater contaminant plumes at CRL.	
Beach Sand									
B08	Fort William	Off-site, Indicator; Annual Grab sample	See Table 21	(should) Consideration should be given to establishing monitoring locations in nearby population centres (other than locations of identified or potential critical groups or locations identified in an ERA or equivalent) for the most dominant contaminants and environmental pathways where there is public concern regarding emissions.	To address public concerns about levels on beach sand for people who use public beaches, i.e., Fort William.	Gamma Emitters (detailed)	(may) The choice of contaminants to monitor in the environment may also be based on the following: there are other business reasons, i.e., stakeholder concerns, due diligence, etc.	Released in measurable/significant quantities from effluent streams and groundwater contaminant plumes at CRL.	11.1

11.9 OBJECTIVE 9: meet the needs and expectations of stakeholders and Indigenous communities, and any other business purposes

CRL meets the requirements of the CNSC Regulatory Requirements document 3.2.1 [27] which is documented in the PIP document [28] and takes into consideration any public requests for environmental monitoring.

To date there have been no additions to the EMP specifically as a result of needing to share data with the public. If public requests are made, they will be taken into consideration for additions into the environmental monitoring program.

12. Sampling and Analysis Frequency and Justification

This Section (in combination with Section 11) covers Step 6 of the Systematic Planning Process (see Figure 9):

Step 6: Develop the Detailed Design of the EMP

Specifically, this Section provides details of the sampling and analysis in place under the EMP including its justification. Sampling needed to meet all of the monitoring Objectives is included here.

In addition to the detailed monitoring information summarized in this section, the monitoring that is in place under the EMP is summarized in a separate CRL Environmental Monitoring Schedule [52]. Note that the EMP is dynamic in nature and is continually evolving. As a result, this plan is current as of its issuance but does not necessarily completely reflect the program after this date. The most current monitoring schedule should always be consulted.

Samples are analyzed at the same frequency as sample collection, except where frequent sub-samples are collected for the purpose of preparing a composite. Concentrations in the environment may vary considerably from point-to-point and day-to-day (due to temperature variations, air and water currents, and other factors). Where variability is high or unknown, a representative sample can be obtained by collecting a composite sample. This sample has a better chance of being closer to the average representative sample than any of the small samples making it up.

The collection of environmental samples is conducted by the Environmental Monitoring Branch (EMB). All surface water and deposition samples are grab samples as per EMB's procedure *Collection of Aqueous Samples* [53]. All foodstuff collection as well as sand grab samples are performed as per EMB's *Collection of Biota and Sand Samples* procedure [54]. The analysis of the environmental thermoluminescent dosimeters (TLDs) is conducted by Dosimetry Services. Analysis for non-radiological parameters in surface water and sediment is completed by ACB or Bureau Veritas (BV). Analysis of all other environmental samples is conducted by EMB. Detailed sampling and analysis methods are described in laboratory specific procedures.

Contaminant concentrations in the environment are measured where feasible (e.g., measurable, accessible, etc.) and otherwise estimated. In cases where monitoring is triggered, but measurement of the medium or contaminant is not practical or necessary, the contaminant

concentration is modelled/estimated (i.e., Killaloe reference location garden produce (KLG) is estimated based on historical data). The decision to model/estimate rather than to measure is based on the guidance provided in *Environmental Monitoring Programs* [1].

12.1 Radiological Sampling and Analysis

Note that all routine monitoring performed under the EMP consists of measurements and not estimations. Estimates are only used to represent local background concentrations, which are based on many years of previous monitoring results.

Subject to the considerations noted in *Environmental Monitoring Programs* [1] and N288.4 [13], default monitoring and sample collection frequencies are provided and justified in Table 21.

12.2 Non-Radiological Sampling and Analysis

During 1990 to 1991, monthly sampling was completed for those surface water monitoring points originally triggered under the Municipal/Industrial Strategy for Abatement (MISA) program (010, 020, PCW, DBS and background location ORC) as well as a few hours following a rain event (>5mm/day) or a thaw [55]. Once the characterization phase of MISA was complete, CNL continued with the program but at a reduced frequency. As a result, semi-annual sampling started in 1991.

Although semi-annual surface water monitoring is not frequent enough to determine seasonal variation in these streams, this frequency is designed to meet the objectives of the EMP in that it is representative of the slow velocities of the site's groundwater from potential contaminant sources (WMAs). This reduced monitoring frequency is appropriate given the slow groundwater velocity. In addition, a grab sample is considered adequate (as opposed to a composite sample) as inputs to these streams are slow and consistent (groundwater seepage).

There is one non-radiological surface water monitoring location that is an exception; South Swamp Weir (SSW) is only collected on an annual basis because of the very low flow that exists at this location. For the majority of the year, there is no surface water to collect at this location therefore samples are collected in the spring when there is most likely flowing water (see Section 12.3.1).

Subject to the considerations noted in *Environmental Monitoring Programs* [1] and N288.4 [13], default monitoring and sample collection frequencies are provided and justified in Table 21.

Where applicable, the flow rates for surface water streams are determined:

- At the time of sample collection, for flow measurements that are taken manually (e.g. based on head measurement at a weir plate or flume); or
- When loading rates are being calculated, for flows that are estimated.

Table 21: Sampling and Analysis Frequency and Justification

Environmental Media	Sample Collection Frequency	Analysis Frequency	Justification
Ambient air	Continuous	*Air quality is typically subject to meteorological variability over the course of a year (i.e. changes in wind direction, wind speed, and atmospheric stability on hourly time scales). To capture this variability and produce representative annual average contaminant concentrations, continuous monitoring frequencies are used.*	
		Tritium in air (HTO) and C-14 in air using passive samplers: Quarterly, Semi-annual	Passive samplers are collected **quarterly** for analysis at most locations; those positioned across the Ottawa River are collected **semi-annually** due to lack of access during the winter. This frequency ensures there is always a diffusion gradient into the sampler. It also permits for the description of seasonal cycles and the interpretation of trends in other environmental media (e.g., surface water, garden produce) in terms of recent air concentrations.
		Direct radiation using passive integrating devices (TLDs): Semi-annual, Annual	Continuous monitoring is desirable due to the fleeting nature of the immersion pathway: The **semi-annual** TLDs remain at each location for six months, at the end of which they are replaced with fresh ones and read out. Contaminants have relatively constant release rates, no anticipated fluctuations in magnitude. This frequency also permits for the description of any seasonal cycles. The **annual** TLDs remain at the location for the year. Contaminants have relatively constant release rates, no anticipated fluctuations in magnitude. This allows for confirmation of the results of semi-annual TLDs.
Surface water	Weekly, monthly, quarterly, semi-annually, annually	*Water quality is subject to natural hydrological variability over the course of a year (e.g. temperature variations, currents, precipitation, etc.). Stream beds that are dry part of the year are sampled when water is flowing.*	
		Weekly, Monthly, Quarterly, semi-annually, or annually at the time of collection; monthly composite of weekly grab samples	Weekly or monthly: Samples are collected at least weekly or monthly from surface water crossing the site boundary and off-site stream or rivers that are subject to drainage from potentially contaminated areas. The weekly frequency is considered adequate to represent the variability in hydrological conditions, such as current direction, to produce a representative annual average concentration. The monthly frequency permits description of any seasonal variation and is considered adequate to produce representative annual average contaminant concentrations. It is also consistent with recommendations in N288.4 [13] and appropriate to the metrics to be applied to the collected data (e.g. monthly DRLs). Quarterly: Samples are collected at least quarterly from on-site water bodies (such as a pond or lake) to sufficiently capture seasonal patterns [13].

Environmental Media	Sample Collection Frequency	Analysis Frequency	Justification
			Semi-annually: Semi-annual collection is performed for non-radiological parameters as inputs from groundwater are slow and consistent. In addition, as radiological samples are collected more frequently, any changing conditions will be identified. Annually: Samples are collected annually at off-site streams and water bodies on-site expected to be not impacted by operations. There is no need to capture variability at these locations as there is no relevance to human exposure.
Sediment/soil/ beach sand	Every 1 – 5 years, depending on deposition rates	Every 1 – 5 years at the time of collection	Sediment samples are collected annually from the on-site surface water bodies chosen for surface water monitoring as variability in sediment composition is not expected [13]. Sediment verification in the Ottawa River is completed every five years [50]. Beach sand is collected annually during the summer months during low water level periods.
Farm Animal	Annually	Annually at the time of collection	At least one sample is collected at the time of slaughter or removal of animals from grazing. In the event that fresh farm animal meat/bone is not available, frozen local beef is purchased.
Large game animals	Annually (opportunistic)	Annually at the time of collection	Samples are collected from vehicle interaction throughout the year or during the hunting season.
Fish	Annually	Annually at the time of collection	Annual sampling during the fishing season is considered adequate to represent the radionuclide levels in fish consumed by local people.
Garden vegetables	Annually	Annually at the time of collection	Fruit and garden vegetable samples are collected annually, despite recommendations in CSA N288.4 [13] that suggest multiple plant samples over the harvest season (plants respond to air/soil on timeframes of days for HTO and weeks for OBT; their concentrations can fluctuate over a harvest season of months). It is not practical to collect multiple samples from private gardens given the volume of produce required for analysis.
Wet and dry deposition	Monthly	Monthly	Wet and dry deposition samples are collected monthly as an indication of concentrations being deposited on, and entering, the soil compartment. They represent deposition over the previous month.

12.3 Deviation from the Default Monitoring Frequency

In certain circumstances, the EMP deviates from the default monitoring frequencies provided above.

When setting the sample collection frequency, a reduced frequency is considered in cases where:

- Expected temporal variability in concentrations and/or conditions is low;
- Capital and operating costs are high;
- The default frequency may lead to significant losses or uncertainties;
- The half-life of the radionuclide(s) being monitored is much less than the default monitoring or sample collection frequency – collection frequency should not normally exceed two half-lives in such cases;
- Concentrations of the radionuclide(s) being monitored are very low (at or near detection levels); and
- The likelihood of concentrations approaching or exceeding an evaluation criteria is negligible.

When setting the sample collection frequency, an increased frequency is considered in cases where:

- There is high variability in releases at the source;
- Expected temporal variability in concentrations and/or conditions is high (more variable quality may require more frequent sampling to obtain sufficiently precise estimates of contaminants);
- Capital and operating costs are low;
- The half-life of the radionuclide(s) being monitored is much longer than the default monitoring or sample collection frequency; and
- Concentrations of the radionuclide(s) being monitored are very high (at or near evaluation criteria) and the likelihood of concentrations approaching or exceeding an evaluation criteria is high.

When setting the analysis frequency, a reduced frequency (i.e. less than the sample collection frequency) is considered in cases where:

- Analysis costs are large relative to sampling costs;
- Analysis is labour/time intensive; and

The objective is to estimate the mean of a population. (Note: Composite samples can produce equally precise or more precise estimates, compared to non-composite samples, with fewer analyses).

12.3.1 Special Consideration

For surface water streams that fall under the jurisdiction of both the EVMP and the EMP (e.g., Perch Creek and Stream 010), the default sample collection frequency is weekly, and the default sample analysis frequency is monthly.

Where the sampling frequency is quarterly or less, sampling is conducted during the season in which flows are occurring. For flows that are associated with precipitation events, an event-based strategy rather than a fixed sampling frequency is considered.

12.4 Duration of Monitoring

Monitoring outlined in this monitoring plan is routine meaning it is to continue indefinitely unless a change to it or its removal is triggered. The process for making modifications to the EMP is described in Section 15.1.

13. Quality Assurance and Quality Control

In order to ensure that the data collected through the program is valid, the monitoring performing laboratories have strong QA/QC programs as required by the *EnvP Program Radiological and Non-Radiological Monitoring Service Quality Assurance Plan* [56]. These laboratories utilize QC tools such as blanks, spiked blanks, and replicate and duplicate samples to address precision, accuracy, sensitivity, and to detect errors in the data. The laboratory QC programs are described in laboratory specific sampling and analysis procedures.

The field QC data generated by the laboratories are supplied to the Environmental Specialist who performs an evaluation to confirm that the performance and acceptance criteria in Section 13.1 are met.

Field QC monitoring is in place for both the non-radioactive and radioactive EVMP and EMP with the frequency set to accommodate both of the programs. The target is that 90% of samples scheduled to be collected are obtained with the results meeting the acceptance criteria provided in Section 13.1. MISA requires that sampling take place annually on one effluent stream but recommends all analytical test groups (ATG) be part of the field QC program [55]. With the current QC monitoring schedule [52], the CRL site exceeds the field QC requirements outlined by MISA and conforms to most MISA recommendations.

To assess field performance the following control samples are collected (the number of field QC samples make up approximately 10% of all samples collected):

- Field duplicate samples to determine precision;
- Field and travelling blank samples to determine contamination events; and
- Travelling spiked samples or spiked samples may be used to determine recovery rates (accuracy), if necessary.

13.1 Performance and Acceptance Criteria

To ensure that the data collected as part of the EMP is adequate for its intended purpose, the data are subject to performance and acceptance criteria.
Performance of the EMP is defined in terms of:

- The percent of planned samples obtained, and
- The percent of samples meeting data acceptance criteria (Section 13.1.2).

13.1.1 Performance Criteria

It is expected that a certain number of samples each year will be unavailable due to sampling equipment malfunction, garden crop failures, scarcity of food, or other logistical reasons. The minimum targets for the number of planned samples to be obtained for acceptable EMP performance are listed in Table 22, with all samples meeting data acceptance criteria.

The general criterion for acceptable EMP performance is that at least 90% of planned samples for each medium will be obtained. The 90% target is based on the potential effect that missing one monthly sample would have on the annual average concentration. For samples that are collected quarterly, a 75% target is defined, considering the implications of missing a single sample. In this case, based on expected variability among samples, one missing sample would not significantly affect the annual average, or unacceptably reduce the precision in dose and risk assessments based on average concentrations.

Sample unavailability for the EMP could be the result of a number of circumstances; for example, sampling according to the monitoring schedule was missed, the collected sample was contaminated or lost, etc. Note: There are no automatic samplers in place under the EMP for the CRL site, therefore automatic sampler unavailability is not considered under this program. As outlined in *Environmental Monitoring Programs* [1], the performance of EMP monitoring systems shall be monitored and instances of unavailability shall be documented in the annual EMP report to the CNSC.

Table 22: Targets for Percent of Planned Samples to be obtained in all Environmental Media

Sample Collection Frequency	Minimum Target for of Planned Samples Obtained
Weekly	90%
Monthly	90%
Quarterly	75%
Semi-annual	100%
Annual (or less)	100%

The program's current Laboratory Method Detection Limit (LMDL) for each parameter in the Non-Radioactive program is compared to SC and EC provided in Table 12 and Table 13 highlighting those LMDLs which are greater than the monitoring limits.

Note: There are a number of additional parameters which are measured under this program which do not have an associated evaluation. Many of these are measures of environmental indicators (e.g., conductivity) versus pollutants and therefore do not have associated guidelines; or they are pollutants without federally or provincially developed guidelines as they have not to date been identified as priority pollutants requiring limit development.

13.1.2 Acceptance Criteria

The data acceptance criteria in place for field sample QC are listed in Table 23. The criteria are applicable to the results of QC samples that are associated with each batch of program samples analyzed.

Table 23: Field Sample QC Acceptance Criteria

Field QV Samples	Quality Verification Test	Acceptance Criteria [54]
Travelling Blank	Contamination	Results ≤ 3 times LMDL
Travelling Spiked Blank	Accuracy	Recovery (Determined Value/Expected x 100) between 50 – 150%
Duplicate*	Precision	Relative Percent Difference ≤ 50%

* If one of the results is ≤ 3 times the MDL, the QC assessment is voided on the basis of low-level result.

The handling of sample data for those samples which do not meet these acceptance criteria is common company-wide and is therefore covered in CNL's *Environmental Monitoring Programs* procedure [1].

14. Records and Data Management

Sample and analysis related monitoring records produced and maintained as part of the CRL EMP include:

- Unique identification of samples collected for analysis (including location and date);
- Final radiological and non-radiological analysis results and physical characteristics; and,
- Documentation providing evidence of maintenance of equipment that was used to collect and analyze samples.

The storage of analytical results produced by CRL Laboratories for the EMP includes:

- Electronic copies of EMB raw data stored in a LabWorks database which are backed up daily.
- ACB and external lab report files are stored in CNL's information management tool (ATOM).
- Once approved by an Environmental Specialist, the result data files are submitted to the Environmental Data Management System (EDMS), which is a GIS viewer data repository designed specifically for CNL. Data records are maintained indefinitely in this system.
- QC results are kept as permanent records with data files retained within EMB. Results are stored in software within EMB files.
- Program results are also reported in the Annual Compliance Monitoring Report [17], which also serves as a record.

The storage of analytical results produced by the external contractors are received and stored in PDF report format, as well as imported to LabWorks and subsequently to EDMS in the corporate records management archive files.

15. Reviews, Assessments, Audits

The details of reviews, assessments and audits of the CRL EMP are covered in the *CRL Environmental Monitoring Program Framework* document [2].

15.1 Modifications of the Environmental Monitoring Program

As outlined in the *CRL Integrated Environmental Monitoring Program Framewor*k [2], many of the required changes for the EMP will be identified during the formal reviews which take place for the program. There are instances, however, where changes to the program need to take place in between these reviews. In either case, changes to the program are formally documented as per the requirement in *Environmental Monitoring Programs* procedure [1].

15.1.1 Reduction of Monitoring

Deletion of samples from the EMP and reductions in sampling or analysis frequency are appropriate if the changes do not impact the effectiveness of the EMP. Any decision to reduce monitoring considers the objectives and criteria that originally triggered the monitoring activity in the first place.

In cases where the absence of anomalous results and/or the absence of results above the detection level are observed over a five year monitoring period, the monitoring frequency may be reduced based on the professional judgment of EMP Staff. Consideration is given to operational experience, the results of the local population survey (e.g., the survey indicates the absence or unavailability of the sample media), the results of historical monitoring (e.g., the results demonstrate that the contaminants are not present), as well as any seasonal variability represented in the data.

If there is a need to reduce the frequency of sample collection or analysis, the justification should include an evaluation showing that the increased sampling interval does not impact the accuracy of the results (e.g., longer analysis intervals may not be appropriate for radionuclides with a short half-life). This can be done by comparing the sample results at the current monitoring frequency with the sample results at the proposed monitoring frequency using appropriate statistical methods.

Reductions in monitoring can be absolute or can be made under the caveat that the parameters be periodically (e.g., every five years) analysed in order to confirm their continued absence. This periodic re-checking is referred to as “confirmatory monitoring”. Should the contaminants be detected in anomalous concentrations from the confirmatory monitoring, the previous sampling frequency is restored.

15.1.2 Additional Monitoring

Additions to the EMP are made in the context of the systematic informed planning process.

In the event that anomalous results are observed, and the monitoring objectives warrant a higher monitoring frequency, the frequency of monitoring may be increased in order to better determine the variability in the monitoring results. This is done through a special investigation (outside of the routine monitoring program) or within the routine monitoring program (added to the monitoring schedule) and again, is based on the professional judgement of EMP staff.

Note: If this occurs in the instance where the frequency of the parameter monitoring was previously reduced due to the absence of anomalous result, the original monitoring frequency will be considered.

16. References

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Appendix A Monitoring Location Description and Justification for Each Non-Radiological Parameter being Monitored

A single table for each location is provided, each including the following information for that specific location.

- A history of the monitoring at that location;
- The classification of the monitoring location under the MISA program, if appropriate;
- The potential sources of contamination in that location (e.g., upstream WMAs);
- A description of the receiving water body; and
- The justification for each of the parameters being monitored at that location.

Table A-1: 010 Stream Monitoring Location History and Justification

010 Stream (010) - Description and Monitoring History
This location was part of the initial set-up of the MISA program (1990) and has been monitored consistently since then. It is classified as a *Storm Water* monitoring location under MISA because it accepts stormwater runoff, groundwater and cooling water from the south-west portion of the built-up area. However, it is also located downgradient from the inactive landfill and Grey Crescent sites and therefore receives contaminated groundwater which has percolated through the disposal site. For this reason, additional landfill type parameters are routinely monitored at this location. Sampling takes place close to the end of the stream, just before the stream discharges into the Ottawa River. After a large-scale stormwater redirection project in 2018, this stream now accepts a natural stream (also fed by fire water overflow), and an increased runoff drainage area from parking lots and storm sceptors, resulting in an increase in flow. Major construction is currently occurring in this section of the built-up area of the site.
Note: Storm Sewer refers to run-off from a storm event or thaw that is discharged from a developed area of a plant, directly or indirectly, to a surface watercourse.

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
1	Chemical Oxygen Demand	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2011: Added in 2011 to align with Research and Productivity Council (MOE) guidelines for landfills.	[A-1]
~~1a~~	~~Biological Oxygen Demand~~		2011: Added in 2011 to align with MOE guidelines for landfills. 2019: Removed in 2019 as was not detected in water samples over the previous 5 years.	[A-2]
3	pH	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location as a gross indicator of effluent quality.	[A-3]
4a	Total Kjedahl Nitrogen	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2011: Added in 2011 to align with MOE guidelines for landfills.	[A-1]
4b	Nitrates, Total Filter Reactive	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location.	[A-3]
5a	Dissolved Organic Carbon	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location.	[A-3]
5b	Carbon, Total Organic	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location.	[A-3]
6	Phosphorus, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location.	[A-3]
7	Conductivity, at 25C	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location.	[A-3]
8	Residue, Particulate (TSS)	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location. 2024: ERA COPC at this undiluted location.	[A-3] [A-4]
8a	Dissolved Solids, Total (TDS)	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2011: Added in 2011 to align with MOE guidelines for landfills.	[A-1]
9	Aluminium, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter) (shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	1990: Core parameter required under MISA specifically for this location as during the pre-regulation monitoring, it showed averages above the respective PWQOs. 2019: ERA COPC at this undiluted location 2024: ERA COPC at this undiluted location	[A-3] [A-5] [A-6
9	Boron, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2011: Added in 2011 to align with MOE guidelines for landfills.	[A-1]
9	Cadmium, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2011: Added in 2011 to align with MOE guidelines for landfills.	[A-1]

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
9	Chromium, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2011: Added in 2011 to align with MOE guidelines for landfills.	[A-1
9	Copper, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter) (shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	1990: Core parameter required under MISA specifically for this location as during the pre-regulation monitoring, it showed averages above the respective PWQOs. 2019: ERA COPC at this location.	[A-3][A-5] [A-6
9	Lead, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Found to be detectable under the pre-regulation monitoring for MISA specifically for this location.	[A-5]
9	Lithium, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	2019: ERA COPC at this location.	[A-6]
9	Nickel, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Found to be present at levels above the PWQOs during the pre-regulation monitoring for MISA specifically for this location.	[A-5]
9	Strontium, Unfiltered Total	-	2014: Included as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Vanadium, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Found to be present at levels above the PWQOs during the pre-regulation monitoring for MISA specifically for this location. 2024: ERA COPC at this location	[A-4][A-5
9	Zinc, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter) (shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	1990: Core parameter required under MISA specifically for this location as during the pre-regulation monitoring, it showed averages above the respective PWQOs. 2019: ERA COPC at this location. 2024: ERA COPC at this location.	[A-3] [A-4][A-5][A-6]
9a	Iron, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location as during pre-regulation monitoring, it showed averages above the respective PWQOs.	[A-3][A-5]
9a	Uranium, Unfiltered Total	(may) The level of risk from unmonitored releases is unknown or has been determined, by the ERA (or equivalent) to be of concern	2014: Included in 2014 as when the lab runs analysis for cadmium, they also analyse for uranium. Since this information is available, it is included in the program.	[A-7]
10	Antimony, Unfiltered Total	-	2014: Added in 2014 as when analysis is run for arsenic, antimony results are also determined (same ATG). Since this information is available, it is included in the program.	[A-7]
10	Arsenic, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2011: Added in 2011 to align with Provincial MOE guidelines for landfills. Also elevated arsenic noted in groundwater in the area (from Grey Crescent landfill leachate).	[A-1][A-8]
10	Selenium, Unfiltered Total	-	2014: Added in 2014 as when analysis is run for arsenic, selenium results are also determined (same ATG). Since this information is available, it is included in the program.	[A-7]
12	Mercury, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2011: Added in 2011 to align with Provincial MOE guidelines for landfills. 2024: ERA COPC at this location	[A-1][A-4]
14	Phenolics, Unfiltered React	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location.	[A-3] [A-5]

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
~~16~~	~~Volatiles, Halogenated~~		2014: Monitored commenced at this location based on detectable levels in groundwater wells in place for the Inactive Landfill. 2019: Removed in 2019 as were not detected in water samples over the previous 5 years.	[A-2]
25	Solvent Extractables	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter) (shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	1990: Core parameter required under MISA specifically for this location. 2019: ERA COPC at this location.	[A-3][A-6]
29	Barium	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	2011: Added in 2011 to align with Provincial MOE guidelines for landfills. 2019: ERA COPC at this location.	[A-1][A-6]
30	Chloride	(may) The level of risk from unmonitored releases is unknown or has been determined, by the ERA (or equivalent) to be of concern. (shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	2007: Added in 2007 to determine road salt effect on the stream as a result of its use in the built-up area (Safety Review Committee (SRC) recommendation). 2012: Identified as having a risk quotient greater than one in the 2012 ERA. 2019: ERA COPC at this location. 2024: ERA COPC at this location.	[A-4][A-6][A-9]
30	Sulphates	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2011: Added in 2011 to align with MOE guidelines for landfills.	[A-1]
93	Flow	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Required under MISA as it is essential for determining loading to watercourses.	[A-3]
-	Alkalinity	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2011: Added in 2011 to align with MOE guidelines for landfills.	[A-1]
-	Dissolved Oxygen	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2011: Added in 2011 to align with MOE guidelines for landfills.	[A-1]
97	Hardness	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2010: Added in 2010 to surface water streams as is a modifying factor in order to compare to PWQO and CWQG for various parameters.	[A-7]

Table A-2: 020 Stream Monitoring Location History and Justification

020 Stream (020) - Description and Monitoring History
This location was part of the initial set-up of the MISA program (1990) and has been monitored consistently since then.
It is classified as a "Waste Disposal Site Effluent" under MISA because it is located downgradient from the Inactive Landfill and Grey Crescent sites and it was believed that it could be contaminated by groundwater percolating through the disposal site. However, monitoring results as well as further understanding of the groundwater flow in this area has identified that the groundwater affected by the landfill may not necessarily discharge into this stream.
Sampling takes place close to the end of the stream, just before the stream discharges into the Ottawa River.

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
1	Chemical Oxygen Demand	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2011: Added in 2011 to align with MOE guidelines for landfills.	[A-1]
~~1a~~	~~Biological Oxygen Demand~~		2011: Added in 2011 to align with MOE guidelines for landfills. 2019: Removed in 2019 as was not detected in water samples over the previous 5 years.	[A-2]
3	pH	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location as a gross indicator of effluent quality.	[A-3]
4a	Total Kjedahl Nitrogen	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2012: Added in 2012 to align with MOE guidelines for landfills.	[A-1]
4b	Nitrates, Total Filter Reactive	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location.	[A-3]
5a	Dissolved Organic Carbon	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location.	[A-3]
5b	Carbon, Total Organic	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location.	[A-3]
6	Phosphorus, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location.	[A-3]
7	Conductivity, at 25C	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location.	[A-3]
8	Residue, Particulate (TSS)	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location. 2024: ERA COPC for this location	[A-3][A-4]
8a	Dissolved Solids, Total (TDS)	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2012: Added in 2012 to align with MOE guidelines for landfills.	[A-1]
9	Aluminium, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter) (shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	1990: Core parameter required under MISA specifically for this location. 2019: ERA COPC for this location.	[A-3][A-6]
9	Boron, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2012: Added in 2012 to align with MOE guidelines for landfills.	[A-1]
9	Cadmium, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2012: Added in 2012 to align with MOE guidelines for landfills.	[A-1]
9	Chromium, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2012: Added in 2012 to align with MOE guidelines for landfills.	[A-1]

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
9	Copper, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location.	[A-3]
9	Lead, Unfiltered Total	-	2014: Included in 2014 as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Lithium, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	2019: ERA COPC for this location.	[A-6]
9	Nickel, Unfiltered Total	-	2014: Included in 2014 as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Strontium, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	2019: ERA COPC for this location.	[A-6]
9	Vanadium, Unfiltered Total	-	2014: Included in 2014 as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Zinc, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location.	[A-3]
9a	Iron, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location.	[A-3]
9a	Uranium, Unfiltered Total	-	2014: Included in 2014 as when the lab runs analysis for iron, they also analyse for uranium. Since this information is available, it is included in the program.	[A-7]
10	Antimony, Unfiltered Total	-	2014: Added in 2014 as when analysis is run for arsenic, antimony results are also determined (same ATG). Since this information is available, it is included in the program.	[A-7]
10	Arsenic, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2012: Added in 2012 to align with MOE guidelines for landfills.	[A-1]
10	Selenium, Unfiltered Total	-	2014: Added in 2014 as when analysis is run for arsenic, selenium results are also determined (same ATG). Since this information is available, it is included in the program.	[A-7]
12	Mercury, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2012: Added in 2012 to align with MOE guidelines for landfills.	[A-1]
14	Phenolics, Unfiltered React	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location.	[A-3]
~~16~~	~~Volatiles, Halogenated~~		2014: Monitored commenced at this location based on detectable levels in groundwater wells in place for the Inactive Landfill. 2019: Removed in 2019 as was not detected in water samples over the previous 5 years.	[A-2] [A-10]
25	Solvent Extractables	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location.	[A-3]
29	Barium	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2012: Added in 2012 to align with MOE guidelines for landfills. 2019: ERA COPC for this location.	[A-1] [A-9]

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
		(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.		
30	Chloride	-	Included as when the lab runs analysis for anions, they also analyse for chloride. Since this information is available, it is included in the program.	[A-7]
30	Sulphates	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2012: Added in 2012 to align with MOE guidelines for landfills.	[A-1] [A-6]
93	Flow	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Required under MISA - essential for determining loading to watercourses.	[A-3]
-	Alkalinity	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2012: Added in 2012 to align with MOE guidelines for landfills.	[A-1]
-	Dissolved Oxygen	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2012: Added in 2012 to align with MOE guidelines for landfills.	[A-1]
97	Hardness	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2010: Added in 2010 to surface water streams as is a modifying factor in order to compare to PWQO and CWQG for various parameters.	[A-10]

Table A-3: Kennedy Creek Monitoring Location History and Justification

Kennedy Creek - Welsh's Bay (KMC) – Ottawa River Direct Basin Reference Monitoring Location
This monitoring location is positioned just off the Chalk River site property in Balmer's Bay. Monitoring at this location commenced in 2009 as a special investigation under the non-radioactive EMP in efforts to identify a surface water reference location in the Ottawa River Direct Watershed after it was speculated that some of the elevated concentrations which were being seen in the program's monitoring results were, in fact, due to naturally elevated levels in the area. In 2012 December, the location was deemed both a reliable source of surface water and accessible for sampling and was added to the non-radioactive EMP.
In 2020, sediment from this location is also sampled as a reference location – analysis for metals (ATG 9) and anions (ATG 30: chloride and sulphate) is included.

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
1	Chemical Oxygen Demand	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2022: Added to the routine monitoring program to align with monitoring taking place at 010 and 020 in the Ottawa River Direct Watershed.	[A-11]
3	pH	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program to align with monitoring taking place at 010 and 020 in the Ottawa River Direct Watershed.	[A-7]
4a	Total Kjedahl Nitrogen	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2014: Added to the routine monitoring program to align with monitoring taking place at 010 and 020 in the Ottawa River Direct Watershed.	[A-7]
4b	Nitrates, Total Filter Reactive	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program to align with monitoring taking place at 010 and 020 in the Ottawa River Direct Watershed.	[A-7]
5a	Dissolved Organic Carbon	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program to align with monitoring taking place at 010 and 020 in the Ottawa River Direct Watershed.	[A-7]
5b	Carbon, Total Organic	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program to align with monitoring taking place at 010 and 020 in the Ottawa River Direct Watershed.	[A-7]
6	Phosphorus, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program to align with monitoring taking place at 010 and 020 in the Ottawa River Direct Watershed.	[A-7]
7	Conductivity, at 25C	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program to align with monitoring taking place at 010 and 020 in the Ottawa River Direct Watershed.	[A-7]
8a	Dissolved Solids, Total (TDS)	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2014: Added to the routine monitoring program to align with monitoring taking place at 010 and 020 in the Ottawa River Direct Watershed.	[A-7]
8	Residue, Particulate (TSS)	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters,	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed.	[A-7]

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
		etc.)	2013: Added to the routine monitoring program to align with monitoring taking place at 010 and 020 in the Ottawa River Direct Watershed.	
9	Aluminium, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program to align with monitoring taking place at 010 and 020 in the Ottawa River Direct Watershed.	[A-7]
9	Boron, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PL1, PL2 and MAR in the Perch Lake Watershed. 2013: Added to the routine monitoring program to align with monitoring taking place at 010 and 020 in the Ottawa River Direct Watershed.	[A-7]
9	Cadmium, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PL1, PL2, MAR and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program to align with monitoring taking place at 010 and 020 in the Ottawa River Direct Watershed.	[A-7]
9	Chromium, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PL1, PL2 and MAR in the Perch Lake Watershed. 2013: Added to the routine monitoring program to align with monitoring taking place at 010 and 020 in the Ottawa River Direct Watershed.	[A-7]
9	Copper, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, and ESW in the Perch Lake Watershed. 2013: Added to the routine monitoring program to align with monitoring taking place at 010 and 020 in the Ottawa River Direct Watershed.	[A-7]
9	Lead, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PL1, PL2, MAR and ESW in the Perch Lake Watershed. 2013: Added to the routine monitoring program.	[A-7]
9	Lithium, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PL1, PL2 and MAR in the Perch Lake Watershed. 2013: Added to the routine monitoring program to align with monitoring taking place at 010 and 020 in the Ottawa River Direct Watershed.	[A-7]
9	Nickel, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PL1, PL2 and MAR in the Perch Lake Watershed. 2013: Added to the routine monitoring program to align with monitoring taking place at 010 and 020 in the Ottawa River Direct Watershed.	[A-7]
9	Strontium, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PL1, PL2, MAR and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program to align with monitoring taking place at 010 and 020 in the Ottawa River Direct Watershed.	[A-7]
9	Vanadium, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PL1, PL2, MAR and ESW in the Perch Lake Watershed. 2013: Added to the routine monitoring program to align with monitoring taking place at 010 and 020 in the Ottawa River Direct Watershed.	[A-7]
9	Zinc, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters,	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed.	[A-7]

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
		etc.)	2013: Added to the routine monitoring program to align with monitoring taking place at 010 and 020 in the Ottawa River Direct Watershed.	
9a	Iron, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program to align with monitoring taking place at 010 and 020 in the Ottawa River Direct Watershed.	[A-7]
9a	Uranium, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW in the Perch Lake Watershed. 2013: Added to the routine monitoring program to align with monitoring taking place at 010 and 020 in the Ottawa River Direct Watershed.	[A-7]
10	Antimony, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2014: Added to the routine monitoring program to align with monitoring taking place at 010 and 020 in the Ottawa River Direct Watershed.	[A-7]
10	Arsenic, unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2014: Added to the routine monitoring program to align with monitoring taking place at 010 and 020 in the Ottawa River Direct Watershed.	[A-7]
10	Selenium, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2014: Added to the routine monitoring program to align with monitoring taking place at 010 and 020 in the Ottawa River Direct Watershed.	[A-7]
12	Mercury, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2014: Added to the routine monitoring program to align with monitoring taking place at 010 and 020 in the Ottawa River Direct Watershed.	[A-7]
14	Phenolics, Unfiltered React	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2014: Added to the routine monitoring program to align with monitoring taking place at 010 and 020 in the Ottawa River Direct Watershed.	[A-7]
25	Solvent Extractables	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program to align with monitoring taking place at 010 and 020 in the Ottawa River Direct Watershed.	[A-7]
29	Barium	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2014: Added to the routine monitoring program to align with monitoring taking place at 010 and 020 in the Ottawa River Direct Watershed.	[A-7]
30	Chloride	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2014: Added to the routine monitoring program to align with monitoring taking place at 010 in the Ottawa River Direct Watershed.	[A-7]]
30	Sulphates	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2014: Added to the routine monitoring program to align with monitoring taking place at 010 and 020 in the Ottawa River Direct Watershed.	[A-7]
-	Alkalinity	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2022: Added to the routine monitoring program to align with monitoring taking place at 010 and 020 in the Ottawa River Direct Watershed.	[A-11]
-	Dissolved Oxygen	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters,	2022: Added to the routine monitoring program to align with monitoring taking place at 010 and 020 in the Ottawa River Direct Watershed.	[A-11]

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
		etc.)		
97	Hardness	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2022: Added to the routine monitoring program to align with monitoring taking place at 010 and 020 in the Ottawa River Direct Watershed.	[A-11]

Table A-4: Duke & Bulk Stream Monitoring Location History and Justification

Duke & Bulk Stream (DBS) - Description and Monitoring History
This location was part of the initial set-up of the MISA program (1990) and has been monitored consistently since then.
It is classified as a "*Waste Disposal Site Effluent*" under MISA because it is fed by groundwater and run-off from its Watershed, which includes WMAs C (low level radioactive), F (Port Hope historic waste) and the newly built Bulk Material Landfill. Sampling is completed just after Duke Stream and Bulk Stream meet and before they discharge into Maskinonge Lake. It serves as the final monitoring point for the Maskinonge Lake Watershed before it leaves the Chalk River site. The list of parameters being monitored has been customized to address the unique nature of some of the wastes in the disposal sites.

Duke Swamp Weir (DSW) – Primarily Effluent Verification Monitoring
DSW surface water is monitored under the EVMP. It is upgradient from the DBS location, capturing only Duke Swamp outflowing water. Sediment monitoring at DSW was added to the EMP after the 2019 ERA identified several metals as COPCs here.

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
3	pH	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location as a gross indicator of effluent quality.	[A-3]
4b	Nitrates, Total Filter Reactive	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location.	[A-3]
5a	Dissolved Organic Carbon	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location.	[A-3]
5b	Carbon, Total Organic	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location.	[A-3]
6	Phosphorus, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location.	[A-3]
7	Conductivity, @ 25C	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location.	[A-3]
8	Residue, Particulate (TSS)	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location. 2024: ERA COPC for this location	[A-3] [A-4]
9	Aluminium, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter) (shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	1990: Core parameter required under MISA specifically for this location. 2019: ERA COPC for this location.	[A-3] [A-6]
9	Boron, Unfiltered Total	-	2014: Included in 2014 as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Cadmium, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	2019: ERA COPC for this location. ERA COPC in sediment in Duke Swamp.	[A-6]
9	Copper, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location.	[A-3]
9	Lead, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	2019: ERA COPC for this location. ERA COPC in sediment in Duke Swamp.	[A-6]
9	Lithium, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical	2019: ERA COPC for this location.	[A-6

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
		stressor to produce effects in the receiving environment.		
9	Nickel, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	2019: ERA COPC for this location. ERA COPC in sediment in Duke Swamp.	[A-6]
9	Strontium, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	2019: ERA COPC for this location. ERA COPC in sediment in Duke Swamp.	[A-6]
9	Vanadium, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	2019: ERA COPC for this location. ERA COPC in sediment in Duke Swamp.	[A-6]
9	Zinc, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location.	[A-3]
9a	Iron, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location.	[A-3]
9a	Uranium, Unfiltered Total	-	2014: Included in 2014 as when the lab runs analysis for iron, they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
10	Antimony, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter) (may) The level of risk from unmonitored releases is unknown or has been determined, by the ERA (or equivalent) to be of concern	1991: Started monitoring in 1992 (based on MISA). Have continued to monitor to present date. In same ATG as arsenic which is a known source of contamination in WMA F.	[A-3] [A-9] [A-12
10	Arsenic, unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter) (shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	1991: Potential for high arsenic levels coming from WMA F from Port Hope Area soil emplacement. 2019: ERA COPC for this location. ERA COPC in sediment in Duke Swamp.	[A-3] [A-6] [A-12]
10	Selenium, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter) (may) The level of risk from unmonitored releases is unknown or has been determined, by the ERA (or equivalent) to be of concern	1991: Started monitoring in 1992 (based on MISA). Monitoring has continued to present date. In same ATG as arsenic which is a known source of contamination in WMA F.	[A-3] [A-7]
12	Mercury, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1991: Added in 1991 as a result of initial MISA monitoring - based on the use of mercury at CNL and the importance of mercury with respect to the environment.	[A-5] [A-12]
14	Phenolics, Unfiltered React	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location.	[A-3
~~16~~	~~Volatiles, Halogenated, incl. 1,1,1 Trichloroethane~~		2000: Added as a result of the detection of chlorinated solvents in the groundwater near Waste Management Areas in the vicinity. 2019: TCFM was identified as an ERA COPC for this location. However, further assessment found this was based on results and background levels below detection limits. Removed in 2019 as was not detected in water samples over the previous 5 years.	[A-9] [A-13]

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
25	Solvent Extractables	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location.	[A-3]
29	Barium	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2012: Added in 2012 to align with MOE guidelines for landfills.	[A-1]
30	Chloride	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2019: ERA COPC for this location. ERA COPC in sediment in Duke Swamp. 2024: ERA COPC for this location. ERA COPC in sediment in Duke Swamp.	[A-4] [A-6
30	Sulphate	-	Included as when the lab runs analysis for anions, they also analyse for sulphate. Since this information is available, it is included in the program.	[A-7]
97	Hardness	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2010: Added to surface water streams as is a modifying factor in order to compare to PWQO and CWQG for various parameters.	[A-10]

Table A-5: Lower Bass Lake Inlet Monitoring Location History and Justification

Lower Bass Lake Inlet (LBL) - Description and Monitoring History
This location was not part of the initial set-up of the MISA program (1990) but was identified as a data gap in the 2019 ERA [A-9] as no non-radiological surface water data were available to assess the receiving environment at Management Unit 11. It was added to the non-radiological monitoring program in 2019.
It can be classified as a "*Waste Disposal Site Effluent*" under MISA because it is fed by groundwater and run-off from its Watershed, which includes WMA C (low level radioactive), and the Nitrate/Thorium/ACS Pits. Sampling is completed just before Lower Bass Lake Inlet enters the lake, after draining the north end of Duke Swamp. The list of parameters being monitored has been customized to address the unique nature of some of the wastes in the disposal sites. Sediment at this location is also monitored for metals (ATG 9, 9a, 10, 12) and anions (ATG 30).

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
3	pH	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2019: Core parameter required under MISA as a gross indicator of effluent quality.	[A-3]
4b	Nitrates, Total Filter Reactive	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2019: Core parameter required under MISA as a gross indicator of effluent quality.	[A-3]
5a	Dissolved Organic Carbon	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2019: Core parameter required under MISA as a gross indicator of effluent quality.	[A-3]
5b	Carbon, Total Organic	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2019: Core parameter required under MISA as a gross indicator of effluent quality.	[A-3]
6	Phosphorus, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2019: Core parameter required under MISA as a gross indicator of effluent quality.	[A-3]
7	Conductivity, @ 25C	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2019: Core parameter required under MISA as a gross indicator of effluent quality.	[A-3]
9	Aluminium, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter) (shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	2019: Core parameter required under MISA as a gross indicator of effluent quality. 2019: ERA COPC identified for Duke Swamp.	[A-3] [A-6]
9				
9	Boron, Unfiltered Total	-	Included as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Cadmium, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	2019: ERA COPC identified for Duke Swamp. ERA COPC in sediment in Duke Swamp.	[A-6]
9	Chromium, Unfiltered Total	-	Included as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Copper, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2019: Core parameter required under MISA as a gross indicator of effluent quality.	[A-3]
9	Lead, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	2019: ERA COPC identified for Duke Swamp. ERA COPC in sediment in Duke Swamp.	[A-6]
9	Lithium, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	2019: ERA COPC identified for Duke Swamp.	[A-6]

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
9	Nickel, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	2019: ERA COPC identified for Duke Swamp. ERA COPC in sediment in Duke Swamp.	[A-6]
9	Strontium, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	2019: ERA COPC identified for Duke Swamp. ERA COPC in sediment in Duke Swamp.	[A-6]
9	Vanadium, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	2019: ERA COPC identified for Duke Swamp. ERA COPC in sediment in Duke Swamp.	[A-6]
9	Zinc, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2019: Core parameter required under MISA as a gross indicator of effluent quality.	[A-3]
9a	Iron, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2019: Core parameter required under MISA as a gross indicator of effluent quality.	[A-3]
9a	Uranium, Unfiltered Total	-	Included as when the lab runs analysis for other core metal parameters in ATG 9a, they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
10	Antimony, Unfiltered Total	-	Included as when the lab runs analysis for other core metal parameters in ATG 10, they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
10	Arsenic, unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	2019: ERA COPC identified for Duke Swamp. ERA COPC in sediment in Duke Swamp.	[A-6]
10	Selenium, Unfiltered Total	-	Included as when the lab runs analysis for other core metal parameters in ATG 10, they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
12	Mercury, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2019: Core parameter required under MISA as a gross indicator of effluent quality.	[A-3]
14	Phenolics, Unfiltered React	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2019: Core parameter required under MISA as a gross indicator of effluent quality.	[A-3]
30	Chloride	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	2020: ERA COPC identified for Duke Swamp sediment, monitored in sediment at this location. 2024: ERA COPC identified at this location.	[A-4[A-6]
93	Flow	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Required under MISA - essential for determining loading to watercourses.	[A-3]

Table A-6: Upper Bass Lake Inlet Monitoring Location History and Justification

Upper Bass Lake Inlet (UBI) - Reference Monitoring Location
Located on the Chalk River site, this background location is on the northern inlet stream of Upper Bass Lake.
Monitoring at this location commenced in 2009 as a special investigation under the non-radioactive Monitoring Program in efforts to identify a surface water reference location in the Maskinonge Lake Watershed after it was speculated that some of the elevated concentrations which were being seen in the program's monitoring results were, in fact, due to naturally elevated parameters in the local area.
Once the location was deemed both a reliable source of surface water and accessible for sampling, it was formally added to the non-radioactive Monitoring Program in 2012 December. Sediment is also sampled at this location for reference.

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
3	pH	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program to align with monitoring taking place at DBS in the Maskinonge Lake Watershed.	[A-7]
4b	Nitrates, Total Filter Reactive	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program to align with monitoring taking place at DBS in the Maskinonge Lake Watershed.	[A-7]
5a	Dissolved Organic Carbon	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program to align with monitoring taking place at DBS in the Maskinonge Lake Watershed.	[A-7]
5b	Carbon, Total Organic	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program to align with monitoring taking place at DBS in the Maskinonge Lake Watershed.	[A-7]
6	Phosphorus, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program to align with monitoring taking place at DBS in the Maskinonge Lake Watershed.	[A-7]
7	Conductivity, at 25C	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program to align with monitoring taking place at DBS in the Maskinonge Lake Watershed.	[A-7]
8	Residue, Particulate (TSS)	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program to align with monitoring taking place at DBS in the Maskinonge Lake Watershed.	[A-7]
9	Aluminium, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program to align with monitoring taking place at DBS in the Maskinonge Lake Watershed.	[A-7]
9	Boron, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PL1, PL2 and MAR in the Perch Lake Watershed.	[A-7]

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
		parameters, etc.)	2013: Added to the routine monitoring program to align with monitoring taking place at DBS in the Maskinonge Lake Watershed.	
9	Cadmium, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PL1, PL2, MAR and SSW in the Perch Lake Watershed. 2013: Not required as not being analyses in this watershed (DBS) and therefore no need for background values. 2019: Identified as a COPC in the watershed, therefore re-instated.	[A-7]
9	Chromium, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PL1, PL2 and MAR in the Perch Lake Watershed. 2013: Added to the routine monitoring program to align with monitoring taking place at DBS in the Maskinonge Lake Watershed.	[A-7]
9	Copper, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, and ESW in the Perch Lake Watershed. 2013: Added to the routine monitoring program to align with monitoring taking place at DBS in the Maskinonge Lake Watershed.	[A-7]
9	Lead, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PL1, PL2, MAR and ESW in the Perch Lake Watershed. 2013: Added to the routine monitoring program to align with monitoring taking place at DBS in the Maskinonge Lake Watershed.	[A-7]
9	Lithium, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PL1, PL2 and MAR in the Perch Lake Watershed. 2013: Added to the routine monitoring program to align with monitoring taking place at DBS in the Maskinonge Lake Watershed.	[A-7]
9	Nickel, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PL1, PL2 and MAR in the Perch Lake Watershed. 2013: Added to the routine monitoring program to align with monitoring taking place at DBS in the Maskinonge Lake Watershed.	[A-7]
9	Strontium, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PL1, PL2, MAR and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program to align with monitoring taking place at DBS in the Maskinonge Lake Watershed.	[A-7]
9	Vanadium, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PL1, PL2, MAR and ESW in the Perch Lake Watershed. 2013: Added to the routine monitoring program.	[A-7]
9	Zinc, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program to align with monitoring taking place at DBS in the Maskinonge Lake Watershed.	[A-7]
9a	Iron, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program to align with monitoring taking place at DBS in the Maskinonge Lake Watershed.	[A-7]

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
9a	Uranium, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW in the Perch Lake Watershed. 2013: Not required as not a requirement in this watershed (DBS, LBL) and therefore no need for background values. However, analysis is completed as part of ATG 9a.	[A-7]
10	Antimony, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2014: Added to the routine monitoring program to align with monitoring taking place at DBS in the Maskinonge Lake Watershed.	[A-7]
10	Arsenic, unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2014: Added to the routine monitoring program to align with monitoring taking place at DBS in the Maskinonge Lake Watershed.	[A-7]
10	Selenium, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2014: Added to the routine monitoring program to align with monitoring taking place at DBS in the Maskinonge Lake Watershed.	[A-7]
12	Mercury, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2014: Added to the routine monitoring program to align with monitoring taking place at DBS in the Maskinonge Lake Watershed.	[A-7]
14	Phenolics, Unfiltered React	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2014: Added to the routine monitoring program to align with monitoring taking place at DBS in the Maskinonge Lake Watershed.	[A-7]
25	Solvent Extractables	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program to align with monitoring taking place at DBS in the Maskinonge Lake Watershed.	[A-7]
29	Barium	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2014: Added to the routine monitoring program to align with monitoring taking place at DBS in the Maskinonge Lake Watershed.	[A-7]
30	Chloride	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2014: Added to the routine monitoring program to align with monitoring taking place at DBS in the Maskinonge Lake Watershed.	[A-7]
30	Sulphate	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2014: Added to the routine monitoring program to align with monitoring taking place at DBS in the Maskinonge Lake Watershed.	[A-7]

Table A-7: Perch Creek Weir Monitoring Location History and Description

Perch Creek Weir (PCW) - Description and Monitoring History
This location was part of the initial set-up of the MISA program (1990) and has been monitored consistently since then.
It is classified as a "*Waste Disposal Site Effluent*" under MISA because it collects groundwater and run-off from the WMAs A, B, D, E, G and H, the Liquid Dispersal Areas (LDAs) (Laundry Pit, Reactor Pits 1 and 2 and the Chemical Pit), the Waste Tank Farm, the Salt Storage Shed and the rest of the Perch Lake Watershed. It subsequently drains to the Ottawa River by way of Perch Creek.
The sampling point is located approximately half way between Perch Lake and the Ottawa River, after all major groundwater contributions. In 2020, sediment collection at PCW was added, analyzing for metals (ATG 9).

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
3	pH	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location as a gross indicator of effluent quality.	[A-3]
4b	Nitrates, Total Filter Reactive	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location.	[A-3]
5a	Dissolved Organic Carbon	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location.	[A-3]
5b	Carbon, Total Organic	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location.	[A-3]
6	Phosphorus, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location.	[A-3]
7	Conductivity, at 25C	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location.	[A-3]
8	Residue, Particulate (TSS)	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location.	[A-3]
9	Aluminium, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location.	[A-3]
9	Boron, Unfiltered Total	-	2014: Included in 2014 as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Cadmium, Unfiltered Total	-	2014: Included in 2014 as when the lab runs analysis for uranium, they also analyse for cadmium. Since this information is available, it is included in the program.	[A-7]
9	Chromium, Unfiltered Total	-	2014: Included in 2014 as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Copper, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter) (shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	1990: Core parameter required under MISA specifically for this location. 2019: ERA COPC for this location.	[A-3][A-6]
9	Lead, Unfiltered Total	-	2014: Included in 2014 as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Lithium, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.	2019: ERA COPC for this location.	[A-6]

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
9	Nickel, Unfiltered Total	-	2014: Included in 2014 as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Strontium, Unfiltered Total	-	2014: Included in 2014 as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Vanadium, Unfiltered Total	-	2014: Included in 2014 as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Zinc, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location.	[A-3]
9a	Iron, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location.	[A-3]
9a	Uranium, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2007: Added in 2007 based on a comment from the SRC suggesting that this parameter should be monitored as a non-radioactive as well as a radioactive.	[A-9]
12	Mercury, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1991: Added in 1991 as a result of initial MISA monitoring. Known elevated results in groundwater surrounding the Chemical pit which discharges off-site through Perch Creek.	[A-5][A-12]
14	Phenolics, Unfiltered React	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location.	[A-3]
~~16~~	~~Volatiles, Halogenated~~		2000: Added in 2000 as a result of the detection of chlorinated solvents in the groundwater near Waste Management Areas 'B' & 'C' and the Liquid Dispersal Area. 2019: TCFM was identified as an ERA COPC for this location. However, further assessment found this was based on results and background levels below detection limits. Removed in 2019 as was not detected in water samples over the previous 5 years.	[A-2][A-13]
25	Solvent Extractables	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Core parameter required under MISA specifically for this location.	[A-3]
27	Polychlorinated Biphenyls (PCB)	(may) The level of risk from unmonitored releases is unknown or has been determined, by the ERA (or equivalent) to be of concern (shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2011: Added in 2011 based on observations in the groundwater in the vicinity of the Chemical Pit (LDAs). This groundwater enters East Swamp, Perch Lake through PL2 and then leaves the site through Perch Creek. 2019: ERA COPC for this location.	[A-8][A-10]
29	Barium	(may) The level of risk from unmonitored releases is unknown or has been determined, by the ERA (or equivalent) to be of concern	2019: The ERA found barium as a COPC at upgradient locations within the Perch Lake basin	[A-6]
30	Chloride	(may) The level of risk from unmonitored releases is unknown or has been determined, by the ERA (or equivalent) to be of concern. (may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2013: Added in 2013 to monitor for road salt impact and based on salt impacts on groundwater which have been noted on this watershed.	[A-10]
93	Flow	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	1990: Required under MISA - essential for determining loading to watercourses.	[A-3]

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
97	Hardness	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2010: Added in 2010 to surface water streams as is a modifying factor in order to compare to PWQO and CWQG for various parameters.	[A-10]

Table A-8: Perch Lake Inlet 1 Monitoring Location History and Justification

Perch Lake Inlet 1 (PL1) - Description and Monitoring History
This monitoring point was not part of the original MISA program as it is upstream of PCW. This inlet location drains into Perch Lake, through Perch Creek and then out into the Ottawa River. The monitoring point was added to the non-radioactive EMP in 2003 when there was interest in the surface water closer to the contaminant sources (i.e. WMAs). Similar to PCW, it would be considered a "*Waste Disposal Site Effluent*" under MISA, collecting groundwater and surface run-off from the west and south portions of WMA B. In 2020, sediment collection was added at this location, analyzing for metals (ATG 9). Samples for this monitoring point are taken just before this stream enters Perch Lake.

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
3	pH	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2003: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points, therefore added to this new point as a gross indicator of effluent quality.	[A-3]
4b	Nitrates, Total Filter Reactive	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2003; Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring point, therefore added to this new point.	[A-3]
5a	Dissolved Organic Carbon	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2003: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points, therefore added to this new point as a gross indicator of effluent quality.	[A-3]
5b	Carbon, Total Organic	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2003: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points, therefore added to this new point as a gross indicator of effluent quality.	[A-3]
6	Phosphorus, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2003: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points, therefore added to this new point as a gross indicator of effluent quality.	[A-3]
7	Conductivity, at 25C	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2003: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points, therefore added to this new point as a gross indicator of effluent quality.	[A-3]
8	Residue, Particulate (TSS)	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2003: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points, therefore added to this new point as a gross indicator of effluent quality. 2024: ERA COPC at this location	[A-3] [A-4
9	Aluminium, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2003: Core parameter required under MISA for all "Waste Disposal Site Effluents", therefore added to this new point.	[A-3]
9	Boron, Unfiltered Total	-	2003: Included in 2003 as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Cadmium, Unfiltered Total	-	2003: Included in 2003 as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Chromium, Unfiltered Total	-	2003: Included in 2003 as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Copper, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2003: Core parameter required under MISA for all monitoring points, therefore added to this new point. 2019: ERA COPC at this location.	[A-3] [A-4][A-8]

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
		(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2024: ERA COPC at this location	
9	Lead, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2019: ERA COPC at this location.	[A-6]
9	Lithium, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2019: ERA COPC at this location.	[A-6]
9	Nickel, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2019: ERA COPC at this location.	[A-6]
9	Strontium, Unfiltered Total	-	2003: Included in 2003 as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Vanadium, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2019: ERA COPC at this location.	[A-6]
9	Zinc, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter) (shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2003: Core parameter required under MISA for all "Waste Disposal Site Effluents", therefore added to this new point. 2019: ERA COPC at this location.	[A-3] [A-6]
9a	Iron, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter) (shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2003: Core parameter required under MISA for all "Waste Disposal Site Effluents", therefore added to this new point. 2019: ERA COPC at this location.	[A-3] [A-6]
9a	Uranium, Unfiltered Total	-	2014: Included in 2014 as when the lab runs analysis for cadmium, they also analyse for uranium. Since this information is available, it is included in the program.	[A-7]
10	Antimony, Unfiltered Total	-	2003: Added to routine program in 2003 due to detected levels of selenium being observed in GWMP results at WMA B West perimeter. All of ATG 10 added at that time.	[A-14]
10	Arsenic, unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2012: Identified as COPC in the 2012 ERA for receptors living near the Spring B area. 2019: Arsenic levels did not exceed criteria in 2019 ERA, but ATG maintained in EMP	[A-6]
10	Selenium, Unfiltered Total	(may) The level of risk from unmonitored releases is unknown or has been determined, by the ERA (or equivalent) to be of concern	2003: Added to routine program in 2003 due to detected levels of selenium being observed in GWMP results at WMA B West perimeter.	[A-14]
12	Mercury, Unfiltered Total	(may) The level of risk from unmonitored releases is unknown or has been determined, by the ERA (or equivalent) to be of concern	2003: Added based on the ongoing storage of mercury in tile holes in WMA B.	[A-14]
14	Phenolics, Unfiltered React	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2003: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points, therefore added to this new point, as a gross indicator of effluent quality.	[A-3] [A-6]

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
		(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2019: ERA COPC for this location.	
~~16~~	~~Volatiles, Halogenated~~		2003: Added as a result of the detection of chlorinated solvents in the groundwater near WMAs B & C and the Liquid Dispersal Area. 2019: TCFM was identified as an ERA COPC for this location. However, further assessment found this was based on results and background levels below detection limits. Removed in 2019 as was not detected in water samples over the previous 5 years.	[A-2][A-14]
25	Solvent Extractables	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter) (shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2003: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points, therefore added to this new point as a gross indicator of effluent quality. 2019: ERA COPC for this location.	[A-3][A-6]
29	Barium	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2019: ERA COPC at this location.	[A-6]
93	Flow	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2003: Required under MISA - essential for determining loading to watercourses.	[A-3]
97	Hardness	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2010: Added in 2010 to surface water streams as is a modifying factor in order to compare to PWQO and CWQG for various parameters.	[A-10]

Table A-9: Perch Lake Inlet 2 Monitoring Location History and Justification

Perch Lake Inlet 2 (PL2) - Description and Monitoring History
This monitoring point was not part of the original MISA program as it is upstream of PCW. It subsequently drains into Perch Lake and Perch Creek before discharging into the Ottawa River. The monitoring point was added to the EMP in 2003 when there was interest in the surface water closer to the contaminant sources (i.e. WMAs). This location collects groundwater and run-off from WMAs A, B (east side), D, E, G and H, the Liquid Dispersal Areas (LDAs) (Laundry Pit, Reactor Pits 1 and 2 and the Chemical Pit), the Waste Tank Farm and the Salt Storage Shed. Similar to PCW, it would be considered a *"Waste Disposal Site Effluent"* under MISA, collecting groundwater and surface run-off from the west and south portions of WMA B. In 2020, sediment collection at this location was added to monitor for dioxins and furans.
Samples for this monitoring point are taken just before this stream enters Perch Lake.

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
3	pH	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2003: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points.	[A-3]
4b	Nitrates, Total Filter Reactive	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2003: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points.	[A-3]
5a	Dissolved Organic Carbon	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2003: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points.	[A-3]
5b	Carbon, Total Organic	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2003: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points.	[A-3]
6	Phosphorus, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2003: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points.	[A-3]
7	Conductivity, at 25C	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2003: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points, therefore added to this new point as a gross indicator of effluent quality.	[A-3]
8	Residue, Particulate (TSS)	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2003: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points, therefore added to this new point as a gross indicator of effluent quality.	[A-3]
9	Aluminium, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2003: Core parameter required under MISA for all monitoring points, therefore added to this new point.	[A-3]
9	Boron, Unfiltered Total	-	2003: Included in 2003 as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Cadmium, Unfiltered Total	-	2003: Included in 2003 as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Chromium, Unfiltered Total	-	2003: Included in 2003 as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Copper, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter) (shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2003: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points, therefore added to this new point, as a gross indicator of effluent quality. 2019: ERA COPC for this location.	[A-3] [A-6]

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
9	Lead, Unfiltered Total	-	2003: Included in 2003 as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Lithium, Unfiltered Total	-	2003: Included in 2003 as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Nickel, Unfiltered Total	-	2003: Included in 2003 as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Strontium, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2019: ERA COPC for this location.	[A-6]
9	Vanadium, Unfiltered Total	-	2003: Included in 2003 as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Zinc, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2003: Core parameter required under MISA for all monitoring point, therefore added to this new point.	[A-3
9a	Iron, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter) (shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2003: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points, therefore added to this new point, as a gross indicator of effluent quality. 2019: ERA COPC for this location.	[A-3] [A-6]
9a	Uranium, Unfiltered Total	-	2014: Included in 2014 as when the lab runs analysis for cadmium, they also analyse for uranium. Since this information is available, it is included in the program.	[A-7]
10	Antimony, Unfiltered Total	-	2003: Added to routine program in 2003 due to detected levels of selenium being observed in GWMP results at WMA B East perimeter and Reactor Pit 1 &2. All of ATG 10 added at that time.	[A-14]
10	Arsenic, unfiltered Total	-	2003: Added to routine program in 2003 due to detected levels of selenium being observed in GWMP results at WMA B East perimeter and Reactor Pit 1 &2. All of ATG 10 added at that time.	[A-14]
10	Selenium, Unfiltered Total	(may) The level of risk from unmonitored releases is unknown or has been determined, by the ERA (or equivalent) to be of concern	2003: Added to routine program in 2003 due to detected levels of selenium being observed in GWMP results at WMA B East perimeter and Reactor Pit 1 &2.	[A-14]
12	Mercury, Unfiltered Total	(may) The level of risk from unmonitored releases is unknown or has been determined, by the ERA (or equivalent) to be of concern	2003: Added based on groundwater results exceeding ecological health-based Environmental Performance Criteria in the vicinity of the Chemical Pit.	[A-14]
14	Phenolics, Unfiltered React	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter) (shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2003: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points, therefore added to this new point, as a gross indicator of effluent quality. 2019: ERA COPC for this location.	[A-3][A-6]

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
~~16~~	~~Volatiles, Halogenated~~		2003: Added as a result of the detection of chlorinated solvents in the groundwater near at WMA B & C and the Liquid Dispersal Area. 2019: TCFM was identified as an ERA COPC for this location. However, further assessment found this was based on results and background levels below detection limits. Removed in 2019 as was not detected in water samples over the previous 5 years.	[A-2][A-14]
24	Chlorinated Dioxins and Furans	(may) The level of risk from unmonitored releases is unknown or has been determined, by the ERA (or equivalent) to be of concern	2008: Added in 2008 based on GWMP results which identified these coming out of the LDA - Chemical pit. 2020: Removed from surface water monitoring due to 5 years of results below detection, but due to hydrophobic nature of these compounds, added to sediment monitoring at this location.	[A-2][A-8]
25	Solvent Extractables	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter) (shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2003: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points, therefore added to this new point as a gross indicator of effluent quality. 2019: ERA COPC at this location.	[A-3][A-6]
27	Polychlorinated Biphenyls (PCB)	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2011: Added in 2011 based on observations in the groundwater in the vicinity of the Chemical pit (LDAs) which enters East Swamp and then PL2. 2019: ERA COPC at this location.	[A-1][A-6]
29	Barium	(may) The level of risk from unmonitored releases is unknown or has been determined, by the ERA (or equivalent) to be of concern	2019: Upgradient locations in the Perch Lake watershed were found to have elevated barium concentrations in the ERA.	[A-6]
30	Chloride	(may) The level of risk from unmonitored releases is unknown or has been determined, by the ERA (or equivalent) to be of concern.	2013: Added in 2013 to monitor for road salt impact and based on salt impacts on groundwater which have been noted on this watershed. 2024: ERA COPC at this location.	[A-4][A-10]
93	Flow	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2003: Required under MISA - essential for determining loading to watercourses.	[A-3]
97	Hardness	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2010: Added in 2010 to surface water streams as is a modifying factor in order to compare to PWQO and CWQG for various parameters.	[A-10]

Table A-10: Main Stream above Plant Road Monitoring Location History and Justification

Main Stream Above Plant Road (MAR) - Description and Monitoring History
This monitoring point was not part of the original MISA program but was instead added to the EMP in 2006. It would be considered a "*Waste Disposal Site Effluent*" under MISA because it collects surface water and groundwater draining from WMAs D, E, G and H, the Salt Storage Shed and the Waste Tank Farm. This stream is fed by No Name Swamp. Surface run-off from the Plant Road is also draining towards this monitoring point. Monitoring parameters are those expected to be present as a result of salt use on roads (i.e. chloride, phosphorus, nitrogen, copper, and zinc). In 2020, sediment collection was added at this location, monitoring for metals (ATG 9) and anions (ATG 30).
The sampling location is right before the stream crosses under Plant Road. This stream runs through MSC and discharges through PL1 into Perch Lake and eventually out to the Ottawa River via Perch Creek.
Note: Many of the MISA core parameters originally monitored at MAR were moved downstream to MSC in 2015.

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
4b	Nitrates, Total Filter Reactive	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2006: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points, therefore added to this new point as a gross indicator of effluent quality.	[A-3]
6	Phosphorus, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter) (shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2006: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points, therefore added to this new point as a gross indicator of effluent quality. 2019: ERA COPC at this location.	[A-3] [A-6]
9	Aluminium, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2006: Core parameter required under MISA for all monitoring point, therefore added to this new point.	[A-3]
9	Boron, Unfiltered Total	-	2006: Included in 2006 as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program. 2024: ERA COPC in sediment at this location.	[A-4][A-7]
9	Cadmium, Unfiltered Total	-	2006: Included in 2006 as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Chromium, Unfiltered Total	-	2006: Included in 2006 as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Copper, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter) (shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2006: Core parameter required under MISA for all monitoring point, therefore added to this new point. 2019: ERA COPC at this location.	[A-3][A-6]
9	Lead, Unfiltered Total	-	2006: Included in 2006 as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Lithium, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2019: ERA COPC at this location.	[A-6]
9	Nickel, Unfiltered Total	-	2006: Included in 2006 as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
9	Strontium, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2019: ERA COPC at this location.	[A-6]
9	Vanadium, Unfiltered Total	-	2006: Included in 2006 as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Zinc, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2006: Core parameter required under MISA for all monitoring point, therefore added to this new point. 2024: ERA COPC at this location.	[A-3] [A-4
9a	Iron, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2006; Core parameter required under MISA for all monitoring point, therefore added to this new point.	[A-3]
9a	Uranium, Unfiltered Total	-	2006: Included in 2006 as when the lab runs analysis for iron, they analyse for all of ATG. Since this information is available, it is included in the program.	[A-10]
29	Barium	(may) The level of risk from unmonitored releases is unknown or has been determined, by the ERA (or equivalent) to be of concern	2019: Numerous locations in the Perch Lake watershed were found to have elevated barium concentrations in the ERA.	[A-6]
30	Chloride	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment (may) The emission of contaminants are highly variable (may) The level of risk from unmonitored releases is unknown or has been determined, by the ERA (or equivalent) to be of concern	2013: Added in 2012 as an indicator for road salt effects from Plant Road as well as groundwater from the Salt Storage shed area. Identified as having a risk quotient greater than one in the 2012 ERA. 2019: ERA COPC at this location. 2024: ERA COPC at this location	[A-4][A-6] [A-7]
30	Sulphate	-	Included in 2012 as when the lab runs analysis for anions, they analyze for all anions.	[A-7]

Table A-11: Main Stream at Culvert Monitoring Location History and Justification

Main Stream at Culvert (MSC) - Description and Monitoring History
This monitoring point was not part of the original MISA program but was instead added to the Environmental Program in 2014. It does not represent a final release point from the Chalk River Site. Based on the results of the GWMP, it was felt that it would be beneficial to determine whether there are similar contaminants found in the surface water. Therefore, parameters chosen are based on those being monitored under the GWMP.
It would be considered a "*Waste Disposal Site Effluent*" under MISA because it collects surface water and groundwater draining from WMAs D, E, G and H, the Salt Storage Shed, the Waste Tank Farm and the East portion of WMA B. This stream is fed by No Name Swamp. This stream discharges through PL1 into Perch Lake and eventually out to the Ottawa River via Perch Creek.

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
3	pH	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2015: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points. Gross indicator of effluent quality. Monitored in Main Stream since 2006, moved from MAR to MSC location in 2015.	[A-3]
4b	Nitrates, Total Filter Reactive	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2015: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points. Gross indicator of effluent quality. Monitored in Main Stream at MAR location since 2006, added at MSC location in 2015.	[A-3]
5a	Dissolved Organic Carbon	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2015: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points. Gross indicator of effluent quality. Monitored in Main Stream since 2006, moved from MAR to MSC location in 2015.	[A-3]
5b	Carbon, Total Organic	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2015: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points. Gross indicator of effluent quality. Monitored in Main Stream since 2006, moved from MAR to MSC location in 2015.	[A-3]
6	Phosphorus, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2015: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points. Gross indicator of effluent quality. Monitored in Main Stream at MAR location since 2006, added at MSC location in 2015.	[A-3]
7	Conductivity, at 25C	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2015: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points. Gross indicator of effluent quality. Monitored in Main Stream since 2006, moved from MAR to MSC location in 2015.	[A-3]
8	Residue, Particulate (TSS)	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2015: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points. Gross indicator of effluent quality. Monitored in Main Stream since 2006, moved from MAR to MSC location in 2015.	[A-3]
9	Aluminium, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2015: Core parameter required under MISA for all monitoring point. Monitored in Main Stream since 2006, moved from MAR to MSC location in 2015.	[A-3]
9	Boron, Unfiltered Total	-	2015: Included as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program. Monitored in Main Stream since 2006, moved from MAR to MSC location in 2015.	[A-7]
9	Cadmium, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2019: ERA COPC at this location	[A-6]
9	Chromium, Unfiltered Total	-	2015: Included as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program. Monitored in Main Stream since 2006, moved from MAR to MSC location in 2015.	[A-7]
9	Copper, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2015: Core parameter required under MISA for all monitoring point. Monitored in Main Stream since 2006, moved from MAR to MSC location in 2015.	[A-3]

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
9	Lead, Unfiltered Total	-	2015: Included as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program. Monitored in Main Stream since 2006, moved from MAR to MSC location in 2015.	[A-7]
9	Lithium, Unfiltered Total	-	2015: Included as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program. Monitored in Main Stream since 2006, moved from MAR to MSC location in 2015.	[A-7]
9	Nickel, Unfiltered Total	-	2015: Included as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program. Monitored in Main Stream since 2006, moved from MAR to MSC location in 2015.	[A-7]
9	Strontium, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2019: ERA COPC at this location	[A-6]
9	Zinc, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2015: Core parameter required under MISA for all monitoring point. Monitored in Main Stream since 2006, moved from MAR to MSC location in 2015.	[A-3]
9a	Iron, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2015: Core parameter required under MISA for all monitoring point. Monitored in Main Stream since 2006, moved from MAR to MSC location in 2015.	[A-3]
9a	Uranium, Unfiltered Total	-	2015: Included as when the lab runs analysis for cadmium, they also analyse for uranium. Since this information is available, it is included in the program. Monitored in Main Stream since 2006, moved from MAR to MSC location in 2015.	[A-7]
10	Antimony, Unfiltered Total	-	2015: Added to routine program due to detected levels of selenium being observed in GWMP results at WMA B East perimeter and Reactor Pit 1 &2. All of ATG 10 monitored in Main Stream since 2006, moved from MAR to MSC location in 2015.	[A-7]
10	Arsenic, unfiltered Total	-	2015: Added to routine program due to detected levels of selenium being observed in GWMP results at WMA B East perimeter and Reactor Pit 1 &2. All of ATG 10 monitored in Main Stream since 2006, moved from MAR to MSC location in 2015.	[A-7]
10	Selenium, Unfiltered Total	(may) The level of risk from unmonitored releases is unknown or has been determined, by the ERA (or equivalent) to be of concern	2015: Added to routine program due to detected levels of selenium being observed in GWMP results at WMA B East perimeter and Reactor Pit 1 &2. All of ATG 10 monitored in Main Stream since 2006, moved from MAR to MSC location in 2015.	[A-14]
12	Mercury, Unfiltered Total	(may) The level of risk from unmonitored releases is unknown or has been determined, by the ERA (or equivalent) to be of concern	2015: Added due to potential contaminant signature in WMA D. Monitored in Main Stream since 2006, moved from MAR to MSC location in 2015.	[A-14]
14	Phenolics, Unfiltered React	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2015: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points. Gross indicator of effluent quality. Monitored in Main Stream since 2006, moved from MAR to MSC location in 2015.	[A-3]
~~16~~	~~Volatiles, Halogenated~~		2014: Observed in Chlorinated solvents in the groundwater near Waste Management Areas 'B'. Therefore added here as well. 2019: Removed in 2019 as was not detected in water samples over the previous 5 years	[A-2] [A-8]
25	Solvent Extractables	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2015: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points. Monitored in Main Stream since 2006, moved from MAR to MSC location in 2015.	[A-3]
29	Barium	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical	2019: ERA COPC at this location	[A-6]

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
		stressor to produce effects in the receiving environment		
30	Chloride	(may) The emission of contaminants are highly variable (may) The level of risk from unmonitored releases is unknown or has been determined, by the ERA (or equivalent) to be of concern	2015: Indicator for road salt effects from Plant Road as well as groundwater from the Salt Storage shed area. Monitored in Main Stream since 2006, moved from MAR to MSC location in 2015. 2024: ERA COPC at this location.	[A-4][A-10]
30	Sulphate	-	2015: Anions monitored in Main Stream since 2015 for chloride	[A-7]
93	Flow	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2015: Required under MISA - essential for determining loading to watercourses. Monitored in Main Stream since 2006, moved from MAR to MSC location in 2015.	[A-3]
97	Hardness	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2010: Added in 2010 to surface water streams as is a modifying factor in order to compare to PWQO and CWQG for various parameters.	[A-10]

Table A-12: East Swamp Weir Monitoring Location History and Justification

East Swamp Weir (ESW) - Description and Monitoring History
This monitoring point was not part of the original MISA program but was instead added to the EMP in 2008. It does not represent a final release point from the Chalk River Site. Based on the results of the GWMP, it was felt that it would be beneficial to determine whether there are similar contaminants found in the surface water. Therefore, many of the parameters chosen are based on those sampled by the GWMP at the time.
It would be considered a "*Waste Disposal Site Effluent*" under MISA because it collects groundwater and surface runoff from the Laundry Pit, the East side of Reactor Pit 2 and the Chemical Pit within the Liquid Disposal Areas (LDAs). The stream then drains to Perch Lake, via PL2, and subsequently to the Ottawa River via Perch Creek. In 2020, sediment collection was added at this location, monitoring for metals, (ATG 9, 10), organics (ATG 16) and dioxins and furans.

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
3	pH	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2008: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points, therefore added to this new point as a gross indicator of effluent quality.	[A-3]
4b	Nitrates, Total Filter Reactive	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2008: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring point, therefore added to this new point.	[A-3]
5a	Dissolved Organic Carbon	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2008: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points, therefore added to this new point as a gross indicator of effluent quality.	[A-3]
5b	Carbon, Total Organic	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2008: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points, therefore added to this new point as a gross indicator of effluent quality.	[A-3]
6	Phosphorus, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2008: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points, therefore added to this new point as a gross indicator of effluent quality. NOTE: Laundry Pit - phosphate-based detergents in the cleaning of laundry was discharged in this area between 1956 and 1958.	[A-3]
7	Conductivity, at 25C	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2008: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points, therefore added to this new point as a gross indicator of effluent quality.	[A-3]
8	Residue, Particulate (TSS)	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2008: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points, therefore added to this new point.	[A-3]
9	Aluminium, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter) (shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2008: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points, therefore added to this new point. 2019: ERA COPC at this location	[A-3] [A-6]
9	Boron, Unfiltered Total	-	2014: Included in 2014 as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Cadmium, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2019: ERA COPC at this location	[A-6]

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
9	Chromium, Unfiltered Total	-	2014: Included in 2014 as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Copper, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter) (shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2008: Core parameter required under MISA for all monitoring point, therefore added to this new point. 2019: ERA COPC for this location	[A-3] [A-6]
9	Lead, Unfiltered Total	(may) The level of risk from unmonitored releases is unknown or has been determined, by the ERA (or equivalent) to be of concern	2008: Observed in the groundwater monitoring program and therefore monitored here since commencement of monitoring.	[A-7]
9	Nickel, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2019: ERA COPC at this location	[A-6]
9	Strontium, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2019: ERA COPC at this location 2024: ERA COPC in East Swamp	[A-4] [A-6]
9	Vanadium, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2019: ERA COPC at this location	[A-6]
9	Zinc, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2008: Core parameter required under MISA for all “Waste Disposal Site Effluent" monitoring points, therefore added to this new point.	[A-3]
9a	Iron, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2019: ERA COPC at this location 2024: ERA COPC in East Swamp	[A-4] [A-6]
9a	Uranium, Unfiltered Total	-	2014: Included in 2014 as when the lab runs analysis for iron, they analyse for all of ATG and to align with monitoring taking place at other surface water monitoring locations.	[A-7]
10	Antimony, Unfiltered Total	(may) The level of risk from unmonitored releases is unknown or has been determined, by the ERA (or equivalent) to be of concern	2008: Observed in the groundwater monitoring program and therefore monitored here since commencement of monitoring.	[A-14]
10	Arsenic, unfiltered Total	(may) The level of risk from unmonitored releases is unknown or has been determined, by the ERA (or equivalent) to be of concern	2008: Observed in the groundwater monitoring program and therefore monitored here since commencement of monitoring.	[A-14]
10	Selenium, Unfiltered Total	(may) The level of risk from unmonitored releases is unknown or has been determined, by the ERA (or equivalent) to be of concern	2008: Observed in the groundwater monitoring program and therefore monitored here since commencement of monitoring.	[A-14]
12	Mercury, Unfiltered Total	(may) The level of risk from unmonitored releases is unknown or has been determined, by the ERA (or equivalent) to be of concern	2008: Observed in the groundwater monitoring program and therefore monitored here since commencement of monitoring. Note: The Chemical Pit has been shown to have noticeable Hg content in	[A-14]

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
			groundwater exceeding the ecological health-based environmental performance criterion.	
14	Phenolics, Unfiltered React	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2014: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points. Gross indicator of effluent quality.	[A-3]
16	Volatiles, Halogenated	(may) The level of risk from unmonitored releases is unknown or has been determined, by the ERA (or equivalent) to be of concern	2008: Observed in the groundwater monitoring program and therefore monitored here since commencement of monitoring. 2019: TCE and TCFM identified as COPC in the ERA, but was based on results below detection limits. Removed from surface water monitoring in 2019 as was not detected in water samples over the previous 5 years and due to volatile nature, but added to sediment monitoring.	[A-2]
24	Chlorinates Dioxins and Furans	(may) The level of risk from unmonitored releases is unknown or has been determined, by the ERA (or equivalent) to be of concern	2008: Added in 2008 based on GWMP results which identified these coming out of the LDA - Chemical Pit. 2019: ERA COPC at this location, but monitored in sediment due to hydrophobic nature of these compounds.	[A-6]
25	Solvent Extractables	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2008: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points, therefore added to this new point.	[A-3]
27	Polychlorinated Biphenyls (PCB)	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2011: Added in 2011 based on detectable levels noted in groundwater near the Chemical Pit (liquid dispersal Area). 2019: ERA COPC at this location	[A-6] [A-8]
29	Barium	(may) The level of risk from unmonitored releases is unknown or has been determined, by the ERA (or equivalent) to be of concern	2019: Numerous locations in the Perch Lake watershed were found to have elevated barium concentrations in the ERA.	[A-6]
93	Flow	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2008: Required under MISA - essential for determining loading to watercourses	[A-1]
97	Hardness	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2010: Added in 2010 to surface water streams as is a modifying factor in order to compare to PWQO and CWQG for various parameters.	[A-10]

Table A-13: South Swamp Weir Monitoring Location History and Justification

South Swamp Weir (SSW) - Description and Monitoring History
This monitoring point was not part of the original MISA program but was instead added to the EMP in 2008. It does not represent a final release point from the Chalk River Site. Based on the results of the GWMP, it was felt that it would be beneficial to determine whether there are similar contaminants found in the surface water. Therefore, parameters chosen are based on those sampled by the GWMP. It would be considered a "*Waste Disposal Site Effluent*" under MISA because it collects groundwater and surface runoff from WMA A and Reactor Pit 2 within the LDAs. The water then drains to Perch Lake, via PL2, and subsequently to the Ottawa River via Perch Creek. In 2020, sediment collection was added at this location, monitoring for metals, (ATG 9, 10) and organics (ATG 16).

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
3	pH	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2008: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points, therefore added to this new point as a gross indicator of effluent quality.	[A-3]
4b	Nitrates, Total Filter Reactive	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2008: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring point, therefore added to this new point.	[A-3]
5a	Dissolved Organic Carbon	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2008: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring point, therefore added to this new point.	[A-3]
5b	Carbon, Total Organic	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2008: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring point, therefore added to this new point.	[A-3]
6	Phosphorus, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2008: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring point, therefore added to this new point.	[A-3]
7	Conductivity, at 25C	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2008: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring point, therefore added to this new point.	[A-3]
8	Residue, Particulate (TSS)	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2008: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring point, therefore added to this new point.	[A-3]
9	Aluminium, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter) (shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2008: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring point, therefore added to this new point. 2019: ERA COPC at this location	[A-3] [A-6]
9	Boron, Unfiltered Total	-	2014: Included in 2014 as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Cadmium, Unfiltered Total	(may) The level of risk from unmonitored releases is unknown or has been determined, by the ERA (or equivalent) to be of concern	2008: Observed in the groundwater monitoring program and therefore monitored here since commencement of monitoring in 2008.	[A-15]
9	Chromium, Unfiltered Total	-	2014: Included in 2014 as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Copper, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2008: Core parameter required under MISA for all monitoring points, therefore added to this new point.	[A-3]
9	Lead, Unfiltered Total	-	2014: Included in 2014 as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
9	Lithium, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2019: ERA COPC at this location	[A-6]
9	Nickel, Unfiltered Total	-	2014: Included in 2014 as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Strontium, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2019: ERA COPC at this location 2024: ERA COPC in South Swamp	[A-4] [A-6]
9	Vanadium, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2019: ERA COPC at this location	[A-6]
9	Zinc, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2008: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points, therefore added to this new point.	[A-3]
9a	Iron, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2008: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points, therefore added to this new point.	[A-3]
9a	Uranium, Unfiltered Total	-	2014: Included in 2014 as when the lab runs analysis for cadmium, they also analyse for uranium. Since this information is available, it is included in the program.	[A-7]
12	Mercury, Unfiltered Total	(may) The level of risk from unmonitored releases is unknown or has been determined, by the ERA (or equivalent) to be of concern	2008: Observed in the groundwater monitoring program and therefore monitored here since commencement of monitoring in 2008. Contaminant signature from WMA A includes mercury.	[A-15]
14	Phenolics, Unfiltered React	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2014: Added in 2014 as is a core parameter required for all surface water monitoring locations. 2024: ERA COPC at this location	[A-3] [A-4
16	Volatiles, Halogenated	(may) The level of risk from unmonitored releases is unknown or has been determined, by the ERA (or equivalent) to be of concern	2008: Observed in the groundwater monitoring program and therefore monitored here since commencement of monitoring in 2008. 2019: TCE and TCFM identified as COPC in the ERA, but was based on results below detection limits. Removed from surface water monitoring in 2019 as was not detected in water samples over the previous 5 years and due to volatile nature, but added to sediment monitoring.	[A-2]
25	Solvent Extractables	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring point, therefore added to this new point.	[A-3]
29	Barium	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2019: ERA COPC at this location	[A-6]
30	Chloride	(may) The level of risk from unmonitored releases is unknown or has been determined, by the ERA (or equivalent) to be of concern (may) The emission of contaminants are highly variable (shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2008: Observed in the groundwater monitoring program and therefore monitored here since commencement of monitoring in 2008. 2019: ERA COPC at this location	[A-6] [A-15]

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
30	Sulphate	-	2008: Anions monitored since 2008 for chloride, all of ATG monitored as a result	[A-7]
97	Hardness	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2010: Added in 2010 to surface water streams as is a modifying factor in order to compare to PWQO and CWQG for various parameters.	[A-10]

Table A-14:Spring B Discharge Monitoring Location History and Justification

Spring B Discharge (SBD) - Description and Monitoring History
This monitoring point was not part of the original MISA program but non-radiological monitoring was added to the EMP in 2019 after being identified as having a high level of uncertainty in the 2019 ERA [A-10]. It does not represent a final release point from the Chalk River Site. Based on the results of the GWMP, it was felt that it would be beneficial to determine whether there are similar contaminants found in the surface water.
It would be considered a "*Waste Disposal Site Effluent*" under MISA because it collects groundwater and surface runoff from the west side of WMA B. The stream then drains to Perch Lake, via PL1, and subsequently to the Ottawa River via Perch Creek. .

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
3	pH	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2019: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points, therefore added to this new point as a gross indicator of effluent quality.	[A-3]
4b	Nitrates, Total Filter Reactive	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2019: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring point, therefore added to this new point.	[A-3]
5a	Dissolved Organic Carbon	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2019: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points, therefore added to this new point as a gross indicator of effluent quality.	[A-3]
5b	Carbon, Total Organic	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2019: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points, therefore added to this new point as a gross indicator of effluent quality.	[A-3]
6	Phosphorus, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2019: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points, therefore added to this new point as a gross indicator of effluent quality.	[A-3]
7	Conductivity, at 25C	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2019: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points, therefore added to this new point as a gross indicator of effluent quality.	[A-3]
8	Residue, Particulate (TSS)	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2019: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points, therefore added to this new point.	[A-3]
9	Aluminium, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2019: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points, therefore added to this new point.	[A-3]
9	Boron, Unfiltered Total	-	2014: Included in 2014 as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Cadmium, Unfiltered Total	-	2014: Included in 2014 as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Chromium, Unfiltered Total	-	2014: Included in 2014 as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Copper, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2019: Core parameter required under MISA for all monitoring point, therefore added to this new point. 2019: ERA COPC for this location	[A-3] [A-6]

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
		(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment		
9	Lead, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2019: ERA COPC at this location	[A-6]
9	Lithium, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2019: ERA COPC at this location	[A-6]
9	Nickel, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2019: ERA COPC at this location	[A-6]
9	Strontium, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2019: ERA COPC at this location	[A-6]
9	Vanadium, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2019: ERA COPC at this location	[A-6]
9	Zinc, Unfiltered Total	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter) (shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2019: Core parameter required under MISA for all “Waste Disposal Site Effluent" monitoring points, therefore added to this new point. 2019: ERA COPC at this location. 2024: ERA COPC at this location	[A-3] [A-4] [A-6]
9a	Iron, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2019: ERA COPC at this location 2024: ERA COPC at this location	[A-4] [A-6]
9a	Uranium, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2019: ERA COPC at this location	[A-6]
10	Antimony, Unfiltered Total	-	2019: Added to routine program due to arsenic being a COPC. All of ATG 10 monitored.	[A-7]
10	Arsenic, unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2019: ERA COPC at this location	[A-6]
10	Selenium, Unfiltered Total	-	2019: Added to routine program due to arsenic being a COPC. All of ATG 10 monitored.	[A-7]
12	Mercury, Unfiltered Total	(may) The level of risk from unmonitored releases is unknown or has been determined, by the ERA (or equivalent) to be of concern	2019: Observed in the groundwater monitoring program and therefore monitored here.	[A-2]
14	Phenolics, Unfiltered React	(should) Triggered by the MISA program (i.e. historical or identified as a core parameter)	2019: Core parameter required under MISA for all "Waste Disposal Site Effluent" monitoring points. Gross indicator of effluent quality. 2019: ERA COPC at this location	[A-3] [A-6

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
		(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment		
30	Chloride	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2024: ERA COPC at this location	[A-4]

Table A-15: Perch Lake Outlet Monitoring Location History and Description

Perch Lake Outlet (PLO) - Description and Monitoring History
PLO is an outlet of Perch Lake, located approximately 1 km upstream of the Perch Creek Weir monitoring location, and receives groundwater and surface runoff from WMAs A, B, D, E, G, H, the LDAs (Laundry Pit, RP1, RP2, and the Chemical Pit), the Waste Tank Farm, the Salt Storage Shed and the rest of the Perch Lake basin. PCW serves as downstream monitoring for BDS, BSD, BBH, BHL, PL2, CPS, FPS, RPS, ESW, SSW, PL1, and PLO. Monitored as part of the Environmental Monitoring Program (EMP).
The sampling point is located at the outflow of Perch Lake into Perch Creek.

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
3	pH	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2023: Field parameters are of usefulness in the evaluation of water quality and potential effects. Monitoring of these parameters is required to verify the effectiveness of mitigation.	[A-16]
4b	Nitrates, Total Filter Reactive	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2023: Added to align with other monitoring in the Perch Lake Basin.	[A-16]
6	Phosphorus, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2023: Added to align with other monitoring in the Perch Lake Basin.	[A-16]
7	Conductivity, at 25C	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2023: Field parameters are of usefulness in the evaluation of water quality and potential effects. Monitoring of these parameters is required to verify the effectiveness of mitigation.	[A-16]
8	Residue, Particulate (TSS)	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2023: Field parameters are of usefulness in the evaluation of water quality and potential effects. Monitoring of these parameters is required to verify the effectiveness of mitigation.	[A-16]
9	Aluminium, Unfiltered Total	-	Included as when the lab runs analysis for other core metal parameters in ATG 9, they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Boron, Unfiltered Total	-	Included as when the lab runs analysis for other core metal parameters in ATG 9, they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Cadmium, Unfiltered Total	-	Included as when the lab runs analysis for other core metal parameters in ATG 9, they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Chromium, Unfiltered Total	-	Included as when the lab runs analysis for other core metal parameters in ATG 9, they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Copper, Unfiltered Total	-	Included as when the lab runs analysis for other core metal parameters in ATG 9, they analyse for all of ATG. Since this information is available, it is included in the program.	[A-16]
9	Lead, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2024: ERA COPC at this location	[A-4]
9	Lithium, Unfiltered Total	(	Included as when the lab runs analysis for other core metal parameters in ATG 9, they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
9	Nickel, Unfiltered Total	-	Included as when the lab runs analysis for other core metal parameters in ATG 9, they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Silver, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2024: ERA COPC at this location	[A-4]
9	Strontium, Unfiltered Total	-	Included as when the lab runs analysis for other core metal parameters in ATG 9, they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Vanadium, Unfiltered Total	-	Included as when the lab runs analysis for other core metal parameters in ATG 9, they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Zinc, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2024: ERA COPC at this location	[A-4]
9a	Iron, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2023: Added to align with other monitoring in the Perch Lake Basin.	[A-16]
9a	Uranium, Unfiltered Total	-	Included as when the lab runs analysis for other core metal parameters in ATG 9, they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
25	Solvent Extractables	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2023: Added to align with other monitoring in the Perch Lake Basin.	[A-16]
30	Chloride	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2023: Added to align with other monitoring in the Perch Lake Basin.	[A-16]
30	Fluoride	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2023: Added to align with other monitoring in the Perch Lake Basin.	[A-16]
93	Flow	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2023: Added to align with other monitoring in the Perch Lake Basin.	[A-16]
96	Dissolved Oxygen	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2023: Added to align with other monitoring in the Perch Lake Basin.	[A-16]

Table A-16: Perch Lake Inlet 4 Monitoring Location History and Justification

Perch Lake Inlet 4 (PL4) - Reference Monitoring Location
Located on the Chalk River site, this background location is on a southern inlet stream entering Perch Lake.
Monitoring at this location started in 2009 as a special investigation under the non-radioactive EMP in efforts to identify a surface water reference location in the Perch Lake Watershed after it was speculated that some of the elevated concentrations which were being seen in the program's monitoring results were, in fact, due to naturally elevated parameters in the local area.
Once the location was deemed both a reliable source of surface water and accessible for sampling, it was formally added to the non-radioactive EMP in 2012 December. Sediment collection added at this location as a reference point.

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
3	pH	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program.	[A-7]
4b	Nitrates, Total Filter Reactive	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program.	[A-7]
5a	Dissolved Organic Carbon	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program.	[A-7]
5b	Carbon, Total Organic	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program.	[A-7]
6	Phosphorus, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program.	[A-7]
7	Conductivity, at 25C	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program.	[A-7]
8	Residue, Particulate (TSS)	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program.	[A-7]
9	Aluminium, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program.	[A-7]
9	Boron, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program.	[A-7]
9	Cadmium, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program.	[A-7]
9	Chromium, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program.	[A-7]

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
9	Copper, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program.	[A-7]
9	Lead, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program.	[A-7]
9	Lithium, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program.	[A-7]
9	Nickel, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program.	[A-7]
9	Strontium, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program.	[A-7]
9	Vanadium, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program.	[A-7]
9	Zinc, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program.	[A-7]
9a	Iron, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program.	[A-7]
9a	Uranium, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program.	[A-7]
10	Antimony, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2014: Added to the routine monitoring program to align with monitoring taking place at PL1, PL2, and ESW in the Perch Lake Watershed.	[A-7]
10	Arsenic, unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2014: Added to the routine monitoring program to align with monitoring taking place at PL1, PL2, and ESW in the Perch Lake Watershed.	[A-7]
10	Selenium, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2014: Added to the routine monitoring program to align with monitoring taking place at PL1, PL2, and ESW in the Perch Lake Watershed.	[A-7]
12	Mercury, Unfiltered Total	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2014: Added to the routine monitoring program to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed.	[A-7]
14	Phenolics, Unfiltered React	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2014: Added to the routine monitoring program to align with monitoring taking place at PCW, PL1, PL2 and MAR in the Perch Lake Watershed.	[A-7]

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
25	Solvent Extractables	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2009: Started monitoring in 2009 as special investigation to align with monitoring taking place at PCW, PL1, PL2, MAR, ESW and SSW in the Perch Lake Watershed. 2013: Added to the routine monitoring program.	[A-7]
29	Barium	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2019: Added in 2019 to align with monitoring taking place in the Perch Lake Watershed.	[A-7]
30	Chloride	(may) There are other business reasons (e.g. stakeholder concerns, due diligence, background/reference parameters, etc.)	2014: Added in 2014 to align with monitoring taking place at PCW and MAR in the Perch Lake Watershed.	[A-7]

Table A-17: Pipeline Stream (PIS) Monitoring Location History and Justification

Pipeline Stream (PIS) - Description and Monitoring History
This monitoring point was not part of the original MISA program but was instead added to the EMP for radiological monitoring. Radiological monitoring was removed from the EMP in 2014.
The O-3 Swamp collects drainage from the Salt Storage Shed and the Waste Tank Farm. This stream is fed by No Name Swamp. Surface run-off from the Plant Road is also draining towards this monitoring point. Monitoring parameters are those expected to be present as a result of salt storage upgradient of the swamp (i.e. chloride, phosphorus, nitrogen, copper, and zinc). In 2020, sediment collection was added at this location, monitoring for metals (ATG 9) and anions (ATG 30).
After the PIS sampling point, this stream joins the firewater overflow runs through culverts of the 010 stormwater system, eventually out to the Ottawa River via the 010 Storm Outfall.

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
6	Phosphorus, Unfiltered Total	(may) The choice of contaminants to monitor in the environment may also be based on due diligence	2024: Added to understand the various inputs to the 010 stormwater system	[A-7]
5a	Dissolved Organic Carbon	(may) The choice of contaminants to monitor in the environment may also be based on due diligence	2024: Added to understand the various inputs to the 010 stormwater system	[A-7]
5b	Total Organic Carbon	(may) The choice of contaminants to monitor in the environment may also be based on due diligence	2024: Added to understand the various inputs to the 010 stormwater system	[A-7]
9	Aluminium, Unfiltered Total	-	2024: Included as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Cd), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Boron, Unfiltered Total	-	2024: Included as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Cd), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Cadmium, Unfiltered Total	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2024: ERA COPC in sediment at this location.	[A-4]
9	Chromium, Unfiltered Total	-	2024: Included as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Cd), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Copper, Unfiltered Total	-	2024: Included as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Cd), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Lead, Unfiltered Total	-	2024: Included as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Cd), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Lithium, Unfiltered Total	-	2024: Included as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Cd), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Nickel, Unfiltered Total	-	2024: Included as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Cd), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Strontium, Unfiltered Total	-	2024: Included as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Cd), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]

ATG	Parameter Name	Criteria for Monitoring	Justification for Monitoring of Parameter	Reference
9	Vanadium, Unfiltered Total	-	2024: Included as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Al), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
9	Zinc, Unfiltered Total	-	2024: Included as when the lab runs analysis for other core metal parameters in ATG 9 (e.g. Cd), they analyse for all of ATG. Since this information is available, it is included in the program.	[A-7]
25	Solvent Extractables	(may) The choice of contaminants to monitor in the environment may also be based on due diligence	2024: Added to understand the various inputs to the 010 stormwater system	[A-7]
30	Chloride	(may) The emission of contaminants are highly variable (may) The level of risk from unmonitored releases is unknown or has been determined, by the ERA (or equivalent) to be of concern	2024: Added as an indicator for road salt effects from Plant Road as well as groundwater from the Salt Storage shed area.	[A-4] [A-6
30	Bromide	(shall) Based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment	2024: ERA COPC in sediment at this location.	[A-4]

A.1 References

[A-1] *ETB Monitoring Services in Support of Non-Radiological Liquid Effluent Monitoring Program at CRL* (CY 2011), EnvP-11-008, 2011 February, 22973179

[A-2] Environmental Monitoring *Program Review Meeting Minutes,* 2019, 2020 , ENVP-509200-025-000, 2020 Feb, 51759166

[A-3] *The Development Document for the Effluent Monitoring Regulation for the Electric Power Generation Sector,* MISA, 1990.

[A-4] 2024 *Environmental Risk Assessment of Chalk River Laboratories,* 2025 January. ENVP-509220-REPT-006396, 69264691

[A-5] *MISA Liquid Effluent Monitoring at CRL: Summary of Monitoring Results for the Period* 1990 June to 1991 May, RC-809 1992 March. 14601444

[A-6] *Environmental Risk Assessment of Chalk River Laboratories* – 2018, 2019 January.ENVP-509220-REPT-003. 42077960

[A-7] Environmental Monitoring Schedule for CRL, 2025 March. CRL-509200-062-000-0002, Ren 26., 50224140

[A-8] *CRL Groundwater Monitoring Program Annual Report for* 2010, 2012 March 22.3611-01612-REPT-009. 22267021

[A-9] SRC *Acceptance of the Annual program Report - Non-Radiological Effluent Monitoring in* 2005 at Chalk River Laboratories, SRCM-62-059, 2006 August 2. 14549259

[A-10] *CRL Annual Safety Review for* 2010, 2011 April.CRL-509243-ASR-2010. 20152020

[A-11] Environmental Monitoring Program Review Meeting Minutes 2022, 2023 March, ENVP-509200-025-000, 60256724

[A-12] *Non-radiological Liquid Effluent Monitoring at CRL: Summary of the Monitoring Results for the Period* 1991 May to 1992 December, RC-1086, 1993 September. 40793178

[A-13] *Non-Radiological Monitoring for Second Half of* 1999, 1999 June 21. EP-C99-032.

[A-14] *CRL Waste Management Areas Operational Control Monitoring Program Annual Report for* 2004, 2006 January, 3611-01612-REPT-002, 22749197

[A-15] C*hanges to the Non-Radiological Monitoring Program for* 2008, EnvP-08-020, 2008 February 21, 24052029

[A-16] Memo: *Changes to the Environmental Monitoring Program Schedule for the 2023 Monitoring Year,* ENVP-23-014., ENVP-509200-021-000, 2023 February, 59556413

Appendix B Chalk River Laboratories Maps

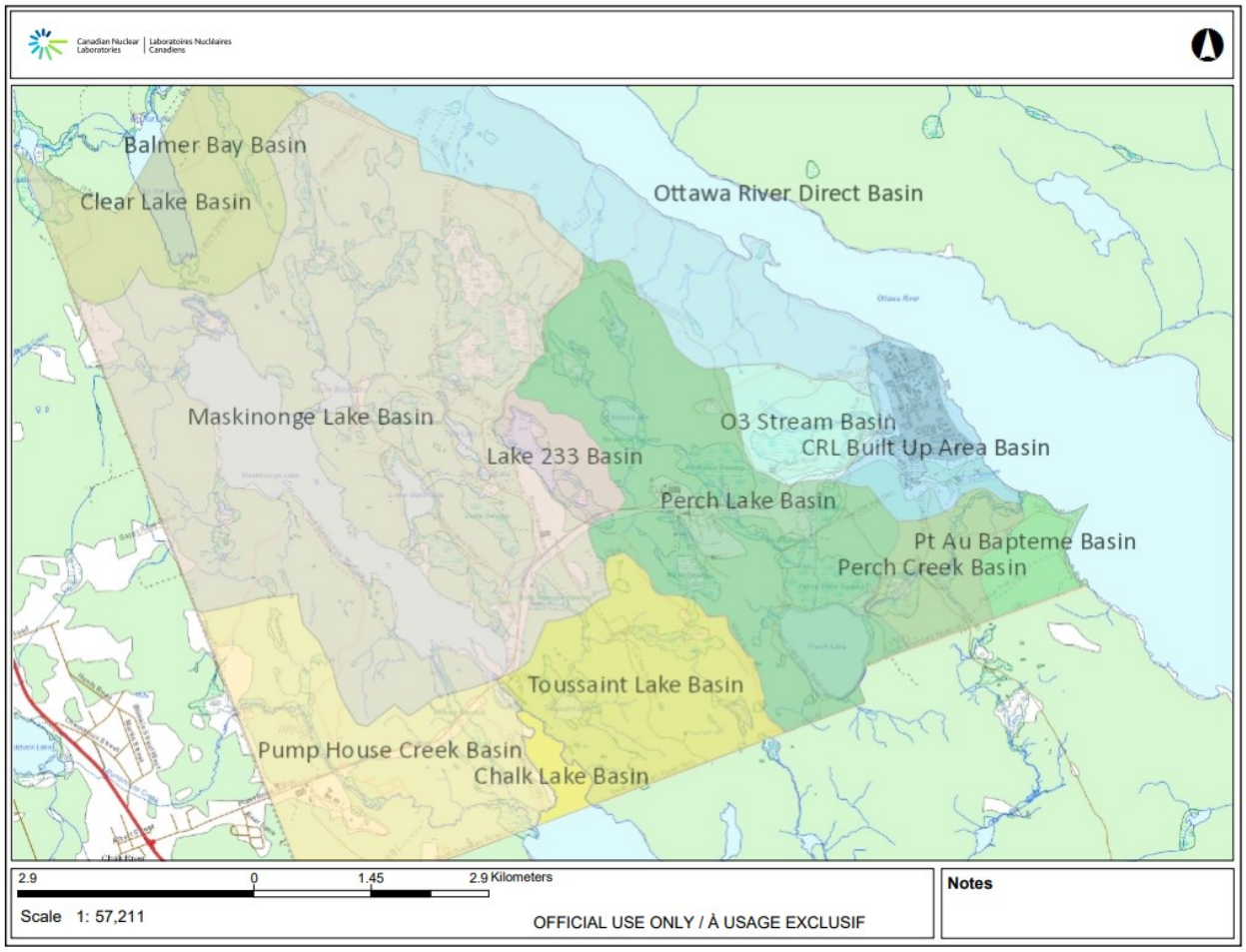


Figure B-1: Drainage Sub-Basins at the CRL Site

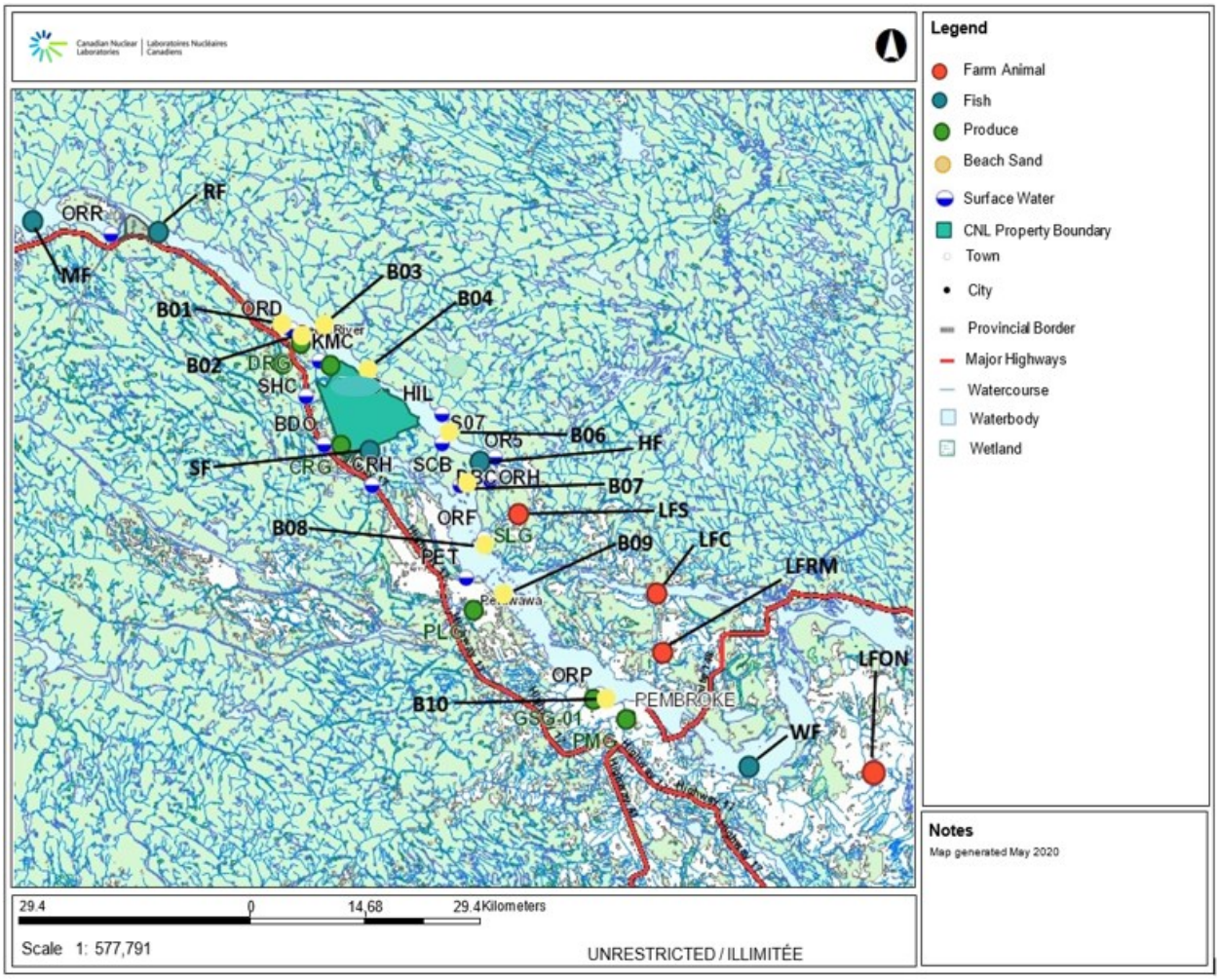


Figure B-2: Radioactive liquid and biological environmental monitoring locations – outside CRL Boundary

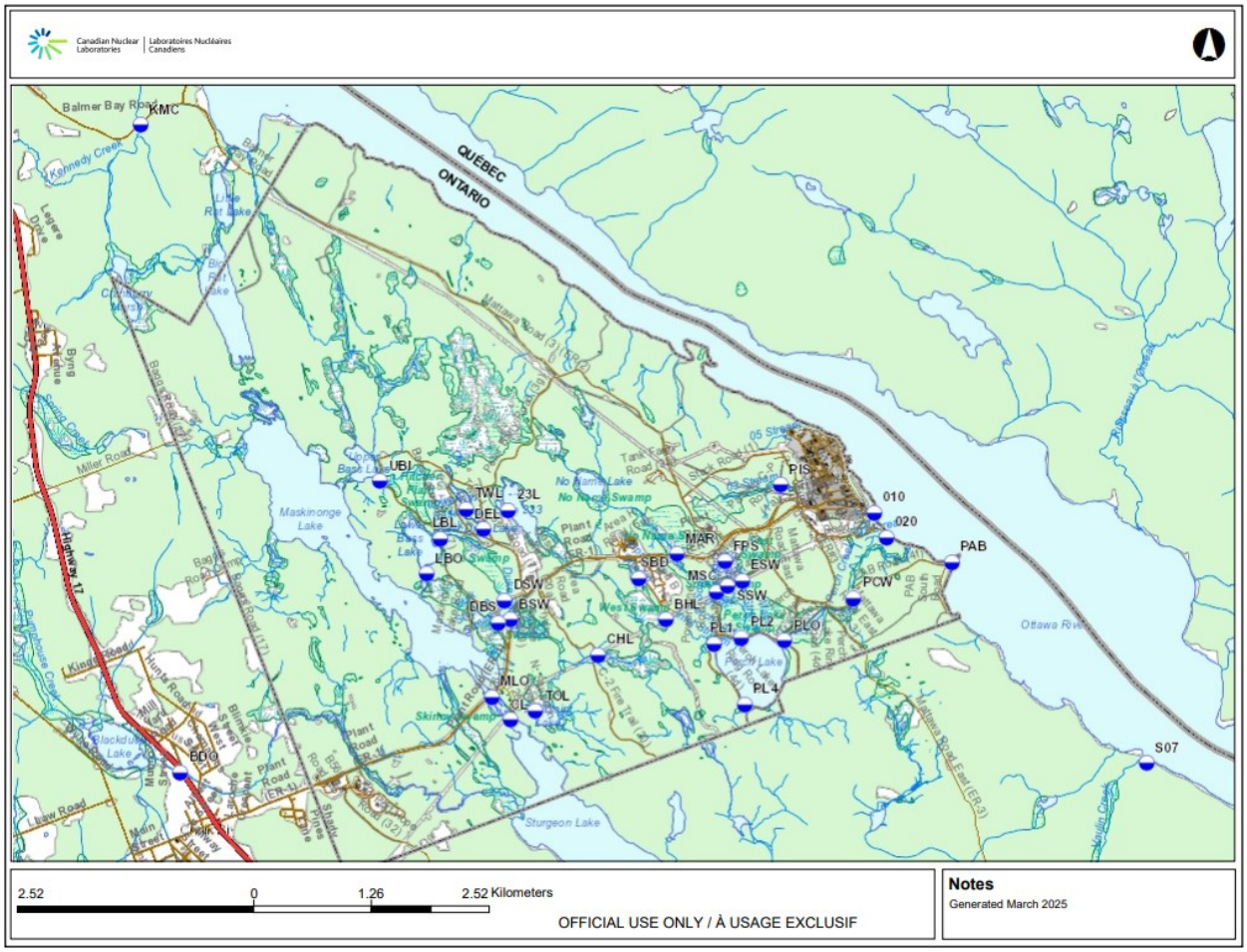


Figure B-3: Environmental surface water monitoring locations – CRL site and Boundary

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Public Information Program for Canadian Nuclear Laboratories

CW-513430-REPT-001

Revision 10.0

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Revision History

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1. INTRODUCTION

As Canada's premier nuclear science and technology laboratory, Canadian Nuclear Laboratories (CNL) is a world leader in the development of innovative nuclear science and technology products and services. Guided by an ambitious corporate strategy known as Vision 2030, CNL works under the direction of Atomic Energy of Canada Limited (AECL), a federal Crown corporation, to fulfil three strategic priorities of national importance – restoring and protecting the environment, advancing clean energy technologies, and contributing to the health of Canadians.

By leveraging the assets owned by AECL, CNL also serves as the nexus between government, the nuclear industry, the broader private sector, and the academic community. CNL works in collaboration with these sectors to advance innovative Canadian products and services towards real-world use, including carbon-free energy, cancer treatments and other therapies, non-proliferation nuclear technologies and waste management solutions.

1.1 Land Acknowledgement

CNL operates on sites located on the traditional lands, waterways and ceded and unceded territories of Indigenous peoples. CNL recognizes and affirms all First Nations, Métis communities, and Inuit in this land we now know as Canada. We acknowledge, respect, and seek to better understand Indigenous history, rights, and title on the lands where we work and develop projects. At CNL we wish to honour and respect the importance of the relationship between Indigenous peoples and their lands, waters, and territories.

1.2 Commitment to Truth and Reconciliation

In alignment with the Truth and Reconciliation Commission Call to Action #92 Business and Reconciliation [4], CNL is committed to advancing truth and reconciliation through meaningful actions. CNL continues to enhance its corporate Indigenous relations program, in collaboration with Indigenous Nations, communities and organizations, through the development of a formal reconciliation action plan, and the establishment of an Indigenous procurement policy. All communications, plans and reporting are reviewed to ensure balanced language and acknowledgement of Indigenous rights and Indigenous knowledge, CNL strives to integrate this into all CNL activities.

1.3 CNL Sites

CNL manages and operates the following sites owned by AECL under a Government-owned, Contractor-operated or "GoCo" model.

1.3.1 Chalk River Laboratories (CRL)

The largest of CNL's sites, Chalk River Laboratories (CRL), is in Renfrew County in the province of Ontario, on the southern shore of the Ottawa River, approximately 200 km northwest of Ottawa. Established in 1944 as Atomic Energy of Canada Limited, the site is approximately 3,700 hectares (ha) (9,100 acres). The Ottawa River forms the eastern boundary of the site.

Abutting the CRL property to the southeast is Canadian military base Garrison Petawawa. The Town of Laurentian Hills lies to the southwest of the site and the Town of Deep River to the northwest.

As one of the region's largest employers, CRL retains more than 3,500 administrative, trades, technical, engineering and scientific staff. While most employees work at the Chalk River site, some staff work in the Town of Deep River where there are two offices, remotely from home offices, or a hybrid of on-site and remote.

The Chalk River site houses over 100 unique laboratories or facilities dedicated to the delivery of nuclear science and technology. There is also a significant effort underway to address historic nuclear liabilities through environmental remediation, decommissioning of aging/redundant facilities, and management of historic wastes, and to revitalize and renew the campus through capital investment in buildings and infrastructure.

CNL operates the CRL site in accordance with Canadian Nuclear Safety Commission (CNSC) Nuclear Research and Test Establishment Operating Licence (NRTEOL-01.01/2028). The current licence expires 2028 March 31.

On 2024 January 9 the Canadian Nuclear Safety Commission announced its decision to amend CNL's nuclear research and test establishment operating licence for CRL to authorize the construction of a near surface disposal facility. The amended nuclear research and test establishment operating licence remains valid until 2028 March 31.

1.3.2 Whiteshell Laboratories (WL)

The second largest of CNL's sites, Whiteshell Laboratories (WL), is located near the Local Government District of Pinawa in the province of Manitoba. The main part of the site is located on the east bank of the Winnipeg River, approximately 100 km northeast of Winnipeg. WL, a Class 1B nuclear facility, was established in the early 1960s and covers an area of about 4,375 hectares (ha) (10,800 acres). CNL is currently decommissioning and remediating the site.

WL retains approximately 350 administrative, trades, technical and scientific staff.

CNL operates the WL Closure Project in accordance with CNSC Nuclear Research and Test Establishment Decommissioning Licence (NRTEDL-W5-8.00/2024). The current licence expires 2024 December 31.

1.3.3 Decommissioning Sites

On behalf of AECL, CNL manages Canada's nuclear legacy liabilities at various sites across Canada. These nuclear legacy liabilities are the result of more than 60 years of nuclear research and development conducted by the National Research Council of Canada and AECL on behalf of the Government of Canada. The liabilities consist of outdated and unused research facilities and buildings, buried, and stored radioactive waste, and affected lands.

Since 1952, AECL/CNL has safely, and cost effectively managed Canada's nuclear research facilities and the waste generated by their operation. During this time, CNL improved waste management technologies and developed expertise in best practices.

Continued decommissioning and waste management activities will occur at the Chalk River Laboratories and the Whiteshell Laboratories. CNL also operates other sites across Canada that fall under the CNL Public Information Program (PIP); these are outlined below.

1.3.4 Prototype Reactor Sites (Waste Facilities)

CNL is the licence holder for three permanently shut down prototype CANDU® (CANada Deuterium Uranium) power reactors: NPD Waste Facility (NPD WF), Douglas Point Waste Facility (DP WF) and Gentilly-1 Waste Facility (G1WF). Each facility consists of a permanently shut down, partially decommissioned demonstration CANDU® reactor and associated structures and ancillaries.

1.3.4.1 Nuclear Power Demonstration Waste Facility (NPD WF)

NPD WF is located in the Town of Laurentian Hills, Renfrew County, Ontario, and is now an active site closure project. NPD was the first Canadian nuclear power reactor and the prototype for the CANDU® reactor design. NPD made history in 1962 when it generated electricity from nuclear power for the first time in Canada from a single 20 MWe pressurized heavy water reactor in what was then known as Rolphton, Ontario. The NPD reactor was the prototype and proving ground for research and development that led to commercial application of the CANDU® system for generating electric power from a nuclear plant using natural uranium fuel, heavy water moderator and coolant in a pressure tube configuration with on-power refuelling.

For 25 years NPD produced sustainable, clean energy and operated as a training centre for nuclear operators and engineers from Canada and around the world.

The NPD site is currently managed under a Waste Facility Decommissioning Licence (WFDL-W4-342.00/2034). Operations at NPD ended in 1987, after which the first stages of decommissioning were completed, including the removal of all nuclear fuel from the site and the draining of the systems. The site has been in a safe shutdown state for the last 30 years. CNL is currently undertaking an environmental assessment as part of the licence application to enable the full decommissioning of this facility.

1.3.4.2 Douglas Point Waste Facility (DPWF)

The Douglas Point Waste Facility is within the Bruce Power Site owned by Ontario Power Generation located on the east shore of Lake Huron in the Municipality of Kincardine, Bruce County, Ontario. The facility consists of the permanently shutdown, partially decommissioned prototype CANDU® reactor and associated structures and ancillaries.

Douglas Point was Canada's first full-scale nuclear power plant, with a 200-megawatt (MW) prototype CANDU® reactor. It was known as the Douglas Point Nuclear Generating Station (DPNGS) and was a joint project between AECL as owner, and Ontario Hydro (currently Ontario Power Generation) as operator.

The reactor ran from 1968 to 1984 when it was permanently shut down, having achieved its prototype objectives. By 1986, the fuel had been removed and reactor coolant drained in accordance with regulatory requirements. The fuel was transferred to onsite dry storage by the

end of 1987 and, since then, the facility has been in a safe shutdown state referred to as "Storage with Surveillance."

The Douglas Point site is currently managed under a Waste Facility Decommissioning Licence (WFDL-W4-332.03/2030). CNL is transitioning the facility, now known as the Douglas Point Waste Facility (DP WF) to the next phase of decommissioning. On March 15, 2021, the Canadian Nuclear Safety Commission announced its decision to amend the waste facility decommissioning licence for the DP WF to allow CNL to begin Phase 3 decommissioning activities, including the decommissioning and dismantlement of certain facilities and structures at the facility.

1.3.4.3 G-1 Waste Facility (G1WF)

The G-1 Waste Facility is on the Hydro-Quebec (HQ) site adjacent to the Gentilly-2 Nuclear Generating Station in Bécancour in the province of Quebec and is located on the St. Lawrence River between Montreal and Quebec City. The Gentilly-1 (G-1) prototype CANDU Boiling Water Reactor has been shut down for more than 40 years and is in a safe shutdown state: the reactor is not operating; the fuel has been removed from the facility and is being left in place to allow for radioactivity decay prior to shipment to CRL.

The Gentilly-1 site is currently managed under a Waste Facility Decommissioning Licence (WFDL-W4-331.00/2034). Maintenance activities are conducted on a regular basis to ensure the safety of the facility, the community, and the environment. The current schedule includes plans to secure the regulatory approvals required to permit full decommissioning of the site by 2060.

1.3.5 Former Heavy Water Plant Site

CNL manages the La Prade Heavy Water Plant Site in Bécancour, Québec. The site is not an active heavy water plant; however, heavy water (tritiated and virgin) is stored on the site, which is operated in accordance with the CNSC Nuclear Substance and Radiation Devices Licence 15193-4-26.2. The current licence expires 2026 September 30.

1.3.6 Port Hope Area Initiative (PHAI)

The Port Hope Area Initiative (PHAI) includes the planned cleanup of approximately 1,200 residential properties and involves tailored one-on-one communications with individual residents. As such, communications and engagement are covered by the *Port Hope Area Initiative Public Information Program*, which is executed in alignment with this CNL Public Information Program.

1.4 Scope

This document describes CNL's *Public Information Program* (PIP) and covers activities of public interest that occur at CNL. It has been prepared in accordance with the CNSC Regulatory Document REGDOC-3.2.1, *Public Information and Disclosure*. As noted above, the PHAI project has a separate public information program tailored to the specific needs of the communities in which the project is being implemented.

In the context of Environmental Assessments or Impact Assessments related to major projects and licencing activities, additional outreach may be undertaken that spans a larger geographic area than outlined in the PIP and may include additional Indigenous Nations, communities and organizations, municipalities and interest groups. For more information, please refer to the project-specific reporting in the Annual Compliance and Monitoring Reports or Indigenous Engagement Reports as relevant.

1.5 Regulatory Requirements and Guidance

The following sections describe how the Public Information Program meets regulatory requirements. Each section notes methods used for information dissemination; how information will address information needs related to the anticipated effects of CNL's operations; and how interactions will be tracked.

All parts of this program apply to each CNL site. However, strategies and tactics are customized to the target audiences at each CNL site.

The requirements for public information programs and disclosure protocols are derived from the stated objectives of the CNSC in the *Nuclear Safety and Control Act* (NSCA) (S.C. 1997, c.9) and associated regulations. The relevant provisions are as follows:

- Paragraph 3(j) of the *Class I Nuclear Facilities Regulations* (SOR/2000-204): "…the proposed program to inform persons living in the vicinity of the site of the general nature and characteristics of the anticipated effects on the environment and the health and safety of persons that may result from the activity to be licensed."
- Paragraph 3(r) of the *Class II Nuclear Facilities and Prescribed Equipment Regulations* (SOR/2000-205): "…the program to inform persons living in the vicinity of the site of the general nature and characteristics of the anticipated effects on the environment and the health and safety of persons that may result from the nuclear facility."

Additional regulations and guidance on public information programs are given in CNSC REGDOC-3.2.1, *Public Information and Disclosure*.

The Public Information Program outlines the ways in which the public receives communication from CNL, including the public disclosure protocol regarding events and developments involving facilities and activities. These specific elements include:

- Publication of documents describing the radiological and environmental impacts of CNL sites;
- Interactions with local communities and Indigenous Nations, communities and organizations to convey the specified information; and
- Publication of the results of CNL's monitoring programs on CNL's external website.

While CNL's Public Information Program is comprehensive, opportunities for improvement are continually considered. Public feedback is considered and addressed, and the program is modified when appropriate. In all instances, accessibility to timely information on CNL and its operations is maintained.

The discussion in the following sub-sections demonstrates CNL's compliance with CNSC REGDOC-3.2.1, *Public Information and Disclosure*.

2. PUBLIC INFORMATION PROGRAM

2.1 Purpose

CNL is committed to organizational transparency, ensuring that Indigenous peoples, the general public, local communities, elected and appointed government officials and industry members are properly informed about activities carried out at CNL sites.

This commitment is met through the company's Public Information Program (PIP), a communications program that was developed to build public awareness and trust, encourage transparent and proactive communication with interested parties, and ensure compliance with CNSC Regulatory Document REGDOC-3.2.1: Public Information and Disclosure, though sharing information related to routine activities, radiological and non-radiological emissions, and non-routine items or events at the different sites managed by CNL.

2.2 Objectives

The objectives of the program are to:

- Continue to sustain open and transparent communication about CNL's plans, activities and performance, and of any resulting related health or environmental risks by:
    - Creating opportunities to engage in transparent and proactive two-way dialogue with Indigenous peoples, community members and the general public.
    - Informing the public and Indigenous Nations, communities and organizations about events that have offsite effects or which may raise concern.
    - Positioning CNL as the source of accurate, timely information about its projects and activities.
- Raise public awareness, understanding and a supportive appreciation of CNL's value and relevance to Canadians by:
    - Demonstrating the positive impact of CNL on the community and the nation.
    - Nurturing existing and foster new relationships to advance CNL objectives.
- Provide an opportunity for community input to further enhance the effectiveness of the public information program.
- Meet regulatory requirements for a public information program.

2.3 Target Audiences

For the purpose of the PIP, CNL continues to focus primarily on the communities neighbouring CNL sites concentrated within a 50-kilometer radius of our operations. CNL routinely widens its communications to include interest groups in the S&T and academic communities, youth and

education sectors, industry supply chain, and with others who have identified themselves as interested members of the public outside our standard catchment area.

2.3.1 Chalk River Laboratories

CNL specifically communicates with:

- CNL staff and CRL-based CNL employee unions
- Laurentian Hills-Deep River Nuclear Emergency Preparedness Committee
- Indigenous Nations, communities, and organizations:
    - Algonquins of Pikwàkanagàn First Nation (AOPFN)
    - Métis Nation of Ontario (MNO)
    - Kitigan Zibi Anishinabeg First Nation
    - Kebaowek First Nation
    - Williams Treaties First Nations
        - Alderville First Nation
        - Beausoleil First Nation
        - Georgina Island First Nation
        - Rama First Nation
        - Curve Lake First Nation
        - Hiawatha First Nation
        - Scugog Island First Nation
    - Anishinabek Nation
    - Algonquins of Barriere Lake First Nation
    - Temiskaming First Nation
    - Wolf Lake First Nation
    - Algonquin Nation Secretariat
    - Algonquin Anishinabeg Nation Tribal Council
- Algonquins of Ontario
- Universities and academia
- Nuclear industry and supply chain
- Public interest groups and environmentally focused organizations and agencies (e.g., Concerned Citizens of Renfrew County, Ottawa Riverkeeper, Ducks Unlimited)
- Local government officials and related committees:

- County of Renfrew
- Pontiac Regional County Municipality (MRC Pontiac)
- Town of Deep River
- Town of Laurentian Hills
- Town of Petawawa
- City of Pembroke
- Member of Parliament for Renfrew - Nipissing – Pembroke
- Member of Provincial Parliament for Renfrew - Nipissing – Pembroke
- Member of Parliament for Pontiac
- Local business partners (e.g., Upper Ottawa Valley Chamber of Commerce, Garrison Petawawa, etc.); and,
- The Environmental Stewardship Council (see Section 2.4.7), and Community Advisory Panel (see Section 2.4.8)

Refer to Appendix A for a map of CRL's primary audience located within a 50-kilometre radius of the Chalk River Laboratories. For practical purposes CNL maintains sharing of information with both regional municipalities of Renfrew and Pontiac Counties and as noted, CNL expands communication activities as necessary.

2.3.2 Whiteshell Laboratories (WL)

CNL specifically communicates with:

- WL-based CNL employee unions
- Indigenous Nations, communities, and organizations:
  - Sagkeeng First Nation
  - Black River First Nation
  - Hollow Water First Nation
  - Manitoba Métis Federation
  - Brokenhead Ojibway Nation
  - Wabaseemoong Independent Nations
  - Grand Council of Treaty 3
- Public Liaison Committee (see section 2.4.9)
- Local business partners (e.g., Pinawa Chamber of Commerce and Lac du Bonnet and District Chamber of Commerce)
- Local government officials/committees:

- Local Government District (LGD) of Pinawa
- Town of Lac du Bonnet
- Rural Municipality of Lac du Bonnet
- Community of Whitemouth
- Town of Beausejour
- Town of Powerview Pine Falls
- Rural Municipality of Alexander
- Member of Parliament for Selkirk-Interlake-Eastman
- Member of Parliament for Provencher
- Member of Parliament for Churchill - Keewatinook Aski
- Member of Legislative Assembly for Lac du Bonnet
- Environmental Groups & Organizations (ENGOs) and citizens groups (eg. Concerned Citizens of Manitoba, Whiteshell Cottagers Association, Manitoba Cottagers Association, Eastman tourism
- Whiteshell Community Regeneration Partnership

Refer to Appendix B for a map of WL's primary audience located within a 50-kilometre radius of the WL site. For practical purposes CNL maintains sharing of information with regional municipalities and as noted, expands communication activities as necessary.

2.3.3 Prototype Reactors

As work proceeds with proposed decommissioning plans for the prototype reactor sites, the target audiences for these projects continue to be developed. Additional details are provided in the following subsections.

2.3.3.1 NPD Closure Project

See Section 2.3.1 Chalk River.

2.3.3.2 Douglas Point

CNL specifically communicates with:

- CNL employees and employee unions
- Bruce County Residents
- Public interest groups
- Local Government officials/committees:
    - Municipality of Kincardine
    - Town of Saugeen Shores

- County of Bruce

- Indigenous Nations, communities and organizations:
  - Saugeen Ojibway Nation (Chippewas of the Saugeen First Nation and Chippewas of Nawash Unceded First Nation)
  - Historic Métis of the Saugeen (HSM)
  - Métis Nation of Ontario (MNO)
  - Chippewas of Kettle and Stony Point First Nation

Refer to Appendix C for a map of Douglas Point's primary audience, which is reflective of Bruce Power's target audience. For practical purposes, CNL maintains sharing of information with regional municipalities and as noted, expands communication activities as necessary.

2.3.3.3 Gentilly-1

CNL specifically communicates with:

- CNL employees and employee unions
- Public interest groups and environmentally focused organizations and agencies (e.g. Société du parc industriel et portuaire de Bécancour, Chambre de commerce et d'industrie du Cœur-du-Québec).
- Local Government officials/committees, and residents in the following areas:
  - Bécancour-Nicolet-Saurel, Saint-Maurice-Champlain
  - Bécancour
  - Trois-Rivières
  - Gentilly District
  - Member of National Assembly for Nicolet-Bécancour
  - Member of Parliament for Bécancour-Nicolet-Saurel
  - Member of Parliament for Saint-Maurice-Champlain
  - Member of National Assembly for Trois-Rivières
  - Minister responsible for the Centre-du-Québec region
- Indigenous Nations, communities and organizations:
  - Huron-Wendat Nation
  - Abenaki Band of Odanak
  - Abenaki Band of Wôlinak
  - W8banaki (formerly Grand Conseil de la Nation Waban-Aki)

Refer to Appendix D for a map of G-1's primary audience, which is reflective of Hydro Quebec's target audience. For practical purposes, CNL maintains sharing of information with regional municipalities and as noted, expands communication activities as necessary.

2.4 Audience Characterization

2.4.1 Employees

As ambassadors for the company, it is critical that CNL employees be kept fully apprised of CNL's business on an ongoing basis so they can also share information with their community contacts and professional networks in an informed and timely way. The tactics used to keep employees apprised include:

- Information updates via the President & CEO, and the Executive Committee
- Ongoing all-union/management meetings and Site Safety and Health Committee meetings
- Employee All Staff engagements
- Employee bulletins via the internal intranet and staff email
- Monthly employee newsletter, Voyageur
- Surveys to gauge employee awareness and measure messaging effectiveness
- New Employee Orientation program and tours for new employees
- Onsite electronic messaging boards for important safety messages (site specific)
- Onsite events and features activities (e.g. Safety Pause, Health & Wellness Fair, Building Openings)

2.4.2 Alumni

Former employees of CNL and AECL are both our strongest supporters and sometimes our toughest critics. Furthermore, they have a keen interest in the nuclear industry and in the operations of CNL sites, programs and projects. The Alumni Network was set up in 2011 as a simple email subscription service. Alumni receive a monthly package that includes electronic copies of the employee newsletter, Voyageur, as well as updates on key topics of interest and milestone accomplishments, invitations to events, and opportunities to provide feedback.

2.4.3 Elected Officials

Elected officials at the federal, provincial, county and municipal levels are notified of CNL activities through email and/or phone to ensure timely distribution of information. It is important that their awareness level be maintained so their offices can triage and quickly provide CNL with any concerns identified by their constituents. Tactics for the sharing information with elected officials include:

- Meetings and updates that promote information sharing and provide opportunities for officials to voice their opinions/concerns
- Topic-specific briefings
- Site tours
- Provision of reports, news releases and information related to daily operations, unplanned events and licensing activities
- Annual updates given to Regional Councils on CNL activities
- Invitations to join CNL at milestone events and project updates

2.4.4 Indigenous Peoples

CNL recognizes that the many Indigenous Nations, communities, and organizations with whom we engage have unique needs, resources and interests. The communications with these communities and nations reflect these unique needs and follow agreed-to protocols for information sharing as determined by each community.

Information sharing with Indigenous Nations, communities and organizations may include:

- Presenting information in a format that is easily understood through a variety of communications channels using targeted key messaging.
- Engaging technical experts to communicate information in various formats.
- Accomplishing all required activities in a timely manner; and
- Providing various means for Indigenous Nations, communities, and organizations to access information.

CNL proactively provides information regarding business activities and environmental remediation management projects. Notification is done through email, letter, community, and face-to-face meetings to ensure appropriate distribution of information.

Representatives of the Algonquins of Pikwakanagan First Nation, the Métis Nation of Ontario, and the Kitigan Zibi Anishinabeg First Nation are included in Chalk River Laboratories' Environmental Stewardship Council. Additionally, a representative of the Algonquins of Pikwakanagan First Nation participates in CNL's Community Advisory Panel.

CNL also engages Indigenous Nations, communities, and organizations in support of the Environment Assessment process, per CNSC REGDOC-3.2.2, *Indigenous Engagement*.

2.4.5 General Public

social media, our toll-free line, and through involvement in community events. Communications initiatives include:

- Manage the delivery of the Environmental Stewardship Council (CRL) or Public Liaison Committee (WL) by municipal officials;

- Community meetings and webinars where information on site operations, projects etc., is provided and opportunities to ask questions are encouraged;
- Evaluation of communications efforts, including web analytics and stakeholder feedback review;
- Opinion polling or similar community survey (no less than once every 5 years) to gauge community concerns;
- CNL's Nuclear Education and Outreach Program to school and youth;
- Maintenance of and timely updates to www.CNL.ca;
- Sponsorship and participation in industry events and conferences;
- Execution of tours and visits to the various site for interest groups, school, organizations; and,
- Distribution of a bilingual newsletter CONTACT and Kids CONTACT to residences and businesses in communities surrounding the Chalk River and Whiteshell Laboratories. The newsletter is also posted on CNL's external website.
- Sharing of information through CNL's social media pages; and
- Annual Community Update webinar.

Through participation in local events, fairs, tradeshows etc. CNL is recognized as a strong community partner and is actively involved in a wide range of local events and fundraising initiatives.

2.4.6 Public Interest Groups and Environmentally Focused Organizations and Agencies

CNL continues to proactively provide information to public interest groups and environmentally focused organizations and agencies. Operational announcements and unplanned events are shared; notification is predominantly done through email and via www.CNL.ca. Information on projects that seek public input is provided with letters of advance notification of community meeting dates, venues and times.

As noted previously, CNL respects that members of various agencies outside of the immediate area are also interested in CNL's operations. Where appropriate, a nomination will be facilitated for participation on the Environmental Stewardship Council or Public Liaison Committee.

2.4.7 Environmental Stewardship Council at CRL

To provide Indigenous peoples and the public opportunities for dialogue and feedback, CNL established the Environmental Stewardship Council (ESC) in 2006. The ESC is independently facilitated and comprised of members of public interest groups, Indigenous peoples, and members designated by local councils and representatives from CNL. The council openly discusses a broad range of matters of mutual interest to both CNL and the community, to seek

input for solutions to remediate and/or continually improve CNL's environmental performance and provides ongoing and consistent two-way interactions with interested parties on CNL's business (not just environmental issues). The ESC meets three times a year. Membership, meeting notes and minutes are available to the public on www.cnl.ca.

A list of ESC members can be found in Appendix C.

2.4.8 Community Advisory Panel

The Chalk River Laboratories' Community Advisory Panel (CAP) objective is to bring new voices from the community into the dialogue between CNL and the Renfrew and Pontiac region. Through the CAP, CNL seeks to increase understanding, grow our appreciation of our communities' diverse perspectives, and enable members of the community to access first-hand knowledge about CNL activities. Discussions between CNL and the CAP will focus on the activities that are subject to licensing and environmental regulation as well as activities that may affect the social and economic life of the community.

The CAP consists of a diverse group of community members with varying backgrounds, most of whom are residents of Renfrew or Pontiac County.

CNL hosts regular meetings four times a calendar year. CAP meetings are facilitated by independent third-party facilitators. Meeting notes are taken at each meeting, recording all questions and actions that occurred.

Meeting notes and minutes are available to the public on www.cnl.ca.

2.4.9 Public Liaison Committee at Whiteshell

To provide Indigenous peoples and the public with opportunities for dialogue and feedback, CNL established the Public Liaison Committee (PLC) in 2003. Similarly referred to as a Community Advisory Group by nuclear utilities, the PLC is independently facilitated and comprised of members of public interest groups, members designated by local councils, and representatives from CNL. The council openly discusses a broad range of matters of mutual interest to both CNL and the community and provides ongoing and consistent two-way interactions with interested parties on the decommissioning activities of the Whiteshell Laboratories. The PLC meets two times a year.

A list of PLC members can be found in Appendix D. Information is shared with PLC members through:

2.4.10 Intervenors

CNL values the input from citizens received during regulatory processes (e.g., licensing hearings, Commission appearances, environmental assessments). In this regard, CNL undertakes to advise those intervenors (where contact information is available) of activities through:

- Personal response and an invitation to be added to the relevant projects' mailing list to receive ongoing information on CNL's operations; and,

- Invitations to community meetings that promote information sharing and provide opportunities for interested parties to voice their opinions/concerns.

2.4.11 Atomic Energy of Canada Limited

It is important that our client, Atomic Energy of Canada Limited (AECL), be kept apprised of CNL activities. Communication is ongoing and CNL engages with AECL to provide regular updates to AECL staff on the status of progress on CNL activities.

2.4.12 Canadian Nuclear Safety Commission

CNL recognizes the importance of keeping the CNSC informed on issues that may be important to the CNSC in terms of public communications. CNL is required to notify the CNSC of any public disclosures at the same time or prior to the disclosure.

The CNSC also maintains a site office located at CRL, which is staffed by full-time CNSC staff. This ongoing site presence affords CNSC staff with direct access to all site facilities and activities.

CNSC and CNL interactions are supplemented by regular meetings with regulatory, licensing, project and program staff.

2.4.13 Target Audience Development

There is an ongoing requirement to assess and grow appropriate relationships within all of the identified communities.

At sites where environmental remediation management projects are in their early stages, relationships with local elected officials and Indigenous peoples will continue to be strengthened.

The CNL Public Information Program and public disclosure protocol are proportionate with the public's perception of risk and the level of public interest in the licensed activities as outlined in CNSC REGDOC-3.2.1, *Public Information and Disclosure*.

2.5 Public and Media Opinion

Ongoing and open communications with the media is an important component of CNL's Public Information Program as the media offers a means for information dissemination to the public.

Through the PIP, CNL actively seeks to engage media to ensure access to information, and to provide a balance of information regarding CNL operations and projects. This includes media releases, direct contact, media monitoring, dedicated media visits and media participation in events as security requirements permit.

2.6 Public Information Strategy and Products

2.6.1 Dissemination of Information to the Public

Information is disseminated in a number of ways:

- CNL's corporate website: www.CNL.ca;
- Community Information Bulletins;
- Web postings and media releases;
- CONTACT newsletter (Chalk River and Whiteshell editions);
- Kids CONTACT newsletters (mailed to Port Hope, Chalk River, and Whiteshell catchments)
- Community meetings and events;
- Public engagement activities;
- Topical webinars;
- Social media (multiple platforms);
- Individual discussions by email, phone and in person;
- Visits to the project sites and laboratories;
- Paid advertisement in traditional and social media; and
- Speaking opportunities at conferences and trade events.
- CNL's corporate website, www.CNL.ca is used to post specific environmental information:
    - Reports on site environmental performance are posted quarterly in the Performance Report section of the external website; and,
    - Event Reports for all CNL sites are posted quarterly in the Event Reports section of the external website.

2.6.2 Social Media

The role of social media as a vehicle for communicating with the general public has grown substantially in recent years. Use of social media greatly enhances CNL's ability to deliver against the commitments made in the Public Information Program: regular, open and honest communications with various interested parties.

In addition, CNL endeavours to present itself as a modern, technologically advanced organization. It is expected that organizations of this nature are active participants in social media.

With respect to social media use, Corporate Communications maintains an official Canadian Nuclear Laboratories presence through the following social media tools under the following identifiers:

1. X (formally know as Twitter): CNL_LNC (www.twitter.com/CNL_LNC)
2. LinkedIn: Canadian Nuclear Laboratories (EN) Laboratoires Nucléaires Canada (FR) (https://www.linkedin.com/company/9191967)

3. YouTube: Canadian Nuclear Laboratories / Laboratoires Nucléaires Canada (www.youtube.com/c/CNLCanada)
4. Flickr: Canadian Nuclear Laboratories (https://www.flickr.com/photos/cnl_lnc)
5. Facebook: Canadian Nuclear Laboratories (http://www.facebook.com/CanadianNuclearLaboratories)
6. Instagram: canadiannuclearlaboratories (https://www.instagram.com/canadiannuclearlaboratories/)

2.6.3 Education and Outreach

Since 2008 there has been a steady increase in the outreach activities that have been occurring between CNL and the education communities.

Yearly, CNL actively participates in Take Our Kids to Work Day. Over 100 students participate annually across CNL sites. There are information sessions as well as site visits that students participate in throughout the day.

CNLinvites local high school science classes to the Chalk River Laboratories to participate in a site visit. CNL provides opportunities for two school visits per month of the academic year. CNL staff regularly participate as judges for local Science Fairs. This is further supplemented by in-class and online engagements, averaging two per month across a range of topics.

In 2021, CNL introduced a “Science Camp” targeting ages 9-12. During this week long session (offered twice annually), CNL hosts groups of 20 youth from local communities, introducing them to a range of scientific disciplines and providing them an opportunity to visit the laboratories and interact with the technical leads.

CNL routinely participates in national events such as Nuclear Science Week, International Day of Women and Girls in Science, Let’s Talk Energy Week and Science Odyssey. When requested, CNL staff will make classroom presentations about CNL and about career options. CNL continues to actively grow and develop outreach activities directly related to support Science, Technology, Engineering and Mathematics (STEM) education.

CNL supports youth in exploring careers in the skilled trades and actively participates in activities such as the Renfrew County OPTIONS Skilled Trades Fair and supports local Women in Nuclear (WiN), North American Young Generation in Nuclear (NAYGN) as well as the Canadian Nuclear Society (CNS).

2.6.4 Supply Chain

CNL seeks to maintain a healthy supply base to undertake the diverse range of work the laboratories carry out. To improve line of sight on CNL supply chain opportunities a Vendor Portal and an Indigenous Vendor Portal are maintained.

The purpose of these portals is to provide potential or current suppliers to CNL, with information about how CNL plans and carries out procurement activities for goods, services, equipment, decommissioning and

2.6.5 Gathering comments and feedback from the public

Comments and feedback are received in a number of ways. CNL receives comments and feedback through responses to CNL's active offer during in person, online and external announcements, publications, postings and events. These comments, questions and feedback are typically are related to the content as opposed to the PIP itself. These comments are delivered to CNL though:

- Emails to community email addresses
- Phone calls to the community toll free line
- Phone calls to the media line
- Emails to the media email address
- Paper letters through conventional mail
- Commentary posted to CNL's social media accounts
- Feedback forms collected following in person events
- Questions raised during community events (in person and on line)
- Letters and editorials published in news outlets
- Interventions at public hearings

Comments received are assessed through a variety of methods, both qualitative and quantitative to identify trends and areas for increased focus. They are looked at in a temporal perspective and in totality to understand whether the comments are related to a specific event/moment or reflect a broader concern.

- Email and phone contacts are monitored daily, with automated notification included to ensure a rapid response if needed. This information is logged, and assessed on an ongoing basis.
- Notes are taken at community meetings and actions are tracked as appropriate;
- Community meetings include a feedback form assessing meeting effectiveness and providing comments on improvement;
- ESC, CAP, and PLC meetings include a feedback form assessing meeting effectiveness and providing comments on improvement;
- Newspaper articles and other media reports of CNL's operational and community-based activities are compiled through the assistance of media monitoring
- Website and social media analytics are examined for trends; and
- Opinion polling, undertaken a minimum of every five years.

Table 1: Public Information Strategy and Products Table

Tactics	Products/Activities	Targeted Audiences
Online Communications • Provide information on CNL including descriptions of current and upcoming work, environmental monitoring reports, news releases and community involvement • Provide public disclosure of unplanned project events **Availability** • 24 hour a day access	• Website – www.CNL.ca • CNL Facebook account • CNL Twitter account • CNL YouTube channel • CNL LinkedIn account • CNL Instagram	All
Newsletters • Provide updates on currents projects, descriptions of upcoming work, highlights from ongoing work and community involvement **Availability** • CONTACT (3x per year) • Kids CONTACT (3x per year) • WL CONTACT published annually • Voyageur published monthly	• CRL CONTACT • Kids CONTACT • WL CONTACT • Voyageur	• CONTACT – Regional distribution to all households in surrounding area of both CRL and WL respectively. • Kids CONTACT is distributed to households in CRL, PH and WL regions • Voyageur is distributed across all CNL sites
Community Inquiries/Media Line • Provides direct line of communication • Provides follow-up for non-urgent inquiries **Availability** • 24 hour a day access to send emails/leave messages	• 1-800 Community Line • 1-800 Media Line • Email address	• Public • Media

Tactics	Products/Activities	Targeted Audiences
Presentations • Provide information on current and planned project activities, site operations and environmental programs • Provide an educational tool for schools on different areas of interest to the students **Availability** • Regularly scheduled for interested parties; upon request for others	• PowerPoint slide shows and related handouts • Information Poster Boards • Fact sheets • Interactive touch screens • Informational videos • Online webinars and live streamed sessions	• All
Site Visits • Led by Subject Matter Experts • Facilitate understanding and appreciation for complexity and importance of work at CNL and major projects • Educate about safety, environmental monitoring, and all aspects of how the site operates **Availability** • An Open House is held every five years • Two local school tours per month during school year • Additional upon request (average >40 per year)	• PowerPoint presentations • Guided tours of different facilities and projects • Interactive demonstrations	• All
Citizen Groups • Community Advisory Panel • Environmental Stewardship Council • Public Liaison Committee	• Regularly scheduled meetings in their respective areas • PowerPoint presentations and discussions • Tours of sites and areas	• Local residents • Representatives from interest groups • Representatives from Municipalities • Representatives from Indigenous Nations,

Tactics	Products/Activities	Targeted Audiences
	of interest • Question and answer periods	communities and organizations
Community Notifications • Provide notifications about activities at CNL and/or notable changes to schedules or work to residents and businesses located in close proximity to the site • Provide advance notifications of upcoming work or events that may affect the local community • Provide disclosures of unplanned events • Provide notification of public events and career opportunities **Availability** • Various	• Phone calls and emails to elected officials or community leaders • Website and social media postings • Advertising – print and/or radio	• Public • First responder organizations • Municipal staff
Information Sessions – Public • Inform community about upcoming projects and related monitoring, mitigation and health and safety measures in place to protect people and the environment • Provide updates on planned or changed project activity • Receive feedback from the public and discuss issues and areas of concern for those in proximity to the work sites **Availability**	• Informational Poster Boards • Presentations • Subject Matter Experts to discuss and answer questions • Fact sheets • Visual aids and displays • Fact sheets • Informational videos • Feedback forms	• Communities in close proximity to projects • Media • Elected Officials • Staff

Tactics	Products/Activities	Targeted Audiences
• As required to relay new information, developments and project updates to local communities and interested groups • Upon request		
Media Relations • Brief the media and leverage their reach to inform the community and broader audiences • Reinforce CNL as primary source of accurate, timely information • Demonstrate transparency by disclosing any unplanned events or occurrences **Availability** • Proactively on milestone achievements or major developments • Proactively when current events justify outreach • Upon request	• Media releases • Media engagements • Media interviews with CNL technical experts • Letters to the Editor • Provision of footage and photography • Access to site for filming, walk downs and interviews	• Media • Public • Social Media
Participation in External Events • Provide broader public with information about CNL activities, projects and health and safety measures in place to protect people and the environment • Provide opportunity for CNL staff to act as ambassadors and broaden awareness of CNL **Availability** • Annually • Upon request	**Events include:** • Local Home shows • Community Events • Educational events • Local agricultural fairs • Industry events • Career Fairs • School / In Class	• Public • Schools • Industry

Tactics	Products/Activities	Targeted Audiences
CNL Attitude Study • Gain insights into public opinion and understanding of CNL • Gather feedback on effective/ineffective communications tools, areas of interest and areas to improve	• Delivered through recommendations of external polling firm • Internal staff surveys • Undertaken every 5 years.	• Local Residents (with no ties to CNL) • Local Residents (with ties to CNL) • Staff
County Day • Intensive one day visit to the Laboratories, with the extended elected officials and community councils • Annual event	• Mix of presentations and on site tours • Provides opportunity for updates, performance reporting, and dialogue	• Elected officials and extended council members (CRL)
Annual Community Update Webinar • Live stream through dedicated page, and through social media • Mix of presentations and moderated Q&A • Heavily promoted within the local community and industry members	• Shared opportunity for AECL and CNL to address progress, performance, and plans for the future • Bilingual, a French stream is available	• Chalk River Laboratories • Industry members • Interest groups • Alumni

2.6.6 Performance Reports

2.6.6.1 Environmental Performance

Through CNL's corporate website, information is regularly posted regarding CNL's environmental impact, including results from our environmental monitoring program.

Links can be found for the following policies and documents on www.CNL.ca:

- CNL Environment Policy;
- CRL Environmental Performance Reports (updated quarterly);
- WL Environmental Performance Reports (updated annually);
- CRL Environmental Risk Assessment (updated as required);
- WL Environmental Risk Assessment (updated as required);
- Douglas Point Environmental Risk Assessment (updated as required);
- G-1 Environmental Risk Assessment (updated as required);
- Executive Summary of CRL Annual Compliance and Monitoring Report (updated annually);
- Executive Summary of WL Annual Compliance and Monitoring Report (updated annually);
- Executive Summary of NPD Annual Compliance and Monitoring Report (updated annually);
- Executive Summary of Douglas Point Annual Compliance and Monitoring Report (updated annually);
- Executive Summary of G-1 Annual Compliance and Monitoring Report (updated annually); and
- Executive Summary of Near Surface Disposal Facility Environmental Assessment Follow-up Monitoring Program Report (updated annually).

In addition, CNL has achieved the ISO 14001 Environmental Management System certification, recognized internationally as a key to guiding organizations to environmental responsibility and continual improvement.

3. PUBLIC DISCLOSURE PROTOCOL

3.1 Public Information

Event Reports

CNL provides to the public an up-to-date list of events as reported to the Canadian Nuclear Safety Commission (CNSC). The listing is updated 60 days following the end of the preceding quarter.

Details on these events are available upon request to CNL.

In addition to general information on CNL activities, CNL also has Public Disclosure priorities that differ by locations, a site summary follows.

3.2 Public Disclosure

CNL is committed to maintaining a public information program that includes public access to information related to routine radiological and non-radiological emissions, and non-routine items or events at Chalk River Laboratories, NPD, Douglas Point, G-1 and Whiteshell Laboratories. CNL manages public disclosure related to the following licences:

- Nuclear Research and Test Establishment Operating Licence (Chalk River Laboratories),
- Nuclear Research and Test Establishment Decommissioning Licence (Whiteshell Laboratories),
- The Prototype Waste Facilities – Waste Facility Decommissioning Licence for Nuclear Power Demonstration,
- The Prototype Waste Facilities – Waste Facility Decommissioning Licence for Douglas Point
- The Prototype Waste Facilities – Waste Facility Decommissioning Licence for Gentilly-1

For all sites the primary means for reporting non-routine items or events is CNL's external website, www.CNL.ca, while CNL may elect to notify key local officials and interested parties through direct contact should the event have off-site or community impacts. The reporting timeframe for disclosure items is typically within four business days; however, CNL balances between securing reliable information and ensuring the public and interested parties are kept informed.

3.2.1 Public Disclosure at Chalk River Criteria for Public Disclosure

1. The licensee shall provide the following routine emissions information to the public:
   a) airborne emissions of Nitrogen Oxides (NOx) and Sulfur Oxides (SOx), updated annually;
   b) airborne emissions of tritium, updated quarterly; and
   c) waterborne emissions of tritium, updated quarterly.

   Routine emissions information will be reported through CNL's external website, www.CNL.ca, and updated as necessary. Posting will have a one period lag to allow for processing of the samples, preparation of the information, and verification of the report.

2. The licensee shall periodically review and update the routine emissions report to reflect operational changes and feedback from interested parties.

3. The licensee shall provide information to the public regarding non-routine items or events as specified below:

   a) Exceeding an action level for any radiological emissions where it also exceeds 0.1% of the derived release limit.

   b) Loss of refrigerant as listed under the Federal Halocarbon Regulations greater than 100 kg;

   c) Other events that could have offsite effects or result in media attention including fires, earthquakes, serious vehicle or industrial accidents, non-compliant releases to the Ottawa River, and significant business developments.

   d) Quarterly updates of event reports to the public through website.

   e) Opportunities for public participation in CRL licencing activities.

4. Environmental and Performance Reporting

Note: Licence Applications

Licence renewal applications to the Commission Registrar may be posted on the external CNL website as submitted to the CNSC, at the discretion of the applicable site licence holder.

In addition to quarterly reporting and posting of “routine emissions”, noted in section one (1) above, CNL also prepares and posts an Annual Compliance Monitoring Report summarizing Effluent Verification and Environmental Monitoring for the Chalk River Laboratories.

This report reviews and summarizes the results of the Chalk River Laboratories (CRL) Environmental Monitoring Program (EMP) for a specified calendar year. CNL reports the monitoring results annually to the Canadian Nuclear Safety Commission (CNSC). The report is made available to the public.

These environmental performance reports are available via the Performance Reporting page found at www.CNL.ca.

3.2.2 Public Disclosure at Whiteshell Laboratories Criteria for Public Disclosure

1. The licensee shall provide the following routine emissions information to the public:

   a) airborne emissions, updated semi-annually;

   b) airborne emissions of NOx and SOx, updated annually.

2. The licensee shall periodically review and update the routine emissions report to reflect operational changes and feedback from interested parties.

3. The licensee shall provide information to the public regarding non-routine items or events as specified below:

a) Loss of refrigerant as listed under the Federal Halocarbon Regulations greater than 100 kg;

b) Other events that could have offsite effects or a result in media attention including fires, earthquakes, vehicle or industrial accidents, non-compliant releases to the Winnipeg River, and significant business developments.

c) Opportunities for public participation in Whiteshell Laboratories' licencing activities.

4. Environmental and Performance Reporting

Note: Licence Applications

Licence renewal applications to the Commission Secretariat may be posted on the external CNL website as submitted to the CNSC, at the discretion of the applicable site licence holder.

In addition to reporting and posting of "routine emissions", noted in section one (1) above, CNL also prepares and posts an Annual Safety Report summarizing annual performance data for the Whiteshell Laboratories.

This report reviews and summarizes the results of the Whiteshell Laboratories' annual performance and environmental data for a specified calendar year. CNL reports the monitoring results annually to the Canadian Nuclear Safety Commission (CNSC). The report can be made available to the public.

These Whiteshell Laboratories' performance reports are available via Performance Reporting page found at www.CNL.ca.

3.2.3 Public Disclosure of Prototype Reactor Sites

Criteria for Public Disclosure:

1. The licensee shall provide information to the public regarding non-routine items or events where:

   a) Loss of refrigerant as listed under the Federal Halocarbon Regulations greater than 100 kg;

   b) Other events that could have offsite effects or result in media attention including fires, earthquakes, serious vehicle or industrial accidents, non-compliant releases to the environment, and significant business developments.

   c) Opportunities for public participation in licencing activities.

   Public Disclosure for each Prototype Reactor site will be reviewed prior to starting any physical environmental remediation work.

2. Environmental and Performance Reporting

Annual Compliance Monitoring Reports are prepared for each site and summarize the present status of the Prototype Waste Facilities and notable activities conducted within these facilities for a specific calendar year. The report includes results of operations, the results of monitoring

programs, changes made to key procedures, equipment, or structures, as well as a summary of reports made pursuant to Sections 29 and 30 of the General Nuclear Safety and Control Regulations.

Executive Summaries of the Annual Compliance Monitoring Reports for the Prototype Waste Facilities sites are available via the Performance Reporting page found at www.CNL.ca.

Note: Licence Applications

Licence renewal applications to the Commission Secretariat may be posted on the external CNL website as submitted to the CNSC, at the discretion of the applicable site licence holder.

3.3 CNL Emergency Preparedness

CNL is committed to providing the safest environment for our public and employees. CNL follows the industry and Canadian comprehensive all-hazards approach to safeguard the public from any potential incidents.

In the unlikely scenario that an event does occur, CNL has plans to ensure these events are properly managed and risks to people as well as the environment are minimized. Emergency preparedness is a highly integrated process. Documentation and plans are aligned and the Emergency Operations Centre (EOC) interfaces are clearly established between CNL, the municipalities, the provinces, and the federal government. These preparations include a trained emergency operation team and subject matter experts who are on-call and ready to respond.

3.3.1 Chalk River Laboratories

The primary zone is the areas in which extensive planning and response preparations for an incident or radiological event are required. The size of each primary zone is defined by the province and the response requirement for each zone is defined by our regulators. For CRL, the primary zone, in both Ontario and Quebec, is a nine-kilometre radius from the NRU reactor, which as of 2018 March 31 is no longer an operating reactor.

3.3.2 Whiteshell Laboratories

WL is currently undergoing decommissioning. WL operates an Emergency Preparedness program committed to ensuring the safety and security of our staff and the public. WL currently utilizes a variety of emergency signals for site-wide alerting and provides public alerting through their Emergency Operations Centre processes.

4. PROGRAM EVALUATION PROCESS

The Corporate Communications group coordinates activities and interactions with CNL's interested parties and Indigenous Nations, communities and organizations.

4.1 Questions and Issus Management

For the purposes of the Public Information Program, an issue is defined as something that could positively or negatively impact on CNL's operations, credibility or reputation.

Where questions and issues arise, CNL attempts to identify the issue, determine its basis or cause, assess its implications, and, if possible, identify means to inform on the issue to the satisfaction of the concerned parties and the public. CNL endeavours to acknowledge and address questions and issues within 30 working days.

4.2 Assessment and Evaluation

The Public Information Program is not static. The identified activities are carried out with full intent. The program is reviewed regularly as it progresses and its effectiveness measured, based on public input and other factors. Revisions to the program may be required to incorporate input from the public, to adapt to changing business needs or circumstances, to accommodate new information, or in response to other factors.

4.3 Documentation

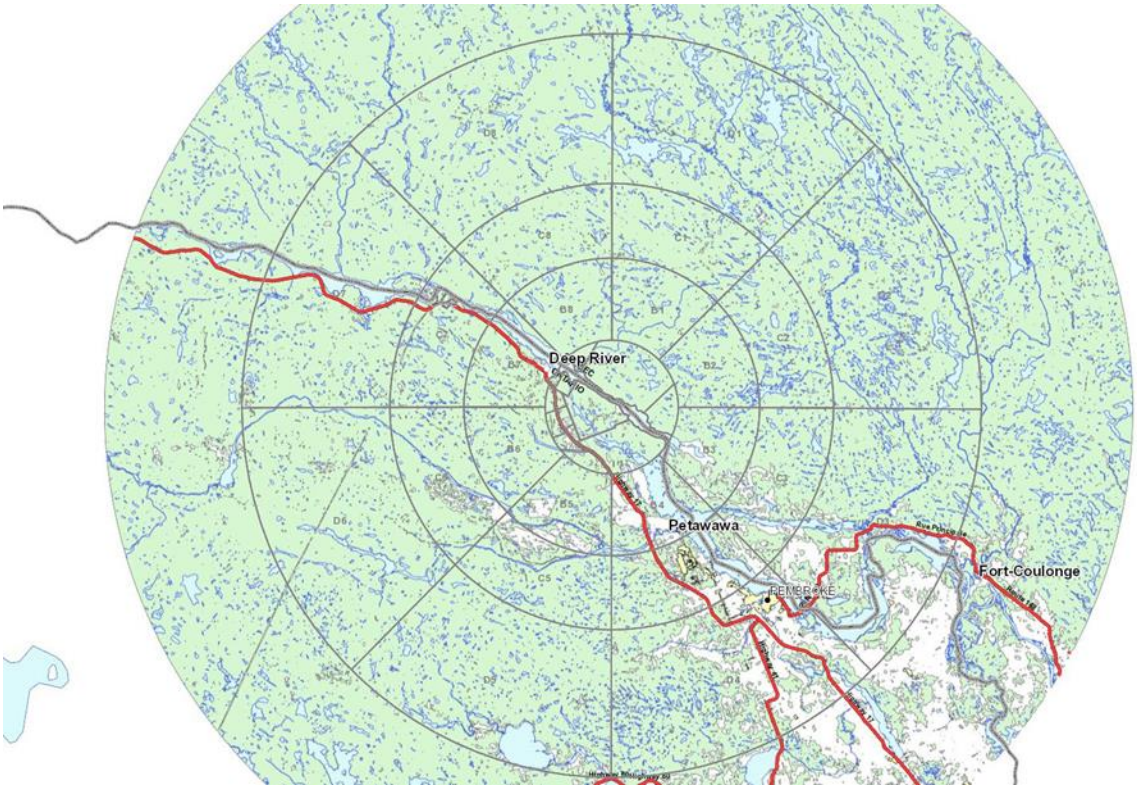
The Public Information Program is available to the public in both official languages through www.cnl.ca. While day-to-day interactions with CNL's many audiences are not stored as records, given the nature of this program, documents which provide evidence of its delivery are widely available; for example, press releases, event listings, and public disclosures are posted online; copies of newsletters are archived on www.cnl.ca; webinars are published to our YouTube channel and available for viewing on demand; records of attendance at site visits are maintained; records of attendance at major public events are stored; records of key public and Indigenous engagements are recorded.

5. CONTACT INFORMATION

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286 Plant Road
Chalk River, ON K0J 1J0 Canada

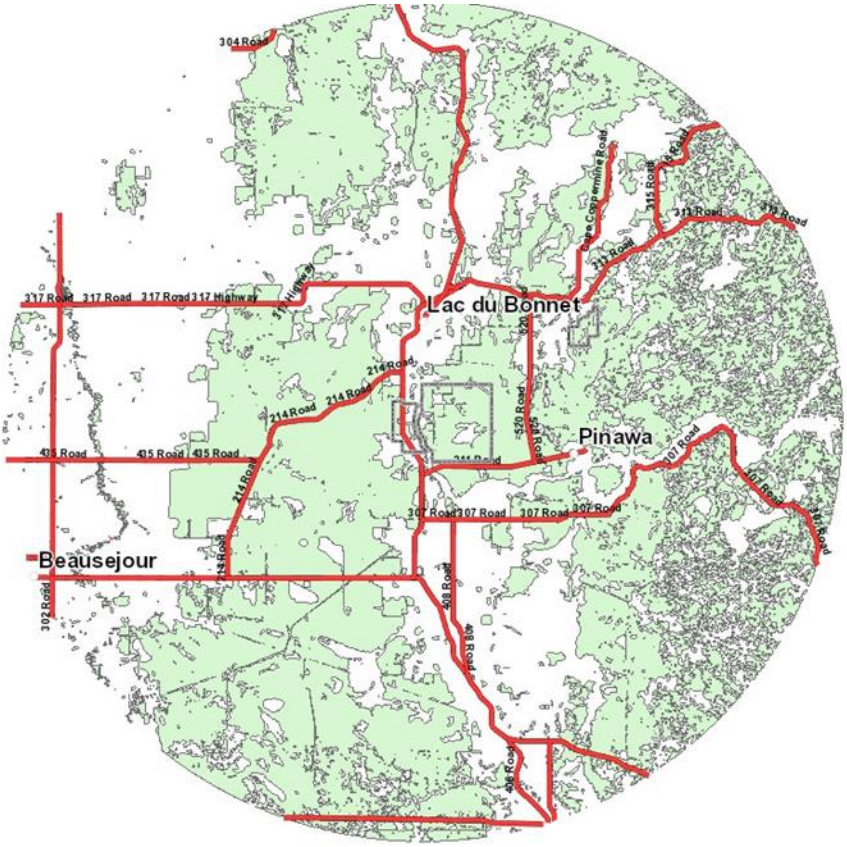
Tel.: (613) 584-8811, ask for Corporate Communications
Fax: (613) 584-8272
Toll free: (800) 364-6989
Email: communications@cnl.ca
Web: www.CNL.ca

Appendix A MAP OF CRL AND NPD'S PRIMARY AUDIENCE



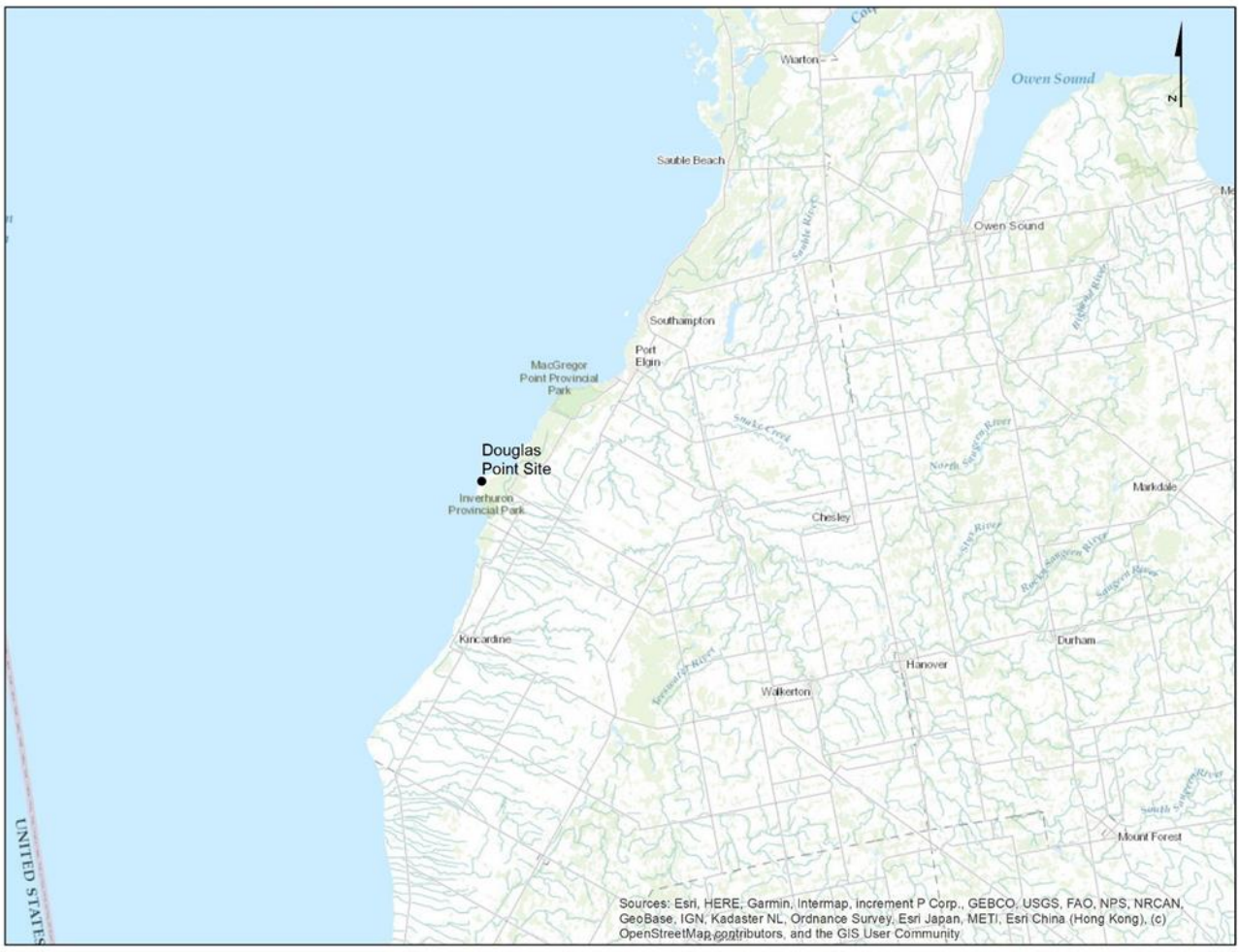
CRL and NPD's primary audience is located within a 50-kilometre radius of the Chalk River Laboratories. For practical purposes CNL maintains sharing of information with both regional municipalities of Renfrew and Pontiac Counties, and as noted previously CNL expands communication activities as necessary.

Appendix B MAP OF WL's PRIMARY AUDIENCE



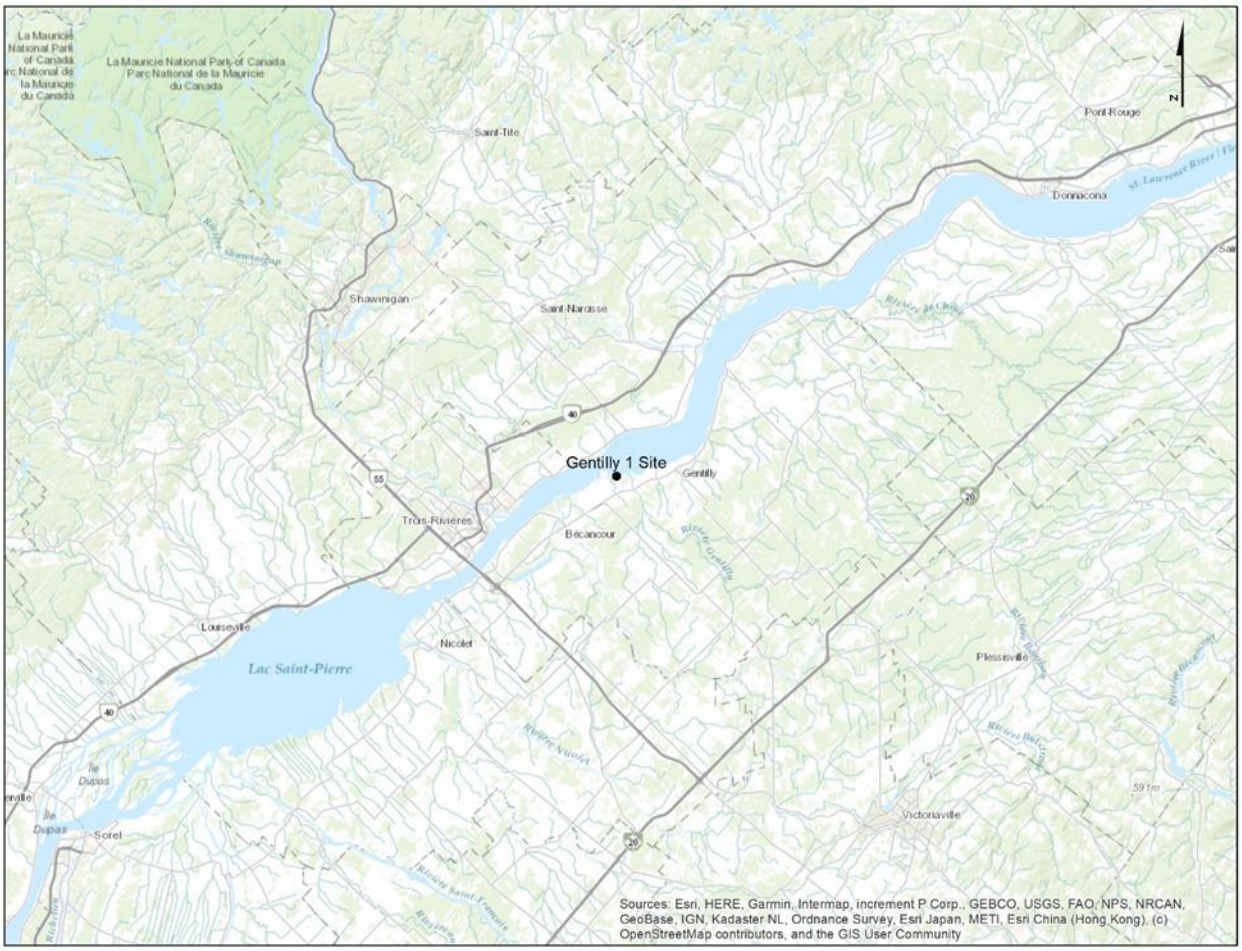
WL's primary audience is located within a 50-kilometre radius of the Whiteshell Laboratories. For practical purposes CNL maintains sharing of information with regional municipalities and as noted previously CNL expands communication activities as necessary.

Appendix C MAP OF DOUGLAS POINT PRIMARY AUDIENCE



Douglas Point's primary audience is reflective of Bruce Power's target audience. For practical purposes CNL maintains sharing of information with regional municipalities and as noted previously CNL expands communication activities as necessary.

Appendix D MAP OF G-1'S PRIMARY AUDIENCE



G-1's primary audience is reflective of Hydro Quebec's target audience, which is made up of neighboring communities of the facilities in the regions of Centre-du-Québec and Mauricie. For practical purposes CNL maintains sharing of information with regional municipalities and as noted previously CNL expands communication activities as necessary.

Appendix E LIST OF EXTERNAL ORGANIZATIONS WHO ARE MEMBERS ON THE ENVIRONMENTAL STEWARDSHIP COUNCIL AS OF 2023 OCTOBER

- Facilitator – Innovation Works
- Member – Canadian Nuclear Laboratories
- Member – City of Pembroke
- Member – Concerned Citizens of Renfrew County
- Member – Deep River Horticultural Society
- Member – Four Seasons Conservancy
- Member – Garrison Petawawa
- Member – Métis Nation of Ontario
- Member – Municipalitié régionale de Comté de Pontiac (MRC)
- Member – Old Fort William Cottagers' Association
- Member – Ottawa River Keeper
- Member – Pembroke and Area Field Naturalists
- Member – Petawawa Research Forest
- Member – Renfrew County Council
- Member – Town of Deep River
- Member – Town of Laurentian Hills
- Member – Town of Petawawa
- Member – City of Ottawa
- Observer – Algonquins of Pikwakanagan First Nation (Note: Expected to move to Member status in 2024.)
- Observer – Atomic Energy of Canada Limited (AECL)
- Observer – Canadian Nuclear Safety Commission (CNCS)

Appendix F LIST OF EXTERNAL ORGANIZATIONS WHO ARE MEMBERS ON THE PUBLIC LIAISON COMMITTEE AS OF 2020 AUGUST

- Local Government District of Pinawa
- Rural Municipality of Lac du Bonnet
- Town of Lac du Bonnet
- Town of Beausejour
- Rural Municipality of Whitemouth
- Manitoba Sustainable Development
- Rural Municipality of Brokenhead
- Rural Municipality of Alexander
- Town of Powerview – Pinefalls
- Manitoba Department of Sustainable Development
- MLA Lac du Bonnet (Observer)
- MP Selkirk (Observer)
- Sagkeeng First Nation (Observer)
- MP Provencher (Observer)
- Canadian Nuclear Safety Commission (Observer)

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Intended for Public Release

Chalk River Laboratories Overview Decommissioning and Cleanup Plan REV 2

225-508300-PLA-001

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Accepted by	Title	Date
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Effective Date: 2023/06/23

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Revision History

Rev. No.	Date	Details of Rev.	Authored By	Reviewed By	Approved By
R2	2023/05/08	Issued as "Approved For Use". Major Changes: Revised to incorporate dispositions to CNSC comments: -Executive Summary and Section 14.1 to include Total Present Value Cost of Cleanup at CRL. - Executive Summary, 3.3, 4.3.2, 4.4 (Table 1), 9.1.2 (Table 5), 9.2, 9.7.2 (Table 6), 9.7.3, 10 (Table 7), 10.2, 10.8, 10.11, Table A-3, Table A-6, Table B-2, to disposition minor comments. Once CNSC Accepts, this document replaces the *Comprehensive Preliminary Decommissioning Plan*, CPDP-508300-PDP-001 Revision 4, 2018 March, 40526618.	L. Robitaille R. Silke S. Clemow	S. Scott	G. Snell **Accepted By** A. Tisler
R1.1	2023/01/16	Issued as "Approved For Use" for CNSC acceptance Once CNSC Accepts, this document replaces the *Comprehensive Preliminary Decommissioning Plan*, CPDP-508300-PDP-001 Revision 4, 2018 March, 40526618.	L. Robitaille R. Silke S. Clemow	S. Scott	G. Snell **Accepted By** A. Tisler
R1.1D1	2023/01/12	Issued for formal "Review & Comment". Minor Revisions: Incorporated opportunities for improvement as per SRC Memo: SRC-514416-021-000, WMDS-22-022, 2022 Dec 12.	L. Robitaille R. Silke S. Clemow	S. Scott	

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Rev. No.	Date	Details of Rev.	Authored By	Reviewed By	Approved By
		Revised Section 14.1 as per recommendation from G. Snell			
R1	2022/12/12	Issued to SRC for acceptance	L. Robitaille R. Silke S. Clemow	S. Scott	G. Snell
R1D1	2022/11/10	Issued for formal "Review & Comment". Revisions: Added current status of projects and company plans; Replaced "Area of Concern" with "Area of Potential Environmental Concern"; Updated section 6 with most recent engagement activities and feedback; Updated lists for building/structure decommissioning status in Appendix A.	L. Robitaille R. Silke S. Clemow	J. McCafferty (AECL) R. Chennette C. De Waele J. Faught C. Gallagher G. Hamilton C. Igwe L. Jones M. MacKay P. Neal P. Pottelberg M. Scheer S. Scott L. Theil	
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D4	2022/04/07	Issued for formal "Review & Comment" to AECL and CRL Safety Review Committee; revised to address comments on D3 from internal consultations with SMEs	L. Robitaille R. Silke S. Clemow	J. McCafferty P. McClelland J. McKenna A. Fournier J. Carver U. Senaratne	
D3	2022/01/17	Issued for formal "Review & Comment" internally and 3rd party (Golder); revised to address comments on D2; moved detailed Management Unit content from the body of the document into Appendices, reorganized sections for readability, added in updated content from internal consultations with SMEs	L. Robitaille R. Silke S. Clemow	M. Mackay P. Pottelberg N. MacDonald G. Hamilton K. Lariviere R. Chennette G. Al Haddad J. DeWilde (Golder) P. Hurst (Golder) F. Trzebiatowski T. Hennessy P. Pentney D. Campbell C. Trudeau S. Melnyk V. Lim S. Scott S. Gamley J. Byrne D. Yuke P. Aikens M. Klukas A. Morin B. Janke S. Mistry G. Snell B. Moric L. Jones M. Scheer R. Dufour	

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Rev. No.	Date	Details of Rev.	Authored By	Reviewed By	Approved By
D2	2021/03/31	Issued for "Information" to AECL to provide support for Milestone completion; revised to address comments on D1	L. Robitaille R. Silke S. Clemow	G. Snell	
D1	2021/02/18	Issued for informal "Review & Comment". This plan was originally registered under CPDP-01600-PDP-002 and subsequently CPDP-508300-PDP-001 and underwent review and comment under those document numbers.	L. Robitaille R. Silke S. Clemow	D. Priyanto C. Gallagher T. Gorman P. Pottelberg M. Labriola A. Blanchard R. Chennette M. MacKay B. Swarbrick H. Athauda-Arachige G. Snell S. Brewer B. Janke J. Faught L. Jones G. Hamilton M. Scheer	

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Executive Summary

This Overview Decommissioning and Cleanup Plan (ODCP) provides a general summary of the proposed approach to decommissioning and environmental remediation for the Chalk River Laboratories (CRL) site. The ODCP expands upon and supersedes the previous "Comprehensive Preliminary Decommissioning Plan" (CPDP) for the site. The ODCP fulfills the requirement that the licensee shall submit an overarching Preliminary Decommissioning Plan for sites with more than one facility as stated in Canadian Nuclear Safety Commission's Regulatory Document (REGDOC) 2.11.2.

Canadian Nuclear Laboratories respectfully acknowledges that the CRL site is located on the unceded and unsurrendered territory of the Algonquin Anishnaabe Nation. CNL recognizes and appreciates their historic connection to this land, and their role as customary keepers and defenders of the Ottawa River and its tributaries. CNL recognizes the contributions that all First Nations, Métis and Inuit peoples have made, and continue to make, in shaping this land we now know as Canada. CNL management and staff acknowledge, respect and seek to better understand unique Indigenous history, rights and title on the lands where we work.

In accordance with its Public Information Program requirements as outlined in the CRL Nuclear Research and Test Establishment Operating Licence, CNL employs a variety of methods to inform, educate, and discuss the project with stakeholders and to enable the public to provide valuable feedback. The ODCP is a forward-looking document, intended to support stakeholder, Indigenous and community engagement to gather input and incorporate public and Indigenous needs and concerns into CNL's cleanup plans. To support this journey, CNL has recently formed a Community Advisory Panel comprised of members of the public who will provide ongoing input into key elements of the cleanup of the CRL site and other broader topics, as part of their mandate. In addition, an ongoing dialogue continues with local Indigenous communities and organizations regarding various issues related to the cleanup of the CRL site.

The CRL site is owned by Atomic Energy of Canada Limited (AECL), a federal Crown corporation. AECL has contracted CNL to manage and operate its sites, including the CRL site. CNL is Canada's premier nuclear science organization, and a world leader in developing technology for peaceful and innovative applications. This work has included the production of medical isotopes for the diagnosis and treatment of over one billion patients worldwide, as well as developments in clean energy that reduce greenhouse gas emissions. The revitalization of the CRL campus, which is currently underway, will allow that innovative science to continue into the future.

AECL and CNL are also committed to reporting publicly on performance against the cleanup outcomes identified in this ODCP, in support of their respective sustainability efforts.

The ODCP provides a holistic and strategic approach to cleanup in support of revitalization efforts underway at CRL which are leading to the creation of a modern campus environment dedicated to world-class research and development in nuclear science and technology. The plan gives an overview of future redevelopment opportunities created by decommissioning and removing obsolete buildings and infrastructure within the built up area of the site (i.e., the Campus Precinct area). It highlights the framework for several new facilities that will be

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required as part of CNL's commitment to growing the research conducted at CRL and outlines the environmental remediation efforts underway to reduce and effectively manage Canada's nuclear liabilities.

Canadian Nuclear Laboratories is committed to the revitalization of the site and advancement of the decommissioning, environmental remediation and waste management missions. Several elements of this revitalization effort and cleanup plan rest on the pending regulatory approval of an on-site low-level radioactive waste (LLW) disposal facility; the proposed Near Surface Disposal Facility (NSDF). In particular, the Integrated Waste Strategy, a CNL-wide guiding document about waste management across all sites, includes a contingency plan that ensures storage space for LLW at CRL until at least 2030.

Also, to mitigate the need for additional storage capability, the timing of some of the cleanup activities at CRL, including any large-scale environmental remediation efforts, may be deferred to align with the availability of LLW disposal capability at CRL, limiting risks, and costs associated with interim storage and subsequent re-handling of waste. The environmental remediation of land areas impacted by previous operations must be undertaken to allow for new development.

The ODCP highlights several additional essential enabling facilities, capabilities and factors that are required for effective cleanup of the CRL site.

The CRL site end-state has yet to be determined. CNL will take into account the most appropriate next land use for each area, recognizing that that there is no planned end date for the science and technology mission at CRL. Final end-state conditions must be approved by AECL (as the site and land owner) and the Canadian Nuclear Safety Commission (as the regulator).

Detailed decommissioning plans and remedial action plans will be developed based upon the most likely future land uses at each location, whether proposed for an industrial, parkland, or alternative land use, giving consideration to the future needs of the surrounding communities, the general site conditions and long-term site needs. Industrial, parkland, and unrestricted land use scenarios have been used in the development of CRL-specific soil screening criteria to determine the extent of soil remediation required to protect human and ecological health.

The ODCP presents an overview of decommissioning strategy and a summary of environmental conditions across the site detailed by Management Unit (MU). The MUs consist of groupings of historical waste management areas, support facilities, and experimental research installations. For each MU a description is provided which includes the following:

- Revitalization projects and proposed enabling facilities;
- Status of existing buildings/structures;
- Affected lands and brownfield areas of potential environmental concern; and,
- Where available, volume estimates of waste materials and environmental media that may require remediation, updated based on comparison of environmental characterization data with risk-based soil screening criteria.

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The overall costs to clean up the CRL site are based on the initial estimates developed in 2013 as part of the Government of Canada's former Nuclear Legacy Liabilities Program (NLLP). Since then, the cost estimates that support AECL's decommissioning, remediation and waste management liabilities are actively updated and managed and the work is outlined in the latest 10 Year Plan and Annual Program of Work and Budget, which are updated on a 3-year and annual basis, respectively. Additional remaining future work will be planned in detail as decommissioning and environmental remediation progresses. As of 2023 March, AECL's liabilities totaled $6.7 billion (net present value) for the decommissioning and remediation associated with the CRL site. This estimate includes the cost required to decontaminate and remediate areas of the CRL site and dispose of waste to an acceptable standard. As noted above, AECL has tasked CNL to manage its liabilities on its behalf and to propose projects and undertake the necessary activities to address and reduce those liabilities.

This plan is a living document and will be updated as decommissioning and remediation work proceeds and new information and strategies develop. While this plan reflects the conditions and data available at the time of its publication, CNL is required to revise the ODCP every five years, at a minimum.

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1. Overview Decommissioning and Cleanup Plan

1.1 Introduction

The Chalk River Laboratories (CRL) site is undergoing major revitalization efforts to enable Canadian Nuclear Laboratories' (CNL) mission to advance nuclear science and technology and develop peaceful and innovative applications through its world class expertise in advanced reactors, safety & security, isotopes, radiobiology, the environment, hydrogen and tritium technologies and reactor fleet sustainability.

CNL is committed to ensuring that Canadians and people around the world are confident that they are safely and securely receiving energy, health, and environmental benefits from nuclear science and technology. CNL works to safely deliver all work activities and to provide the highest level of performance in meeting the commitments expected of them by regulators, customers, stakeholders, and the public.

To support its mission, CNL is in the process of creating a modernized research campus by first decommissioning and removing old, obsolete buildings and infrastructure, mostly within the built-up area. Once environmental remediation is undertaken to clean up the contamination associated with any impacted areas, reusable land will be available for new facilities to support innovative research and development in nuclear science and technology.

These revitalization efforts support the effective management and reduction of Canada's nuclear liabilities through environmental remediation towards a sustainable and healthy environment. A strategic approach is integrated to make land use decisions that will reduce long-term operational costs, effectively manage the site footprint, protect the surrounding natural environment, and bring impacted areas of the site to the desired final end state.

This Overview Decommissioning and Cleanup Plan (ODCP) is the next iteration of the *Comprehensive Preliminary Decommissioning Plan* (CPDP) [1]. The ODCP highlights a consolidated review of near-term needs, plans and priorities, while also integrating the input from current operations, future Science and Technology development projects, waste management capabilities, remediation and site constraints. CNL has renamed the document to better reflect the content of the document which provides a holistic view of cleanup, i.e., an overview of planned decommissioning as well as environmental remediation activities. The ODCP addresses all the requirements of a Preliminary Decommissioning Plan (PDP) as listed in the CSA standard N294-19 [2] and CNSC REGDOC-2.11.2 [3].

The input of public stakeholders and of Indigenous communities and organizations is integral in developing a sustainable and responsible plan that has long-term positive impacts on the natural environment and the socio-economic potential of the area, while ensuring the safety of its neighbours. A Community Advisory Panel, has been formed to provide input into the cleanup plans for the CRL site as part of their mandate. Regular meetings began with local Indigenous communities and organizations to discuss the site cleanup in 2022. This ODCP reflects CNL's holistic and flexible approach to effectively manage CRL's environmental legacy, reduce the

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footprint of its operations, return land safely for beneficial reuse and reduce and mitigate long-term risks while considering the needs of local and Indigenous communities.

The ODCP is a living document and will be updated periodically, as decommissioning and remediation work proceeds, as new data is collected and as new research and development opportunities develop. While this plan reflects the conditions and data available at the time of its publication, CNL is required, under REGDOC-2.11.2, Section 6.1 [3], to revise the ODCP every five years, at a minimum.

1.2 Purpose

The purpose of the ODCP is to meet the requirements specified in the Canadian Nuclear Safety Commission (CNSC) document, *Decommissioning*, REGDOC-2.11.2 [3], and of Canadian Standards Association (CSA) standard, *Decommissioning of Facilities Containing Nuclear Substances*, N294-19 [2] [1]. REGDOC 2.11.2, Section 6.1 states that a "licensee shall prepare a PDP [Preliminary Decommissioning Plan] and submit it to the CNSC for acceptance with an application for a licence in respect of a nuclear facility or the conduct of a licensed activity in accordance with the conditions of its licence". For sites with more than one facility, as is the case at CRL, the licensee is required to submit an overarching PDP to ensure that interdependencies between planning envelopes or facilities are taken into account [4].

In accordance with the *CRL Nuclear Research and Test Establishment Operating Licence* [4] associated *Licence Conditions Handbook* [5], and REGDOC-2.11.2 [3], the site-wide PDP is to be reviewed and revised at such times as CNSC staff may require, no later than five years from the previous revision. The ODCP is the fifth revision of the site-wide, overview Preliminary Decommissioning Plan for CRL and builds on the information provided in the four previous revisions of the CPDP [1]. This revision includes information about the CRL site, in its configuration as of 2022 December, and the contents are supportive of the *CRL Nuclear Research and Test Establishment Operating Licence* [4] and associated *Licence Conditions Handbook* [5] issued by the CNSC.

The ODCP documents CNL's strategic cleanup approach to decommissioning and remediating the CRL site's buildings, infrastructure, and contaminated lands at a Management Unit (MU) level. The ODCP will allow CNL to integrate its overall cleanup plans with its operational needs and revitalization efforts.

The ODCP summarizes the current level of information available for the areas of the CRL site that require decommissioning and remediation, highlighting recommendations to rectify any

[1] It is significant to note that in the preamble to the May, 30th 2019 CNSC Staff review of the 2018 CPDP for the Chalk River Laboratories site [7], CNSC states the following: "Although there are no specific timelines for the revision of the CRL CPDP in the current Licence and the associated LCH, CNL is advised that the new draft CNSC regulatory document REGDOC-2.11.2 on decommissioning and the CSA N294 new revision (2019) would include a requirement to update the decommissioning plans every five years at the latest." Both these documents have since been published and were consequently used as references in the development of the present ODCP as they were specifically mentioned in the CNSC's CPDP review letter and represent the most current requirements associated with decommissioning nuclear facilities in Canada.

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knowledge gaps. Key elements of the CNL *Integrated Waste Strategy* [6]were considered in developing the cleanup plan, including the availability and limitations associated with waste management, such as storage, disposal pathways and the need for enabling facilities required for the safe processing, treatment, storage and disposal of Low-Level radioactive Waste (LLW), Intermediate-Level radioactive Waste (ILW) and High-Level radioactive Waste (HLW).

The ODCP describes future cleanup efforts and will be informed by engagement and consultation with the public and Indigenous communities. CNL will incorporate their respective feedback and concerns and document how CNL has addressed such feedback into CRL's ODCP ahead of the next review of the CRL Site Licence in 2023, and beyond.

1.3 Scope

While CNL is responsible for managing and operating all of AECL's sites, this ODCP is exclusively applicable to the CRL site.

1.4 Abbreviations and Terminology

This document relies primarily on word meaning as found in common dictionaries. The current CNSC REGDOC-3.6 *Glossary of CNSC Terminology* [8] contains specific meanings for those words that require further clarification.

Four terms are used extensively throughout this document and are defined as follows:

Area of Potential Environmental Concern: is a portion of a site where contamination is suspected or confirmed [9].

Cleanup: Technical actions taken to retire a facility permanently from service or to rehabilitate an affected land area and restore it to a predetermined end-state condition. In this document, cleanup includes decommissioning and environmental remediation, as defined below.

Decommissioning: Planned action, procedures, processes and work activities taken to retire a facility with due regards for the health and safety of people or the environment. Activities may include decontamination, dismantling, demolition, storage with surveillance and disposal of legacy structures or facilities toward achieving the desired end-state goals.

Remediation: Environmental remediation is the removal, reduction or control of contaminants in soil, groundwater, surface water and/or sediment in order to protect human health and the environment. Remediation in this document refers to environmental remediation except where indicated.

ACS	Acid-Chemical-Solvent
AECL	Atomic Energy of Canada Ltd.
AHJ	Authority Having Jurisdiction
ALARA	As Low As Reasonably Achievable
AOPFN	Algonquins of Pikwakanagan First Nation

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APEC	Area of Potential Environmental Concern
ANMRC	Advanced Nuclear Materials Research Centre
BRP	Building Removal Plan
CA	Controlled Area
CANDU®	CANada Deuterium Uranium
CAP	Community Advisory Panel
CCME	Canadian Council of Ministers of the Environment
CNL	Canadian Nuclear Laboratories
CNSC	Canadian Nuclear Safety Commission
CPDP	Comprehensive Preliminary Decommissioning Plan
CRL	Chalk River Laboratories
CSA	Canadian Standards Association
D&D	Decommissioning and Demolition
DDP	Detailed Decommissioning Plan
DGR	Deep Geological Repository
ECM	Engineered Containment Mound
EDMS	Environmental Data Management System
EIS	Environmental Impact Statement
EMP	Environmental Monitoring Program
ENVP	Environmental Protection
ERA	Environmental Risk Assessment
ESC	Environmental Stewardship Council
EVMP	Effluent Verification Monitoring Program
GWMP	Groundwater Monitoring Program
HEU	Highly-Enriched Uranium
HLW	High-Level Waste
IAA	Impact Assessment Act
ILW	Intermediate-Level Waste
IWS	Integrated Waste Strategy
LDA	Liquid Dispersal Area

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LLW	Low-Level Waste
MU	Management Unit
NCCA	Nuclear Criticality Controlled Area
NPD	Nuclear Power Demonstration
NRC	National Research Council
NRU	National Research Universal
NRX	National Research Experimental
NSDF	Near Surface Disposal Facility
NWMO	Nuclear Waste Management Organization
OA	Outer Area
ODCP	Overview Decommissioning and Cleanup Plan
PDP	Preliminary Decommissioning Plan
PNERP	Provincial Nuclear Emergency Response Plan
PRB	Permeable Reactive Barrier
RACER	Remedial Action Cost Engineering Requirements
RAP	Remedial Action Plan
REGDOC	Regulatory Document
RESRAD	RESidual RADioactive (family of dose assessment codes)
RP1	Reactor Pit 1
RP2	Reactor Pit 2
S&T	Science and Technology
SA	Supervised Area
SMP	Site Master Plan
SMAGS	Shielded Modular Above Ground Storage
SWS	Storage with Surveillance
TRC	Truth and Reconciliation Commission
VC	Valued Component
WAF	Waste Analysis Facility
WMA	Waste Management Area

Radioisotopes of the following elements are presented within this document: Aluminum (Al),

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Barium (Ba), Carbon (C), Cerium (Ce), Chlorine (Cl), Cobalt (Co), Chromium (Cr), Cesium (Cs), Iron (Fe), Tritium (H3), Iodine (I), Molybdenum (Mo), Niobium (Nb), Nickel (Ni), Plutonium (Pu), Radium (Ra), Ruthenium (Ru), Strontium (Sr), Technetium (Tc), Thorium (Th), Uranium (U), Yttrium (Y), Zinc (Zn), Zirconium (Zr).

2. Changes since Last Revision of the Comprehensive Preliminary Decommissioning Plan

This document supersedes and expands on the previous *Comprehensive Preliminary Decommissioning Plan* (CPDP), issued in 2018 [1], and addresses gaps highlighted by the CNSC during their last CPDP review [7]. The new name for this document, the Overview Decommissioning and Cleanup Plan (ODCP) is a better reflection of the Plan's purpose as it covers both decommissioning and environmental remediation activities.

A description of the changes since the last CPDP is summarized in this Section.

Planning Updates:

- Expansion into a more holistic plan inclusive of environmental remediation aspects
- New Land Use Program launched and managed by the Cleanup Function
- Expansion of future land use scenarios to include a parkland land use category in addition to industrial and unrestricted land uses
- Introduction of CRL-specific risk-based screening criteria for radionuclides in unsaturated soils
- An overview of the Management Units (MU) of the CRL site; the revitalization plans, decommissioning and demolition status of buildings (as applicable), and the Area of Potential Environmental Concern (APEC) status within each MU
- Changes to the MU delineations include the following:
  - Expansion of MU 2 to include the increased footprint of Waste Management Area (WMA) H;
  - Expansion of MU 7 to include the full length of the National Research Experimental (NRX) Emergency Pipeline route and associated soil contamination;
  - Expansion of MU 8 to include the full footprint of WMA J; and
  - Expansion of MU 6 to include Perch Lake (previously included in MU 4).

Progress in Decommissioning and Remediation:

- The proposed Near Surface Disposal Facility (NSDF) project Environmental Impact Statement (EIS) and licence amendment application was accepted by the CNSC [10], and Public Commission hearings occurred in 2022. A licensing decision is pending.[2]
- Risk-based soil screening criteria were developed for unsaturated soils and have been applied to provide preliminary evaluation of APECs
- The upgraded New Spring B Groundwater Treatment Facility (MU 3) was commissioned

[2] Current regulatory review status is available at: https://www.cnsc-ccsn.gc.ca/eng/reactors/research-reactors/nuclear-facilities/chalk-river/near-surface-disposal-facility-regulatory-review.cfm

- Progress was made on the Stored Liquid Waste Project with some liquid waste material being transferred to the Waste Treatment Centre facilities to be processed. CNL is actively planning upcoming field schedules
- The National Research Universal (NRU) reactor was permanently shut down and defueled. The heavy water was drained from the system. Work continues to progress the NRU reactor to a Storage With Surveillance state
- As of 2022 December, 114 buildings and structures have been decommissioned and removed since September 2015, resulting in a reduction of 26,301 square meters in floor space (mainly in MU 1 and MU 7)
- As part of decommissioning activities underway since September 2015, 20,248,793 kg of clean waste including 251,779 kg of asbestos waste have been removed and disposed. In addition, more than 3,113,349 kg of low-level radioactive waste and 46,747 kg of intermediate-level radioactive waste have been safely stored in CRL's waste management areas
- Decommissioning work is underway in several buildings in the inner Controlled Area, including Building [redacted] and select buildings in the [redacted] series, along with associated soil characterization resulting in significant hazard reduction
- Progress on the non-nuclear decommissioning and hazard reduction of the NRX Stage 1, a Class 1 nuclear facility
- Repatriation of unused Highly-Enriched Uranium (HEU), Target Residue Materials from the Mo-99 Production Facility and NRU/NRX HEU fuel rods from WMA B was completed
- Initial environmental characterization of Acid-Chemical-Solvent (ACS) Pits, Thorium Pit and Nitrate Plant (MU 11) was completed
- The wash pad at WMA F (MU 10) was partially remediated
- The majority of the Liquid Dispersal Area (LDA) pipeline in MU 7 was removed and environmentally remediated
- The environmental characterization of WMA A and LDA (MU 6) has advanced
- A site-specific prioritization tool was developed to help in cleanup planning
- Fuel associated with the Fuel Packaging and Storage Facility project was successfully transferred to the facility, dried, and placed in long-term indoor storage
- The new Sort and Segregation Pilot Facility and Waste Sort and Segregation Facility for LLW processing have reached operational status

Progress in Site Revitalization:

- The Harriet Brooks Building, a logistics warehouse facility (the Minwamon building) and the Support Facility have been constructed and are occupied
- Construction of the new Science Collaboration Centre is in progress with a target completion date in 2023
- Portions of the Site Utilities Revitalization Plan were completed in November 2021 to facilitate new construction. This scope included the relocation of infrastructure within the Advanced Nuclear Materials Research Centre (ANMRC) footprint, utility upgrades to

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Foundation Road along the river, and the utility corridor behind the Harriet Brooks Building

- CNL broke ground on the new ANMRC, a state-of-the-art nuclear research complex, in 2022
- As a result of the COVID-19 pandemic, CNL transitioned over half of its staff to a remote workforce. Building on the successes of that effort, a Digital Workplace program was created to support the continuation of a remote work arrangement for about one-third of the CRL site-based staff post-pandemic.

3. Site Location and Physical Setting

The CRL site is located on the unceded and unsurrendered territory of the Algonquin Anishnaabe Nation, in Renfrew County in the Province of Ontario, on the shore of the Ottawa River, approximately 200 km northwest of Ottawa as illustrated in Figure 1. The CRL site occupies an area of approximately 40 km^2 and extends approximately 6.5 km inland from the Ottawa River.

CRL operations have been concentrated, for more than 70 years, over an area representing only approximately 6% of the entire site footprint, mostly along both sides of Plant Road and nearest the Ottawa River. Other than a few small farms which were present prior to the development of CRL, the vast majority of the site has been left undisturbed and remains in a natural state.

The CRL site is within the boundaries of the Corporation of the Town of Deep River. The Federal Department of National Defence Garrison Petawawa borders the CRL site to the southeast, and the Village of Chalk River in the Municipality of Laurentian Hills is to the southwest. The Ottawa River forms the northeastern boundary of the CRL site. The natural features of the site are typical of the surrounding land–forested, uneven terrain interspersed with small lakes, wetlands and rock outcrops.

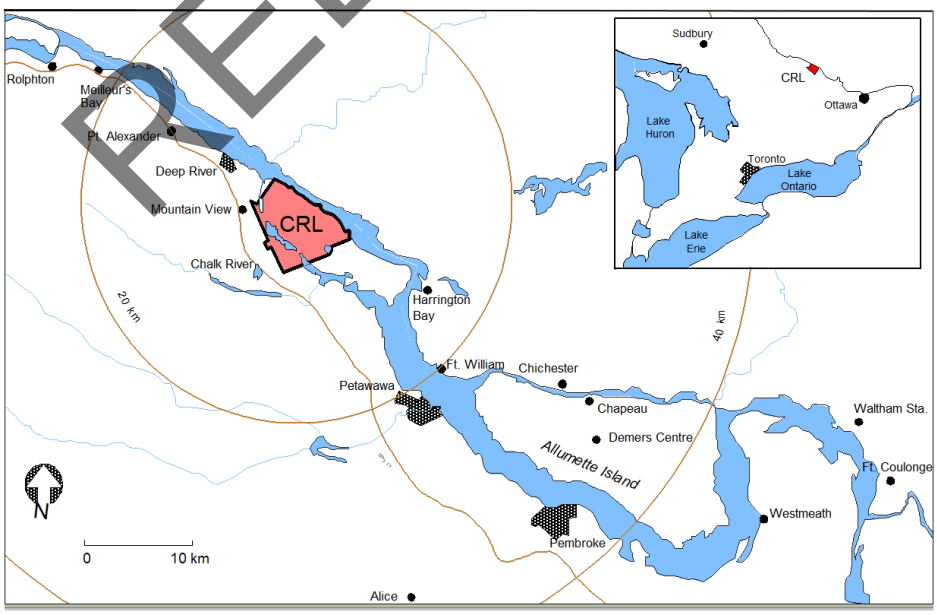


Figure 1: Location of the Chalk River Laboratories

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The following Sections summarize additional information describing the CRL site. For more details, see Section 2 of the 2018 *Environmental Risk Assessment of Chalk River Laboratories*, [11].

3.1 Surrounding Communities

The population surrounding CRL in Renfrew County, Ontario, is relatively stable at approximately 106,365 residents (2021 Census) with an overall population density of approximately 14.5 persons/km^2. Most of the closest local residents live in and surrounding the Town of Deep River and the Village of Chalk River. Deep River is 10 km upstream from CRL. Chalk River is located at the western border of the site, about 3 km away from the nearest WMA. Surrounding these two population centres are the townships of Rolph, Buchanan, Wylie and McKay, which, with Chalk River, form the Town of Laurentian Hills.

According to the 2021 Census of Population, Deep River has 4,175 residents and Laurentian Hills has a combined population of 2,885. The Town of Petawawa, including Garrison Petawawa, has approximately 18,160 residents, and is located 20 km downstream from CRL. Other large population centres are the City of Pembroke with approximately 14,364 residents, 35 km downstream from CRL, and the Township of Laurentian Valley which surrounds Pembroke, with 9,450 residents.

North Bay and Ottawa are approximately 140 km up and 180 km down river, respectively.

The portion of Pontiac Regional County Municipality in the Province of Quebec, immediately north and east of the river and opposite the CRL site, is primarily inhabited only seasonally during the summer months when a few cottage dwellers may be present. The closest permanent residents in the Pontiac Regional County Municipality are located 3 km southeast of the CRL site, in the Harrington Bay area. The next closest permanent residents are 11 km downriver, in the Downey Bay area. The closest populated area on the Québec side is the Municipality of Sheenboro including Fort William, approximately 16 km down river, with a population of approximately 150 residents.

The closest First Nations community to the CRL site is the Algonquins of Pikwakanagan First Nation (AOPFN), located on the southeast shore of Golden Lake where it flows in to the Bonnechere River, in Renfrew County, Ontario and covers an area of 688.8 hectares. The AOPFN are part of the Algonquins of Ontario organization, which has reached an Agreement-In-Principle with the Governments of Ontario and Canada regarding a land claim for their traditional homelands in the Ottawa Valley which includes the National Capital Region, all of Renfrew County, and most of Algonquin Park, including the CRL site [12]. In addition, the CRL property also overlaps the Mattawa/Lake Nipissing Traditional Harvesting Territory for the Métis Nation of Ontario [13]. Discussions with Williams Treaties First Nation communities and Algonquin Anishinabeg Nation Tribal Council member's communities (Kebaowek First Nation and Kitigan Zibi Anishinabeg First Nation) have also indicated that traditional harvest occurs in the general area surrounding the Chalk River Laboratories site [14].

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A proposed list of the Indigenous communities and organizations identified by CNL in the vicinity of the CRL site (specifically, the NSDF Project) is found in Section 3, Table 3-1 of the NSDF Indigenous Engagement Report [14].

Access to the CRL site is restricted and has not been used for traditional purposes by Indigenous Peoples since the formation of the site.

Canadian Nuclear Laboratories is one of the two major employers in Renfrew County and the nearby communities of Pembroke, Petawawa, Deep River and Laurentian Hills. Garrison Petawawa is the main employer with 7,000 military and civilian personnel. CNL employs about 2,900 highly trained staff at CRL, including scientists, engineers, technicians, trades, and administrative staff.

The campus revitalization efforts at CRL will provide, for decades to come, numerous opportunities for new R&D research and development projects and supporting installations, in particular around nuclear applications of Science and Technology (S&T). In addition, environmental remediation efforts will also progress over a number of years at CRL.

A public attitude survey conducted in 2022 April [15] and *The County of Renfrew Social, Economic and Environmental Impact Analysis of CNL/CRL* [16] conducted in 2021 April, showed high levels of awareness of and support for CRL within the community, including:

- Acknowledging the positive impacts of the laboratories on local employment and business growth
- Appreciating the importance of CRL in generating employment, talent attraction/retention and business activity
- Recognizing the strict environmental standards that CRL adheres to

Decommissioning and remediation work requires skills in the following disciplines: radiation protection, radiochemistry, nuclear and environmental engineering, hydrogeology, skilled trades, safety case development, criticality assessment, nuclear safety, licensing, control and instrumentation, waste management, mathematical modelling, facility management, maintenance, engineering and project management. Training and employment of highly qualified people will therefore be required for many decades.

The CRL Implementing Plan [17] of the Provincial Nuclear Emergency Response Plan (PNERP) Master Plan [18] provides estimates of the Primary Zone population figures. The Primary Zone is the zone around a nuclear installation within which planning and preparedness is carried out for measures against exposure to a radioactive plume. A revised assessment is currently underway to evaluate the significant reduction in risk to the surrounding off-site populations resulting from the shutdown of the NRU reactor in 2018 March. Discussions proposing that CRL be removed from the PNERP are underway with the CNSC (on behalf of the Province on Ontario) and the Province of Quebec.

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3.2 Land Use

Atomic Energy Canada Limited is the landowner of the CRL site and remains responsible for the legacy liabilities at the site.

The 2018 CPDP [1] assumed that all current land use at CRL was classified as industrial due to the operations and activities undertaken by CNL, restrictions on public access and prohibition of third-party land uses. Large portions of the site are, however, covered by natural forests, wetlands and surface water bodies. For future cleanup planning purposes it has therefore been proposed that in addition to industrial land use, where appropriate, targeted next land uses will also include unrestricted as well as parkland (see Section 9.1.2).

Land use in the region consists primarily of forestry, recreation and tourism, with limited agriculture, trapping and mining. Upstream of CRL, except for the Municipality of Rapides Des Joachims in Quebec, the majority of settlement and development is located on the Ontario side of the Ottawa River. Very little development has taken place on the Quebec side of the river, northwest of Allumette Lake. A wide range of types and scales of farming exist in the upper Ottawa Valley, from small scale mixed (hobby) farming to commercial-scale beef farming and dairy farming with associated forage crops. Most large-scale farming activities occur over 20 km from CRL in the Petawawa-Pembroke region (and further southeast). There are a few smaller farms in the Chalk/Deep River area, including an alpaca farm. The nearest area of significant agriculture is approximately 35 km downstream on the Ontario side of the river and further downstream on the Quebec side. No harvesting (hunting, trapping, fishing, or gathering) is permitted on the CRL site.

The Ottawa River, referred to in the Algonquin language as “Kichi-Sìbì” or Big River, is of significant heritage, cultural and spiritual value to Indigenous communities due to its use as a traditional travel route [19]. In 2016, the Ottawa River was designated to the Canadian Heritage Rivers System for its cultural value. Sport fishing is carried out in lakes outside of the CRL property boundary, as well as in the Ottawa River. There is no commercial fishing in the area. Only fishing for environmental monitoring purposes is permitted on the CRL property. Fish found in local waters within and surrounding the CRL property include pike, bass, walleye, pickerel, muskellunge and sturgeon.

One of the largest military bases in Canada is in Renfrew County, adjacent to the CNL property at Garrison Petawawa. Because of its irregular boundaries, the eastern edge of Algonquin Park (Provincial) ranges from 8 to 15 km west of Highway 17. Most of the remaining land in the region is undeveloped.

3.3 Topography and Hydrology

One of the dominant topographic features of the CRL property is the ridge that separates the Maskinonge-Chalk Lake valley from the Ottawa River. Many of the site’s topographic features are bedrock-controlled and where exposed, the bedrock surface is frequently knobby, with highs and lows on a scale of several hundred meters laterally and tens of meters vertically.

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The Ottawa River is the dominant drainage feature in the area. The CRL property is located in the Allumette Lake and Lac Coulonge reach of the Ottawa River, which extends approximately 90 kilometers between La Passe and the Des Joachims Dam.

The site contains several small drainage basins that discharge either directly to the Ottawa River or to smaller lakes and streams, which in turn, drain to the Ottawa River. Direct drainage to the river occurs from the Ottawa River Direct basin which covers 12% of the site area, including the built-up area. The Perch Lake basin drains 15% of CRL property. Maskinonge Lake is the largest surface water body entirely within the CRL site boundary and its catchment (drainage basin) accounts for almost 40% of the site's area. Drainage from the Maskinonge Lake basin is into Sturgeon Lake and then into the Ottawa River. Chalk Lake East and West water basins, located in the southwest corner of the site also drain into Sturgeon Lake (also known as Chalk Lake).

Ottawa River flows are controlled and measured at various locations upstream. The Des Joachims Generating Station, operated by Ontario Power Generation is located approximately 35 km upstream of CRL near Rolphton and is the nearest control point.

3.4 Wildlife and Habitats

The CRL site is characterized by a forest cover consisting of white, red and jack pine; white and yellow birch; hemlock; white, red and black spruce; beech, sugar and red maple; red oak and poplar. The pine species are the most significant from a commercial viewpoint.

The area supports a wide range of wildlife species, including moose, deer, black bear, ruffed grouse, hare, turtles and waterfowl. The area also supports many fur bearing animals such as beaver, mink, fisher, marten, otter, muskrat, fox and raccoon. The surrounding area is not situated within a major waterfowl flyway; however, numerous wetlands provide a suitable nesting habitat for waterfowl.

Several wildlife species observed at the CRL site are listed as species at risk (see Section 7.2.1).

CNL recognizes that there are valued components in the aquatic, terrestrial and cultural environments reflecting Indigenous interests within the CRL site and the adjacent Ottawa River [14], [19]. A summarized list of the wide range of valued components reflecting environmental effects and Indigenous interests selected for the proposed NSDF project is presented in Table 5-2 of the NSDF *Indigenous Engagement Report* [14], and will be considered as cleanup planning progresses.

3.5 Geology

The CRL Site is typical of its immediate surroundings-a mixture of exposed bedrock, glacial till, fluvial sand, Aeolian sand dunes and organic materials mostly found in small lakes and marshes. Ground surface elevations vary from the level of the Ottawa River which is approximately 111 to 200 metres (m) above mean sea level.

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The bedrock in the CRL site consists principally of deformed metamorphic gneiss rock formations. A major fault is observed along the Ottawa River, and a branch from this fault extends through the CRL site.

The earliest unconsolidated sedimentary material in the CRL area dates to near the end of the last ice age and consist of fluvial sand and interbedded silt. These materials have been locally reworked by the wind to form large, fine sand dunes, where several of the CRL site's waste management areas have been located. Underlying these sandy deposits, relatively thin deposits of very boulder like glacial till are found on much of the CRL property. However, at certain locations at the CRL site, thickness of the till has been found to vary from less than 0.3 m to 30 m thick. The till contains a wide range of grain size, from automobile size blocks of rock to clay size particles.

3.6 Climate

The climate of the area is classified as humid continental, with warm summers, cold winters, and no distinct dry season. According to meteorological data from Environment Canada, the average daily temperature in Renfrew County is 4.9°C, with a high daily average temperature for the month of July of 26.6°C and a low daily average temperature for the month of January of -17.6°C. Annual average precipitation of 811.5 millimetres (mm) equivalent is observed for the region, with the highest precipitation typically occurring in the summer and an average annual snowfall of 195.5 centimetres (cm). The extreme daily precipitation (most rain or snow in one day) of 110 mm of rain was recorded in September 1989 and 39 cm of snow in February 1984.

4. Site Missions and Background for Cleanup Planning

4.1 Chalk River Laboratories' Strategic Priorities

The CRL site holds unique expertise and specialized facilities that support research in advanced nuclear technology and innovation in safety, security, health, environmental and clean energy technologies. CRL was instrumental in the development of the CANada Deuterium Uranium (CANDU®) reactor technology. Until the shutdown of the National Research Universal reactor in 2018, CRL produced a large share of the world's supply of medical radioisotopes.

Significant industrial/commercial activities are still generated at CRL, including research and development of innovative applications for nuclear technology and the design and engineering of specialized technology, waste management, decommissioning and environmental remediation. CNL is committed to ensuring that Canadians and people around the world are confident that they are safely and securely receiving energy, health, and environmental benefits from nuclear science and technology. See Figure 2 for CNL's strategic priorities. CNL works to safely deliver all work activities and to provide the highest level of performance in meeting the commitments expected of them by regulators, customers, stakeholders, the public and Indigenous peoples.

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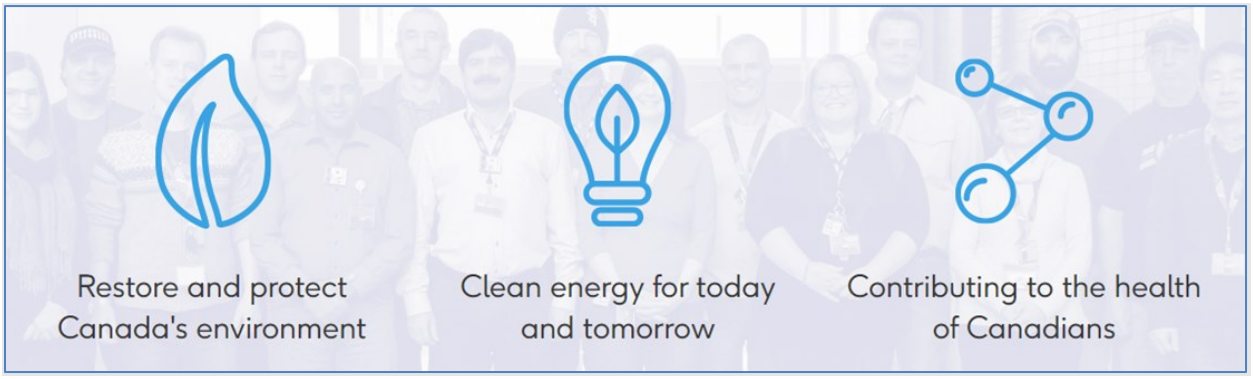


Figure 2: CNL's Strategic Priorities

Canadian Nuclear Laboratories strives to advance nuclear S&T for a clean and secure world and to undertake the following missions at the CRL site:

- We will restore and protect Canada's environment by reducing and effectively managing nuclear liabilities
- We will provide the world with sustainable energy solutions including the extension of reactor operating lifetimes, hydrogen energy technologies, and fuel development for the reactor designs of tomorrow
- Together, with partners, we will demonstrate the commercial viability of advanced reactor designs including Small Modular Reactor (SMR)
- We will work collaboratively with medical/educational institutions and pharmaceutical companies to pioneer new alpha therapies for cancer treatments that save countless lives
- We will leverage all of our capabilities for commercial success in Canadian and international markets

Advancing nuclear S&T for a clean and secure world is CNL's purpose. New infrastructure and refurbishment of existing infrastructure to support this S&T mission will be extensive. Cleanup planning will support these missions at CRL by providing a safe and effective framework to reduce the environmental liabilities through decommissioning and remediation allowing for the development of the new, revitalized S&T campus.

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4.2 CRL Operating History

The construction of CRL began in August 1944. Nuclear research at the Chalk River site began in 1945 under the administration of the National Research Council (NRC) with the completion of the Zero Energy Experimental Pile (ZEEP) reactor which was designed to provide basic information on the physics of neutrons in a natural uranium/heavy water environment and to optimize the design of the planned National Research Experimental (NRX) reactor. In 1946, the Atomic Energy Control Act established the Atomic Energy Control Board (AECB), and the AECB asked the NRC to continue to operate CRL on their behalf.

The NRX reactor and its associated facilities began operating in 1947 and continued to operate until 1993. The focus of the early NRX operation was the production and recovery of Plutonium

and Uranium-233, and the building complex included facilities for processing irradiated uranium and thorium and packaging the recovered products. Government approval to proceed with the National Research Universal (NRU) reactor was received in 1950. The NRU reactor operated as a multi-purpose research science facility until 2018. It also generated radionuclides used to annually diagnose and treat over 20 million people in 80 countries. The NRU was the neutron source for the NRC Canadian Neutron Beam Centre and it was the first test bed for the CANDU® reactor.

In 1952, the Canadian government formed Atomic Energy of Canada Ltd (AECL), a Crown corporation with the mandate to develop peaceful uses of nuclear technology, to take over operation of the Chalk River site from the NRC. That same year, NRX suffered an accident that resulted in extensive fuel failure, severe damage to the reactor core and release of radioactive material. Solid and liquid wastes from the NRX accident, including reactor components, were taken to dedicated Waste Management Areas, in particular WMA A and WMA B.

Six such WMAs (WMA A, WMA B, WMA C, WMA D, WMA E, and WMA F) were developed during the 1950s and 1960s to manage low-level radioactive wastes and other CRL wastes. Three of these WMAs (i.e., WMA A, WMA E, WMA F) stopped accepting waste between the 1960s and the early 1980s, once their respective design capacities were reached.

Three of these WMAs are still in operation (WMA B, WMA C, WMA D) while two additional WMAs (WMA G and WMA H) were added between 1988 and 2002 and are also still in operation. An area was assigned as WMA I, but the facility was never constructed. WMA J is the most recent addition. It was constructed in 2011 to accept dewatered sewage sludge from the wastewater treatment system and is still in operation today.

Environmental characterization and monitoring of groundwater and surface quality has been ongoing at each of these WMAs since the start of their operations and continues to this day. The legacy waste management areas at the CRL site were designed and built prior to development of modern standards thus, do not meet all aspects of modern design requirements. Specifically, the legacy waste management areas lack robust containment, which has affected the surrounding environment. These areas will require further analysis and environmental remediation options analysis, as is discussed further in this plan.

Several of these WMAs have been the source of radioactive contaminant plumes, some of which have been mitigated using active or passive treatment systems. Radionuclide concentrations in soil and water have been decreasing at most locations due to natural attenuation and radioactive decay.

In 1954, a revision of the Atomic Energy Control Act changed the relationship between the AECB and AECL, with AECL reporting directly to the designated Minister. The research focus shifted in 1954 from plutonium production to the application of nuclear technology for electrical power generation based on the natural uranium fuelled, heavy water moderated concept, subsequently dubbed CANDU® (CANada Deuterium Uranium). Nuclear facilities were installed to support this research program, (e.g. for development, fabrication, testing and post-irradiation examination of fuels and reactor components). Engineering programs were initiated to support development of the prototypes for the CANDU® nuclear power reactor and

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advanced reactor concepts. Support facilities and services such as machine and instrument shops, analytical laboratories, engineering, computation, stores, radiation protection, environmental and biological research, nuclear materials and waste management, administration, cafeteria, and other support facilities were constructed, as required. The larger NRU reactor and its associated facilities began operation in 1957 and ceased operating in March 2018. ZED-2 is currently the only remaining reactor operating on the CRL site.

In 2015, following a restructuring process led by the Government of Canada, AECL moved from a Government-owned, Government-operated model to a Government-owned, Contractor-operated (GoCo) model. Through this model, AECL contracts the management and operation of its sites to CNL, which is a private-sector company responsible for the day-to-day management and operation of all AECL's sites, facilities and assets, including CRL. AECL remains the owner of all land, assets, properties, and liabilities. CNL is licensed by the CNSC to operate AECL's sites.

In the past five years, several new facilities and projects have been completed and since September 2015, 114 buildings and structures have been safely decommissioned and demolished. The NRU reactor remains under an operating licence in a permanent safe shutdown state (defueled and dewatered). Work continues to progress the NRU reactor to a Storage with Surveillance state which will be followed by the initiation of decommissioning execution in 2029. Buildings [redacted] (storage tanks) and [redacted] (Chemical Laboratories) have also been shut down and have been recently characterized as part of decommissioning. The Harriet Brooks Building ([redacted]), the Minwamon Building, i.e., the new Logistics Warehouse facility ([redacted]) and the Support Facility ([redacted]) opened in 2018, 2020, and 2021 respectively. More details on recent infrastructure projects are presented in Section 4.3.5.

4.3 Site Layout

The CRL land boundaries are shown in Figure 3. The CRL site includes a wide variety of buildings, WMAs and structures used directly or in support of nuclear S&T and industrial activities. The Campus Precinct area of the CRL site, as of 2022 December, is shown in Figure 4. To assist in site cleanup planning, the CRL site has been divided into 11 Management Units (MUs), as shown in Figure 5. An MU is an area with potential or known environmental impact associated with historic or ongoing site operations within a defined boundary. Further description of the MUs is provided in Section 4.3.4.

Over the next 10 years, from 2023 to 2032, CNL will continue to transform the CRL site through the revitalization of essential infrastructure, decommissioning of aging buildings, and investments into new facilities. Re-use of already disturbed lands (brownfield areas) is a priority over developing undisturbed green field areas. The total built footprint of the site will be reduced with development consolidated on a smaller area of land. Development blocks have been identified to control the extent of the built environment and optimize servicing (e.g., roads, utilities, emergency response, etc.) during redevelopment.

For development planning purposes, the site has been divided into three areas - the Entry Precinct, the Outer Precinct and the Campus Precinct:

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- The Entry Precinct is located immediately next to the Village of Chalk River and is the first point of arrival to the site. No significant decommissioning or environmental remediation activities are foreseen in the Entry Precinct over the near term.
- The Outer Precinct covers the majority of the site and is largely in a natural state except for the Plant Road corridor where the WMAs are located and where development blocks have been identified. The site of the proposed NSDF is located in the Outer Precinct.
- The Campus Precinct includes the main built-up area of the site (Figure 4), including the inner Supervised and Controlled areas which consist of approximately 48 hectares next to the Ottawa River. The Campus Precinct is the focus of the transformation of the CRL site for new world-class nuclear S&T facilities. The goal is that site cleanup will contribute to a significantly reduced built footprint.

4.3.1 Controlled, Supervised, and Outer Areas

The CRL site consists of three types of designated areas under progressive degrees of access and radiation protection controls, as follows:

- Controlled Area (CA): CRL site areas within which normal working conditions, including unplanned events, require all personnel to follow well-established radiation protection procedures and practices. The predominant hazard may be either external radiation or contamination. Controlled Areas have access restrictions and most have perimeter fencing. The north section of the Campus Precinct is often referred to as the 'inner area', which is currently a [redacted] section. There are also CAs located in the Outer Precinct consisting of the Waste Management Areas, most of which are fenced. The ones without fencing still require authorization before gaining access. There are also CA 'islands' (active areas in 4 buildings) in the Supervised Areas.
- Supervised Area (SA): CRL site areas in which working conditions are to be kept under review, but special radiation protection procedures are not normally needed. Work with radiation sources and the storage of radioactive materials is not permitted without authorization. SAs include the southern [redacted] section of the Campus Precinct, referred to as the inner SA, as well as operational and affected areas in the 'Outer Area'.
- Outer Area (OA): The area within the site boundaries is known as the 'Outer Area'. The Outer Precinct is predominantly made up of the 'Outer Area'. The 'Outer Area' is accessed from Highway 17 in the Village of Chalk River. Access to the interior of the site by authorized personnel is by road through a security checkpoint.

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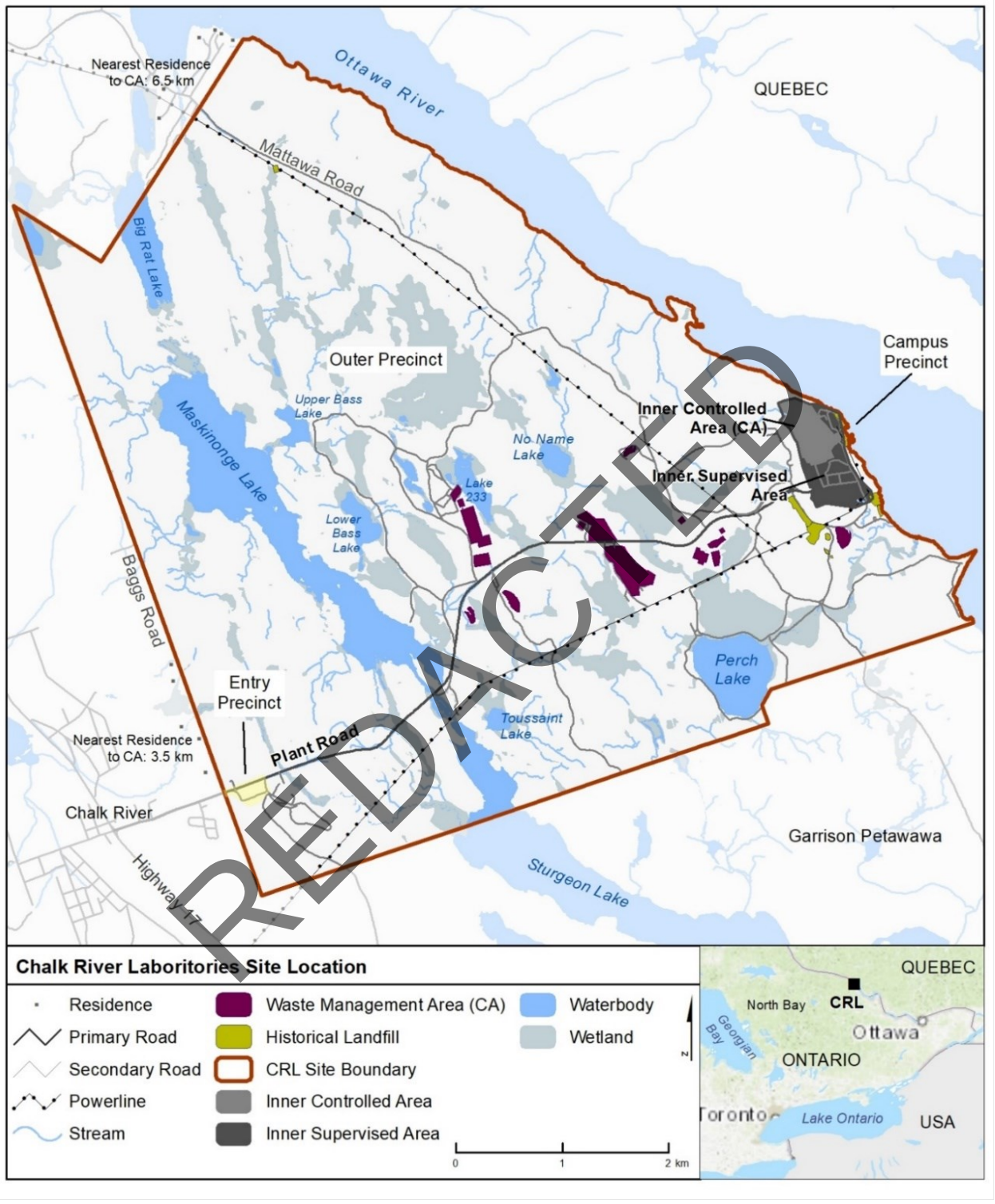


Figure 3 Map of Chalk River Laboratories Site Layout

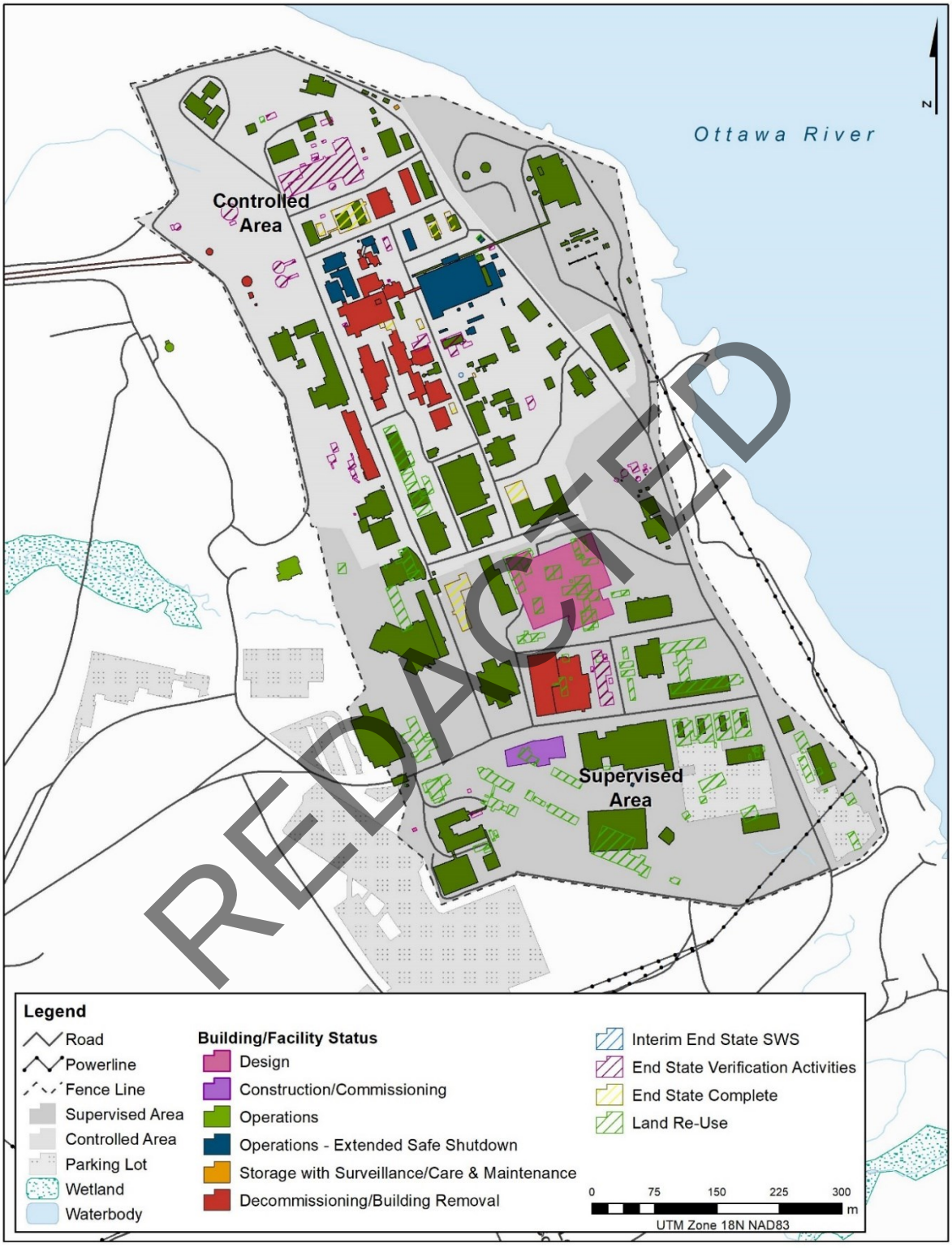


Figure 4: Map of the Campus Precinct of Chalk River Laboratories

(See Appendix A for descriptions of the Building/Facility Status Categories)

4.3.2 Buildings, Facilities, and Support Functions (Active/Operational)

The Campus Precinct, which includes the Inner CA and the Inner SA, represents the highest concentration of development and decommissioning activities planned for the 2023-2027 period and beyond.

Green space and landscaping is presently limited to a small area between the Entrance Building ([redacted]) and the Cafeteria ([redacted]) and to the north and south of the cafeteria. The Campus Precinct contains many end-of-life buildings scheduled for removal. The list of buildings to be demolished and those that will remain in the Campus Precinct are included in Appendix A.

Ultimately, a large portion of the Campus Precinct is planned to be converted to green space. The cleanup activities will also provide opportunities for reutilization of brownfield lands which will be dependent on the results of subsurface characterization, remediation effort and the need for footprint for new development.

Buildings in the SA are used for applications such as scientific laboratories, research not involving significant amounts of radioactive materials, workshops, administration, and other services, such as the new logistics warehouse facility (the Minwamon building), the Waste Analysis Facility (WAF), and the low background counting building. There are a few minor exceptions, such as the use of radioisotopes in the Biological Research Facility and the Harriet Brooks Building which are located in the inner SA.

Most buildings located outside of the CA can generally be considered uncontaminated. Nonetheless, precautions are in place to reduce the risk of inadvertent transfer of minor contamination; any transfer of equipment or waste materials that can involve radiation or radiological contamination is subject to Radiation Protection Program requirements [20]. The Campus Precinct section of the SA is approximately 28 hectares (approximately 600 m in the north-south direction by 700 m in the east-west direction) and currently includes approximately 16 permanent buildings, excluding sheds and trailers. The primary access to this area is from the main gate on the west side.

Since September 2015 through 2022 December, 114 structures have been decommissioned and demolished at CRL totalling over 26,301 square meters of building floor space (not building footprint area). These decommissioning efforts have been focused in the inner Controlled and inner Supervised Area. This has created space for several larger new build projects to enable transformation of the Chalk River site into a modern and vibrant campus. The inner CA, is a [redacted] area of approximately 20 hectares (approximately 700 m in the north-south direction by 400 m in the east-west direction), as shown in Figure 4. At the exit of the inner CA, as well as at WMA B, sensitive monitoring portals are installed to eliminate the risk of transporting radioactive contamination outside of the CA.

The inner CA currently consists of 44 permanent buildings and facilities, excluding sheds, trailers, towers and tanks. The buildings in the CA accommodate and support nuclear facilities such as reactors, hot cells, radioisotope laboratories, nuclear materials storage, etc. The more significant of these facilities are listed in the CRL Site *Licence Conditions Handbook* [5] and are operated in accordance with formal documentation, including a Safety Analysis Report, Facility

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Authorization and Conduct of Operations Program. Many of the facilities in this area have been turned over to the Decommissioning Program and are governed by Building Removal Plans (BRP), Preliminary or Detailed Decommissioning Plans (PDP or DDP) and Storage with Surveillance (SWS) Plans.

Many rooms in the buildings in the Campus Precinct are reserved for non-nuclear uses, such as offices, conference rooms, corridors, and storage, and are not expected to exhibit evidence of radiological contamination. Transfers of equipment and waste materials from the CA to the SA are, however, subject to Radiation Protection Program requirements [20]. The focus of decommissioning efforts for 2023 to 2027 is shifting to the disused/vacant facilities in the Controlled Area of the Campus Precinct. These decommissioning activities will significantly reduce health, safety, and environmental risks by removing high-hazard liabilities and will reduce the costs associated with maintaining redundant buildings.

To aid in decommissioning efforts and to provide a modern, right-sized, efficient campus environment, both security and radiation protection programs are shifting away from large area controls. The goal is for central monitoring and fencing to be removed from many areas that do not require these controls in order to blend the 'Inner CA' and 'Inner SA'.

The following new buildings and facilities have been commissioned since the last revision of the CPDP [1]:

- 2018 -Harriet Brooks Building ([redacted])[3]
- 2019 -Hazardous Waste Process and Radioactive Waste Characterization Facility ([redacted])
- 2019 -New Sanitary Sewage Treatment Facility ([redacted])
- 2020 -New Spring B Pump and Treat Facility ([redacted])
- 2020 -Sort and Segregation Facility Pilot (Repurposing of [redacted])
- 2021 -Minwamon Building: Logistics warehouse facility and site entrance building ([redacted])
- 2021 -Support Facility (Maintenance) ([redacted])
- 2021 -WMA-G Service Building ([redacted])
- 2022 -Waste Sort and Segregation Facility ([redacted])
- 2022 -WMA G expanded to add new concrete canisters for the storage of used fuel from other CNL sites (e.g., Whiteshell Laboratories and Gentilly-1)

The description and operational status of buildings, structures, WMA's and services on the CRL site, as of 2022 December, are listed by MU in Appendix A.

4.3.3 Waste Management Areas and Affected Lands

Most of the WMAs at CRL have access controls in place, such as fencing, and require pre-approval to access. The majority of lands within the WMAs are considered as having been affected by previous operational activities. Outside of the Campus Precinct the majority of the lands at CRL are unaffected with the exception of the WMAs and associated plumes, the

[3] The office portion of this building was commissioned in 2016; the remainder was commissioned in 2018.

landfills located in MU 7, and isolated areas where historical research has occurred. These areas are generally referred to as affected lands.

Responsible waste management includes full life cycle management from generation to disposal. As such, AECL, as the waste owner, has tasked CNL to identify solutions for waste management of the entire life cycle of all radioactive waste classifications including LLW, ILW, HLW, hazardous waste, as well as clean (non-radiological) waste which are covered in the CNL Integrated Waste Strategy [6].

The legacy waste management areas at the CRL site were designed and built prior to development of modern standards and thus do not meet all aspects of modern design requirements. Specifically, the legacy waste management areas lack robust containment, which has affected the surrounding environment. Waste storage within the WMAs has resulted in contamination plumes that extend beyond the defined boundaries of some of the WMAs. Some smaller areas have been identified as being affected-environmentally or radiologically–as a result of operations or accidental spills. Additionally, sediments in the Ottawa River adjacent to the site have also been affected by past CRL operations.

4.3.4 Management Units

As shown in Figure 5, the entire CRL site is divided into specific MUs. Assignment of land to a specific MU is based on a combination of criteria including spatial relationships to other units, contribution to the same groundwater plumes, physical characteristics of the area, access considerations, anticipation of similar remedial action strategy (economy of scale), and reasonable number of total units to effectively manage. The division into MUs enables a coordinated approach to the planning of decommissioning and remedial investigations (modeling and characterization), remedial actions and strategies, and the development of interim and long-term management solutions. The MUs currently define the CRL site's "Decision Units" as recommended in CSA N294-19 [2]. Appendix A discusses the MUs, and the WMAs and other Areas of Potential Environmental Concern (APEC) within each, in more detail.

Management Units 1 and 7 comprise the Campus Precinct of the CRL site where most of the redevelopment potential exists and where building decommissioning activities are currently focused. To date, 114 structures across the site have been decommissioned and demolished since September 2015 with several more scheduled for decommissioning in the next 5 years as shown in Appendix A.

While generally less contaminated than the higher priority areas, cleanup may be prioritized in MUs 1 and 7 where new builds are being considered as part of site revitalization efforts. In some cases, this will require more detailed soil and groundwater characterization. This type of information is essential in determining the extent of cleanup efforts required or the type of mitigation measures that will be needed to allow safe future land use of contaminated areas.

Much of the needed environmental remediation work on the CRL site will be focused on the WMAs, in particular those that are sources of contaminated groundwater plumes as described in more detail in Table 1, below, and in Section 10 and Appendix A. The five high priority MUs (MU 3, 6, 8, 10 and 11) each contain radioactive and chemical wastes in below grade facilities

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that do not meet current waste management standards. MUs 3, 6, 8, and 11 include wetlands which have been impacted by migration of contamination in groundwater from waste management areas. Groundwater treatment systems are in place to limit the migration of contaminants toward downgradient receptors from four groundwater plumes originating from WMAs located in MUs 3, 6 and 11.

There is also an impermeable geomembrane cover capping WMA C (MU 8) and decreasing the contaminant migration from wastes contained in the area. The natural wetland areas downgradient of MUs 3, 6, 8, and 11 have not yet been fully characterized and will be addressed in future years

Environmental remediation may also be required in other MUs where contamination is present but to a lesser extent (i.e., MU 1, 7, and 9) and in some cases may be appropriately managed in situ after mitigation measures are put into place. There is currently no evidence of contaminant transport to soil or groundwater from the facilities within MU 2.

Management Unit 5 consists solely of the area of contaminated sediment off-site in the Ottawa River that has been affected by CRL operations. Following detailed quantitative risk assessments, this area is currently being managed using a Monitored Natural Attenuation approach.

Several research and support activities have taken place in MU 4 (the majority of the Outer Precinct) and in most cases these have resulted in limited or localized contamination which has been remediated, at least partially, but may require confirmatory characterization or where necessary complementary environmental remediation.

Such future remediation is planned to proceed sequentially over each MU to allow for better management of the remediation efforts and to limit the impacts of these activities on surrounding areas. As mentioned previously, this approach may be modified, particularly in MU 1 and MU 7, where revitalization efforts may require cleanup of specific sites on a priority basis to allow for proposed redevelopment.

As new facilities are constructed at the CRL site, for example, the proposed NSDF, consideration will be given to whether a new MU should be created, or an abutting MU should be extended to include the new facility.

Changes to the MU delineations since the last iteration of the CPDP [1] include the following:

- Expansion of MU 2 to include the increased footprint of WMA H;
- Expansion of MU 7 to include the full length of the LDA Pipeline and associated soil contamination and the NRX Emergency pipeline corridor;
- Expansion of MU 8 to include the full footprint of WMA J; and
- Expansion of MU 6 to include Perch Lake due to the presence of a groundwater plume which originates in the LDA and WMA A both also located in MU 6 (previously included in MU 4)

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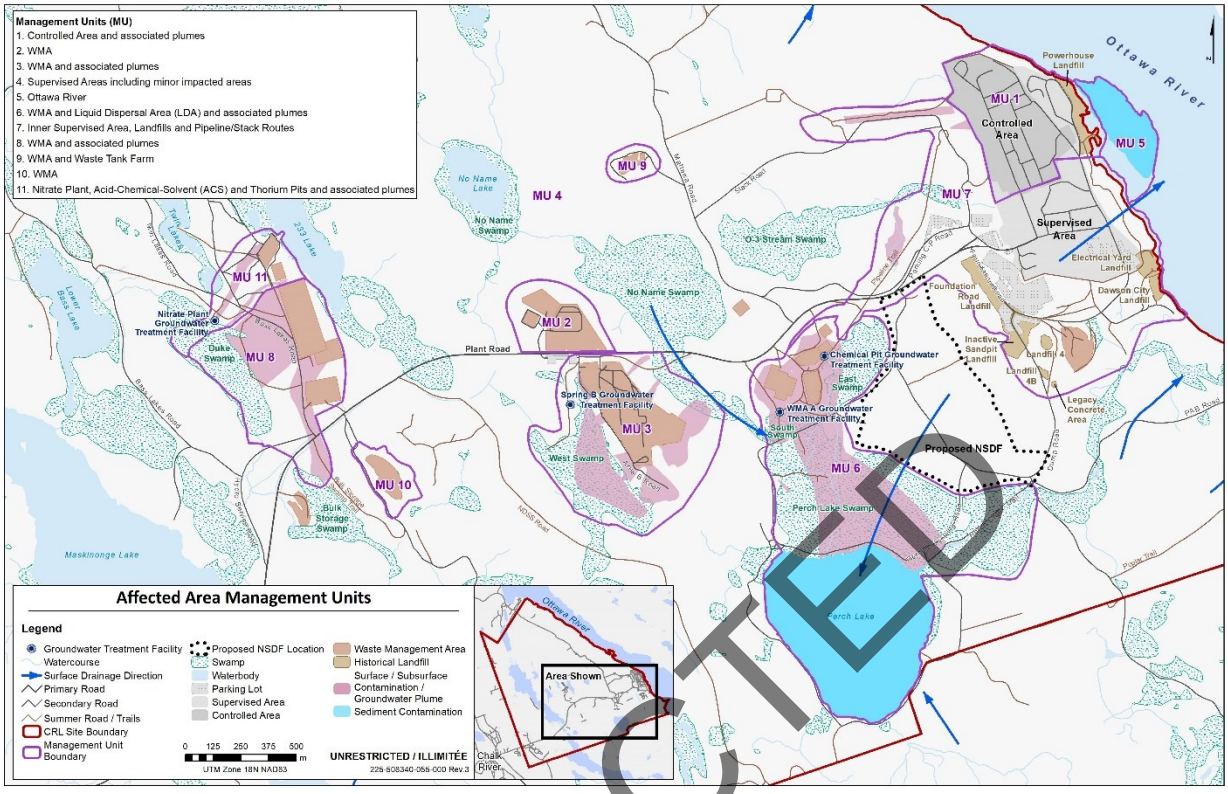


Figure 5: Map of the Management Units on the Chalk River Laboratories Site

4.3.5 Site Master Plan and Future Developments

The purpose of the Site Master Plan (SMP) is to establish a vision for the CRL site and provide an efficient and logical path forward for the redevelopment of CRL that meets business needs, reduces potential land use and infrastructure conflicts, and identifies synergistic opportunities in execution. The SMP envisions the creation of a modern campus environment leveraging its natural setting and will utilize redevelopment opportunities created by decommissioning and removal of old, obsolete infrastructure and cleanup of lands within the built-up area.

The SMP identifies 'Development Blocks' where future development will preferentially take place within the context of a reduced overall site footprint. Proposed projects outside of these identified blocks will require an amendment to the SMP. Preliminary environmental assessments, as well as transportation and utilities planning will be pursued to facilitate the permitting process and provision of site services to projects in these development blocks. Any environmental remediation required to make the development blocks ready for re-use is a key factor in the success of consolidating and shrinking the built footprint.

As planning for decommissioning and remediation at CRL develops it will be important to take into consideration changes to the planned development of the site as documented in the SMP. The maps included in the ODCP outline the areas where wastes or contaminants are known or believed to be present, potentially limiting the redevelopment potential of these areas until remedial activities can occur. For example, the activities associated with cleanup may impose

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timeline constraints that do not align with the potential redevelopment project. It is important to also recognize that several of the contaminated areas are located in or near the Campus Precinct and therefore do have strong redevelopment potential. Supporting redevelopment projects is of high priority and consequently may result in changes to cleanup planning sequence or scope. The construction of proposed facilities, such as the ones listed below, may require that the remediation of certain areas be expedited and this, in turn, may have an impact on waste management planning at CRL.

Considering both plans for site revitalization and sustainability principles, redeveloping previously disturbed areas (brownfield development) is preferable to clearing undeveloped, natural areas (greenfield development), especially when brownfield areas are located close to existing services and infrastructure. When evaluating sites for new development in the future, planned interim and final end states will be part of the consideration. Development activities over the next ten years include the construction of several enabling facilities and capabilities, as well as facilities to transform the current built-up area into a modern research campus:

Outer Precinct:

- Various waste management enabling capabilities and facilities are required to manage all classifications of waste. This includes non-radioactive waste, clean waste, hazardous waste, and radioactive waste; LLW, ILW, and HLW (i.e., used fuel). Details of current and future proposed capabilities and facilities are described in Section 9.7.3.

Campus Precinct:

- Advanced Nuclear Materials Research Centre (ANMRC) (construction began in 2022)
- Central Quad (greenspace that will be in the middle of the current Supervised Area) plus overall greening of the Campus Precinct
- Science Collaboration Centre (under construction, planned to be operational in 2023)
- Small Modular Reactor
- Targeted Alpha Therapy Production Facility

In addition, there are enabling facilities and activities needed to support near-term progress in decommissioning and remediation; details are provided in Section 9.

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4.3.5.1 Infrastructure and Utility Network

The site infrastructure and utilities network consists of services for the district heating system, electrical distribution, natural gas, sanitary sewer, storm sewer, water supply, telecommunication, and other specialized requirements.

Much of the existing infrastructure and utility network at CRL is beyond its life expectancy. This has resulted in high operation and maintenance costs, and ongoing reliability concerns. Currently, much of the effort is spent on corrective maintenance to existing systems.

Canadian Nuclear Laboratories recognizes that modern site infrastructure and utilities are fundamental for the redevelopment of the Campus Precinct. A comprehensive plan to determine the required service improvements is being developed and will align with the development framework established in the Site Master Plan. It is expected that utility corridors

will be established adjacent to roadways to facilitate more efficient use of real estate and improve ease of maintenance.

Portions of the Site Utilities Revitalization Project were completed in November 2021 to support new construction. This included utility upgrades to Foundation Road along the river, the relocation of infrastructure within the proposed ANMRC footprint and the utility corridor behind the Harriet Brooks Building and the new Science Collaboration Centre. Post-2026 work is related to replacing the CRL Power Distribution System, switchyard and site heating and cooling systems and will focus on looking ahead to future projects and tie-ins to the existing infrastructure.

A traffic study was completed in 2022 to assess the current transportation network, regular operational movement of people and vehicles on-site along with mission requirements for truck and material movement and recommends transportation network improvements for the site.

4.4 Nature and Extent of Contamination

The contaminants identified to date in the areas of concern at CRL primarily originate from reactor operations, fuel development and fabrication, isotope production and other nuclear operations at the site, including research and processing of fissile materials. The suite of fission and activation products produced from the NRX and NRU reactors have been very predictable and define the primary source term for waste streams in the MUs.

Tritium and ^{90}Sr are two radiological contaminants that are mobile and have been migrating with groundwater. Most other radiological contaminants are strongly sorbed to soil and have not migrated from their source areas. Fission products such as ^{137}Cs, ^{90}Sr and the actinides, Pu and Am, are also present in waste streams and soil. In many areas, more detailed characterization of chemical parameters in the environment is still required (Section 4.5 details the radiological and non-radiological contaminants that may be present).

Overall, adequate non-radiological and radiological characterization of each MU is required to support remedial action planning. Table 1 provides an overview of the contaminants identified in each MU to date. Detailed information is provided in Appendix A.

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Table 1: Nature and Extent of Known Contamination at CRL by MU

MU	Key Features	Impacted Media	Identified Contaminants [1]
MU 1	Inner Controlled Area (northern part of the Campus Precinct): One operating reactor and four shutdown reactors* as well as facilities such as fuel fabrication and shutdown fuel processing facilities, radioactive research and development laboratories, miscellaneous support structures, [redacted] infiltration pit, and the Power House shoreline landfill. Groundwater tritium and ^{90}Sr plumes emanate from the NRU and NRX reactors. *ZEEP, NRX, NRU and Pool Test Reactor	Groundwater, Sediment	Tritium, ^{90}Sr
		Soil	Mixed fission and activation products
MU 2	WMA D, WMA G, WMA H; located in the Outer Precinct: Operational above-ground radioactive waste storage structures. In 2019, new storage canisters were added to increase the storage capability in WMA G, and WMA H was expanded. WMA H and WMA D now include temporary storage of waste in sealand containers. Minor known subsurface contamination; unconfirmed historical source.	Soil	Localized non-radiological and tritium
MU 3	WMA B, located in the Outer Precinct: Operational; tile holes, cylindrical bunkers; and non-operational facilities, e.g., unlined waste trenches, asphalt lined waste trenches, rectangular concrete bunkers, special burials. Three plumes (tritium, solvent and ^{90}Sr) exist originating from three different waste storage areas within WMA B. West Swamp wetland and streams exist within the footprint of MU 3. A Pump & Treat facility operates to remove ^{90}Sr from a groundwater plume resulting from the unlined waste trenches.	Groundwater, Surface Water, Sediment	Tritium, ^{90}Sr, solvents, mercury
		Soil	Mixed fission and activation products, uranium
MU 4	Outer Area is the majority of the Outer Precinct: includes forests, swamps, streams, lakes. Some areas have minor amounts of contamination (e.g., Bulk Storage Compound, Old Firing Range)	Groundwater, Surface Water, Sediment, Soil	Minor amounts of various contaminants, mainly in localized locations; ^{14}C and ^{3}H from stack effluent atmospheric washout

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MU	Key Features	Impacted Media	Identified Contaminants [1]
	MU 4 includes the footprint of the proposed NSDF for low-level waste. A licensing decision for the project is expected in 2023.		exists in the dominant wind sectors (approximately parallel to the river)
MU 5	The Ottawa River is next to the Campus Precinct, but outside the boundaries of the CRL site: Affected area of sediment is approximately 8 to 10 hectares adjacent to Process Outfall at water depths of approximately 8 to 30 m. Contamination consists of dispersed bulk sediment and discrete radioactive particles.	Sediment	^{137}Cs, ^{60}Co, actinides and mercury
MU 6	Located in the Outer Precinct. WMA A: No longer accepting wastes; direct burial of solid and liquid wastes into unlined sand trenches, discrete buried objects and some buried structures. Liquid Dispersal Area: No longer accepting wastes; Chemical Pits, Reactor Pits 1 and 2, Laundry Pit. Liquid wastes from operational activities in the Inner Controlled Area were pumped through the LDA Pipeline to the appropriate pit and dispersed directly into the ground. Some contaminated metal waste exists in Reactor Pit 1. Frog Pond, various wetlands (South Swamp, East Swamp) and streams, and Perch Lake, exist within the footprint of MU 6. A Pump & Treat facility currently removes ^{90}Sr from the groundwater affected by the Chemical Pit and a Permeable Reactive Barrier (PRB) funnel and gate system intercepts ^{90}Sr from groundwater downgradient of WMA A.	Groundwater, Surface Water, Sediment	Mixed fission and activation products, actinides; (including tritium, ^{90}Sr, and mercury and other metals in groundwater and sediments)
		Soil	Mixed fission and activation products, actinides and metals
MU 7	Inner Supervised Area, (southern part of Campus Precinct): Contains a wide variety of infrastructure, including non-radioactive S&T facilities and general support services as well as buried site services. Includes Electrical Yard Landfill, Foundation Road Landfill, Above-ground Reactor Ventilation Duct, Dawson City, Sanitary (Inactive) Landfill, LDA Pipeline, 1953 NRX Emergency Pipeline corridor	Soil	Isolated hot spots containing minor amounts of various non-radiological and radiological contaminants

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MU	Key Features	Impacted Media	Identified Contaminants [1]
	and other APECs. These areas were used mainly as construction landfills, for waste burning, equipment lay-down/storage, winter snow dumping, and in one case, sand blasting decontamination.		
MU 8	Located in the Outer Precinct. WMA C: Consists of low-level wastes that were direct buried in unlined waste trenches. An engineered impermeable geomembrane cover prevents significant water infiltration through the waste below grade. A tritium groundwater plume is associated with WMA C. Construction / area modifications began in 2022 to prepare WMA C for operational use as a surface storage area for waste. WMA J (Bulk Materials Landfill): Operational; currently used for the long-term management of dewatered sewage sludge from the CRL Sanitary Sewage Treatment Plant.	Groundwater, Surface Water	Tritium, ^{90}Sr, ^{14}C
		Soil	^{14}C, and other mixed fission and activation products
MU 9	Located in the Outer Precinct. WMA E: Non-operational; Suspect-contaminated bulk soils and building materials. Waste Tank Farm ([redacted]): No longer accepting wastes; seven underground stainless steel tanks store highly contaminated liquid waste solutions and sludge from operations in 1960s. Monitoring and surveillance of these tanks is performed and confirms there have been no leaks to the environment. Ongoing operations to remove the liquid wastes are underway.	Soil	Minor discrete areas of mixed fission and activation products
MU 10	WMA F, located in the Outer precinct: No longer accepting wastes; contaminated soils brought to CRL in the 1970s, including alkaline radium mill tailings from Port Hope, niobium refinery slag containing Naturally Occurring Radioactive Material (NORM) from the Ottawa area, and radium waste from Mono Mills, Ontario.	Soil (waste itself; silty soil with some mixed building debris)	Thorium, arsenic, radium, uranium and other metals

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MU	Key Features	Impacted Media	Identified Contaminants [1]
MU 11	Located in the Outer Precinct. Nitrate Plant: Built to decompose ammonium nitrate solutions remaining from spent fuel reprocessing (operated from 1953-1954). Consisted of five structures and an infiltration pit situated adjacent to Lake 233. The buildings were buried in situ. A ^{90}Sr groundwater contamination plume is currently mitigated by the Wall and Curtain PRB system. Thorium Pit, Acids, Chemicals, Solvents Pits: used to dispose of active and/or chemical waste solutions in the ground in 1950s and 1960s. A ^{90}Sr groundwater plume extends from Thorium Pit to Duke Swamp. Duke Swamp wetland and streams exist within the footprint of MU 11.	Groundwater, Soil, Surface Water, Sediment	^{90}Sr, thorium, mixed fission products, transuranic elements
Table Notes: [1] The contaminants identified in this column represent only a list of the primary known contaminants and is not intended to be a complete list of compounds observed to date in each MU			

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4.5 Principal Hazardous Conditions

Hazards expected to be present during cleanup will be addressed in documentation prepared prior to physical decommissioning or remediation activities taking place, with the documentation containing detail appropriate for the structure or area, as per the requirements of the Cleanup Function (i.e., the Land Use, Decommissioning and Demolition (D&D) and Environmental Remediation Programs).

This provides a graded approach to decommissioning, safety analysis, and environmental remediation based on the risk of the hazard and in compliance with the CRL Licence and regulatory requirements.

See Section 5.3.1 for details regarding the programs in place to support the safe and effective cleanup of the CRL site.

The following sections provide discussion of the hazards that may be present on the CRL site.

4.5.1 Radiological Hazards

Based on historical and current operational activities at CRL, the typical radioisotopes expected to be encountered during facility decommissioning and/or environmental remediation activities include (but may not be not limited to):

- Those generated during reactor operations, i.e.;
  - Fission products such as ^{137}Cs, ^{90}Sr, ^{99}Tc & ^{129}I;

  - Activation products bound in materials and typically released through corrosion and degradation such as ^{60}Co, ^{36}Cl, ^{93}Zr and radioactive isotopes of Iron, Nickel, Zinc, Chromium and Aluminium. This also includes isotopes of elements found in Steel and Zircalloy as well as other materials subject to neutron flux like ^{14}C in Graphite and notably Tritium in heavy water; and
  - Actinide contamination arising directly from fuel through historical in-core fuel failure and other incidents, typically ^{241}Am and Plutonium and Uranium isotopes
- Fuel fabrication activities, primarily the Uranium isotopes ^{234}U, ^{235}U and ^{238}U in varying proportion due to both natural and enriched Uranium
- Isotope processing and experiments which have a varied list of isotopes of concern - for instance ^{95}Zr, ^{95}Nb, ^{141}Ce, ^{99}Mo which are associated with decay periods of <100 days and therefore, not likely to be encountered during cleanup)-however, as many of these isotopes are obtained from low burn-up, high enriched fuels, the reference hazards will be those associated with actinide and fission product contamination. This is also true of facilities involved with Advanced CANDU® Fuel Development and Research Reactor Fuel where the isotopes will be similar but may exist in variable proportions and exist as different chemical compounds requiring hazard assessment
- A full range of decay products notably ^{90}Y, ^{137}Ba
- Radioisotopes associated with contaminated wastes from off-site, historic industrial operations stored in waste management areas, such as Radium and Thorium

These radioisotopes are present in some of the structures in the CA and can lead to radiation dose rates and residual contamination hazards. The hazards specific to each building, area or system are estimated using input from historical assessments and are quantified using characterization. Mitigating measures are then introduced to prevent exposure to the worker or the environment through the implementation of *Radiation Protection Program Requirements* [20]. The characterization data is also used to ensure correct containment and packaging of waste.

4.5.2 Nuclear Criticality Control

Inventories of fissile material will be removed from the facilities as part of establishment of the respective permanent Safe Shutdown State, early in the decommissioning process or prior to turnover. If fissile material is encountered during cleanup, a criticality safety assessment, and the planned actions involving fissile material shall be included.

The majority of the Waste Management Areas at CRL are subject to the *CNL Nuclear Criticality Safety Program requirements* [21], whether declared a Nuclear Criticality Controlled Area (NCCA), subject to Criticality Safety Documents, or a non-NCCA, requiring maintenance of a fissionable materials ledger and compliance with non-NCCA limits. Examples include the [redacted] – these facilities will remain operational until disposal pathways are available and will continue to be managed under CNL's *Nuclear Criticality Safety Program Requirements* [21].

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4.5.3 Industrial Hazards

Decommissioning and environmental remediation will include elements that present potential industrial hazards, additional to those recognized during facility operation. In general, the severity of these hazards will be consistent with those presented by conventional demolition jobs for low-rise structures or large-scale excavation activities. These hazards will be mitigated through key support programs such as Occupational Safety and Health [22], [23] and Fire Protection [24], [25].

Although not a complete list, some of the potential industrial hazards consist of:

- Trips, slips and falls
- Strains, sprains, and pinch points
- Heavy equipment and vehicles
- Power tool injuries
- Cutting–dust, sharp object, fire
- Electrical
- Sloping, shoring/trenching
- Working at heights
- Falling objects
- Buried utility
- Radiation sources (e.g., industrial radiography)
- Asbestos containing materials, such as pipe insulation, building siding, floor tiles, transite, drywall, caulking, etc.
- Crystalline silica
- Wildlife
- Inclement weather, including heat exhaustion
- Confined space
- Hot work
- Mobile equipment/cranes/hoisting and rigging
- Traffic
- Chemicals and compressed gases
- Drilling/blasting
- Concrete works
- Noise
- Mobile elevated work platforms

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4.5.4 Chemical Hazards

Operational inventories of chemicals, such as acids, alkalis and solvents will be removed as part of the establishment of the Safe Shutdown State for each building or structure in preparation for the turnover to the decommissioning group. Additionally, chemicals make up a part of the waste inventory of many impacted legacy areas and will need to be managed/accounted for as part of future characterization efforts or remedial actions. These hazards will be mitigated

through key support programs such as Occupational Safety and Health [22], [23] and Fire Protection [24], [25]. Examples of the remaining chemical hazards that may be encountered during decommissioning, although not a complete list, include:

- Residual inventories of industrial chemicals
- Perchlorates
- Mercury switches
- Bio-hazards
- Acids and caustics
- Lead-based paint
- Hydrocarbons, benzene, solvents
- Arsenic
- Cadmium
- Beryllium
- Iso-cyanates
- Nitrates
- Self-igniting chemicals (zirconium)
- Lead bricks and sheets
- Polychlorinated Biphenyls (PCBs) in transformers, fluorescent light fixture ballasts, and to a lesser extent in paint, caulking, mastic and roofing materials, etc. (the bulk of the PCB wastes have been removed and transferred to a national facility for destruction, leaving only isolated small amounts on-site)

All decommissioning work performed on contaminated structures will be conducted in a manner that will minimize the spread of the contamination. When the work is performed, appropriate contamination control techniques will be used in accordance with the OSH Program [22], [23].

4.6 Work Hazard Monitoring and Worker Protection Precautions

The Occupational Safety and Health program [22], [23] and the Integrated Work Control System [26] ensure that the radiological, industrial and chemical hazards are well controlled at all work sites.

Precautions for working in radiation fields, with contaminated equipment and materials and chemical hazards are well understood. CNL's Radiation Protection Program [20] governs the radiological aspect of this work. As part of the Radiation Protection Program, CNL monitors the quantity and concentration of any nuclear substance as a result of the licensed activity and keeps a record of doses of radiation and magnitude of exposure, the effective dose and the equivalent dose received by a person (see Section 8.3.1).

4.7 Design Features to Reduce Contamination and Facilitate Cleanup

Sequencing of work will be considered in order to minimize the movement of wastes and equipment from areas of high levels of contaminants to cleaner areas. Topography and the

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presence of surface water, wetlands and significant habitats will also be taken into consideration to limit impacts to surrounding areas.

The confinement system for CRL structures, systems and components include suitably designed building envelopes, filtered ventilation systems and any other systems that are important for the confinement function. The primary barriers will prevent the migration of loose contamination sources within CRL to the environment. The engineered design features will control or limit the spread of airborne contamination within facilities. Contamination control design features also include drainage systems for CRL facilities.

Radioactive waste generated from dismantling and decommissioning activities will be treated where required to reduce worker exposure to meet the requirements of CNL's Transportation of Dangerous Goods [27], [28] and the regulatory requirements for waste transport and disposal. The necessary packages will be identified, designed, tested and procured prior to decommissioning.

LLW and ILW will be segregated, packaged and stored in CRL waste management areas. LLW that meets the proposed NSDF waste acceptance criteria will be disposed of in the proposed NSDF, once available.

Based upon the proposed cleanup strategy, additional facilities may be required to segregate, screen, process wastes and contaminated materials and contaminated soils. In addition, surface water controls and treatment may be required where excavations will extend below the water table. If large volumes of contaminated saturated soil are required for disposal, dewatering solutions may be required to satisfy moisture disposal requirements.

Emergency response equipment will also need to be located in close proximity depending upon the work taking place. Particularly when working in waste areas where liquid wastes or drummed materials could escape or be released from degraded or damaged containers, provisions will be made to temporarily store these materials in leak proof containers to prevent contaminating surrounding areas.

The groundwater and surface monitoring programs are also an essential tool in recognizing and reducing contamination throughout the site. It also helps identify and assess the potential remediation techniques required to clean up the CRL site as well as verifying their effectiveness.

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5. Applicable Programs and Standards

5.1 Regulatory Framework

The *Nuclear Safety and Control Act* [29] and its regulations, are the primary legislation for the CRL site. Several regulations fall under the *Nuclear Safety and Control Act*. CNL is the licensee responsible for the *CRL Nuclear Research and Test Establishment Operating Licence* [4] and *Licence Condition Handbook* [5] which includes a list of the publications which form the basis of the CRL licence and includes several CSA standards.

The CNSC issues regulatory guidance documents that present general CNSC requirements and expectations, along with recommended approaches that can be followed to meet them. The regulatory documents applicable to the CRL site are listed in CRL's *Licence Conditions Handbook* [5] (i.e., for which CNSC has a regulatory role).

In addition to the Nuclear Safety and Control Act, the CRL site is also regulated by other legislation, including (but not limited to) the following:

- *Migratory Birds Convention Act*, 1994
- *Species at Risk Act,* 2002
- Polychlorinated Biphenyls Regulations, 2008
- *Fisheries Act,* 1985
- Canada Labour Code and Canada Occupational Health and Safety Regulations

Other Federal and Provincial Acts and associated regulations apply to CNL's operating mandate, and specifically to site cleanup, and are documented in CNL's *Environmental Protection Program Requirements Document* [30].

Although the CRL site falls under federal jurisdiction, CNL will, to the extent practical, and to the extent that requirements do not conflict with applicable federal legislation, strive to conform to environmental legislation and associated requirements of general application in force in the province and/or the municipality in which the site is located. For example, the screening criteria being used for non-radiological compounds, to determine the extent of contamination and the need for environmental remediation, are based in part, on the Ontario Ministry of the Environment Soil, Groundwater and Sediment Standards [31], where appropriate.

5.2 CNL/AECL Policies and Commitments

Canadian Nuclear Laboratories has developed a suite of company policies to define CNL's expectations for behaviours in all aspects of CNL activities from Health, Safety Security and the Environment to the protection of Intellectual and Real Property, the Supply Chain and People, Ethics and the Code of Conduct.

In addition to these policies, the *AECL Environmental, Social and Governance Strategy* [32] and *CNL Sustainability Plan* [33] are also applicable to cleanup planning. The *CRL Carbon Neutral Strategy* [34] will also play a role in cleanup processes and approaches.

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5.3 Management System

Chalk River Laboratories maintains a management system comprised of an integrated set of documented policies, expectations, standards, procedures and responsibilities through which CNL is governed and managed, from the setting of direction through to day-to-day operations. CNL's integrated Management System demonstrates and documents the commitment to maintaining a high-level of quality and excellence in the management of all CNL activities within an environment that prioritizes safety and fosters continual improvement. This management system is expected to remain in place until site operations and active decommissioning are completed.

The Management System provides, enables, and defines a detailed framework for full nuclear facility life cycle phases, including construction, commissioning, operations, decommissioning and long-term safety of the nuclear facilities and laboratories at all CNL sites, including the proposed NSDF. The various mature programs and processes already in place will continue to evolve to ensure that all regulatory requirements are achieved.

The management system applies to all CNL management and execution activities. Management activities include setting expectations, enabling, planning and budgeting, and assessing all aspects of business, thereby ensuring delivery against commitments within appropriate accountabilities and controls. Execution activities include the safe, effective and efficient conduct of work across all CNL lines of business, performed by CNL employees as well as third parties engaged through external partnerships, collaboration and CNL's Supply Chain.

The *CNL Management System Manual* (MSM) [35], including subsidiary documents to which it refers, provides the formal reference documentation of CNL's management system. The MSM describes the governance arrangements which enable CNL to operate the assets of AECL and describes and identifies the relevant statutory, regulatory, contractual, and corporate frameworks within which CNL exists and operates. Each Functional Support Area and the associated top tier documents are listed in CRL's *Licence Condition Handbook* under their respective Safety and Control Area and form part of the Compliance Verification Criteria.

5.3.1 Support Programs

Chalk River Laboratories is expected to continue to operate as a Nuclear S&T/industrial site until an undetermined future closure date. During this time, CNL will continue to maintain supporting programs to provide the necessary processes, procedures and guidance in the delivery of safe and effective decommissioning and environmental remediation of the CRL site. These are the key supporting programs:

- Radiation Protection [20], [36]
- Environmental Protection [30], [37]
- Occupational Safety and Health [22], [23]
- Emergency Preparedness [38], [39]
- Fire Protection [24], [25]
- Security [40], [41]

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- Quality Assurance [42], [43]
- Performance Assurance [44], [45]
- Nuclear Criticality Safety [21], [46]
- Nuclear Materials and Safeguards Management [47], [48]
- Site Planning
- Waste Management [49], [50]
- Transportation of Dangerous Goods [27], [28]
- Land Use Planning (Cleanup Function) [51]
- Decommissioning Process (Cleanup Function) [52]
- Environmental Remediation Process (Cleanup Function) [53]
- Engineering [54], [55]
- Safety Analysis [56], [57]

5.3.2 Compliance

The Compliance Program provides the regulatory and licensing framework and the process for independent technical reviews to provide a coordinated and consistent approach in how CNL manages relationships with its regulators. The Compliance Program supports the licencing of CNL nuclear facilities and activities to enable the fulfilment of CNL's mandate. This is accomplished through independent, but related processes to ensure the following:

- A coordinated and consistent approach to how CNL deals with the CNSC regarding company-wide regulatory and licensing matters
- A coordinated and consistent approach to how CNL deals with other regulators (e.g., the Technical Standards and Safety Authority, Environment and Climate Change Canada, and Employment and Social Development Canada) regarding company-wide regulatory and licensing matters
- Independent technical reviews of a proposed nuclear facility or licensed activities before submission to the regulator

The Safety Review Committee and the Nuclear Criticality Safety Panel support independent technical reviews of major safety documentation, related to CNL's licensed facilities and activities, before submission to the regulator. These reviews are based on the type of hazards present and conducted for new facilities, major modifications to operating facilities, decommissioning and environmental remediation activities.

Safety analysis documentation is controlled and periodically reviewed and revised throughout the life of a facility or site. Safety analysis is documented in a manner that is permanently retrievable, facilitates independent review by qualified experts, provides traceability, and is reproducible. Projects at CRL will be subject to this process.

As an example, the safety analysis demonstrates that the following requirements under normal operations, anticipated operational occurrences, design basis accidents, and design extension conditions in the proposed NSDF, have been met:

- The safety of the off-site public, and on-site personnel is protected,

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- The dose acceptance criteria are met for radiological consequences to the on-site and off-site receptors,
- There are no significant adverse impacts on the environment,
- The design of the proposed NSDF conforms to regulatory requirements and guidance provided by the CNSC, and
- The IAEA waste containment is maintained for the duration of the facility operation under normal operating conditions

6. Consultation and Engagement with First Nations, Metis and the Public

Stakeholder, public and Indigenous engagement on the ODCP will be conducted on an ongoing basis and this section summarizes the engagement that has informed the plan up to the date of publication. This aligns with the requirements of Decommissioning of Facilities Containing Nuclear Substances, CSA N294-19 [2]. Included are specific recommendations for stakeholder engagement aspects:

- Public and Indigenous Communications and Engagement Section 5.3 of N294-19 [2]
- Stakeholder Engagement - Annex F1.2, F1.5, H.2 of N294-19 [2].

Canadian Nuclear Laboratories will meet these expectations by providing opportunities for the public and Indigenous communities to provide input into the ODCP. CNL employs a variety of methods and activities to achieve these objectives. Each method or activity is undertaken to build mutual awareness of plans, activities, interests and concerns; share information and support collaboration with various stakeholders. Public, stakeholder and Indigenous participation in the overall process is vital in developing confidence and trust in the cleanup process. Public input will be integrated into the early development of the ODCP and will continue throughout the entire site cleanup process and during any subsequent institutional control period. CNL recognizes the importance of meaningful engagement to build strong relationships with Indigenous Nations. CNL is seeking to understand and incorporate the perspectives and traditional knowledge of Indigenous Peoples in project planning, documentation and reports.

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6.1 Public Information Program

Canadian Nuclear Laboratories Public Information Program is intended to cover public activities that occur at CNL. It has been prepared in accordance with the CNSC Regulatory Document REGDOC-3.2.1 *Public Information and Disclosure*, published in 2018 [58].

As a corporation, CNL makes it a priority to build public awareness, understanding, and a supportive appreciation of CNL's value and relevance to Canadians. In accordance with its *Public Information Program* [59] requirements as outlined in the *CRL Nuclear Research and Test Establishment Operating Licence* [4], CNL will employ a variety of methods to inform, educate, and discuss the project with stakeholders and to enable the public to provide valuable feedback. CNL will employ these methods to meet the engagement objectives outlined in Section 6.2.

6.2 Engagement Objectives

In order to ensure that engagement has informed the ODCP, CNL has developed overarching objectives:

1. Introduce the concepts of the whole-site cleanup plan and ongoing land use to the public, stakeholders and Indigenous communities/organizations
2. Develop meaningful opportunities for the public, stakeholders and Indigenous communities/organizations to provide input and influence CNL's cleanup approach for the CRL site and ongoing opportunities to engage on cleanup activities as they progress
3. Provide greater context to information provided to the public, stakeholders and Indigenous communities/organizations on other CNL projects, for example the proposed NSDF and other enabling facilities
4. Ensure the ODCP, as well as decommissioning and remediation projects, remain reflective of input from the public, stakeholders and Indigenous communities/organizations as it evolves by soliciting and providing their feedback to the CNL project teams
5. Collaborate, understand and incorporate the perspectives and traditional knowledge of Indigenous Peoples in project planning, documentation and reports
6. Meet regulatory requirements related to engagement and provide confidence to the CNSC that mechanisms are in place to ensure that CNL's plans for the CRL site continue to reflect public, stakeholder and Indigenous community feedback

6.3 Engagement with First Nations and Metis Communities

In developing the ODCP, CNL recognizes the importance of meaningful engagement to build strong relationships with Indigenous Nations, communities and organizations. In support, CNL has sought to build meaningful relationships with Indigenous communities and organizations while gaining an understanding of the cultural knowledge of Indigenous Peoples. CNL continues to seek meaningful relationships with Indigenous communities. We acknowledge that Indigenous Peoples have been stewarding and caring for this land since time immemorial, and we remain committed to advancing reconciliation through meaningful actions.

On an ongoing basis, CNL is committed to sharing information and engaging in dialogue and mutual learning opportunities to discuss potential effects of activities at CRL on Indigenous and/or treaty rights, including rights to hunt, trap, fish and conduct cultural ceremonies. CNL will also continue to invite, respond to, and incorporate Indigenous feedback throughout the different phases of the cleanup of the CRL site. It is CNL's ongoing commitment to develop deep, lasting relationships with Indigenous communities and organizations by providing meaningful avenues for participation. This includes CNL's commitment to developing contribution and long-term agreements that include appropriate support to Indigenous Nations, while seeking to understand and incorporate the perspectives and traditional knowledge of Indigenous Peoples in project planning, documentation and reports.

As part of CNL's mission to restore and protect Canada's environment by reducing and effectively managing nuclear liabilities, CNL has embarked on building meaningful, mutually

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beneficial relationships with Indigenous communities and organizations in the interest of safeguarding the environment together. CNL does this through:

1. **Recognition of Rights.** CNL recognizes the constitutionally-protected rights of Indigenous peoples in Canada, and the importance of the relationship between Indigenous Peoples and their traditional lands and resources
2. **Capacity Development.** CNL recognizes that Indigenous Nations and communities have unique interests, priorities, needs and perspectives and will be engaged accordingly, with appropriate capacity supports
3. **Meaningful Engagement.** CNL commits to working with Indigenous communities and organizations in a mutually respectful manner that considers Indigenous perspectives, creating meaningful opportunities for dialogue, participation, and learning. CNL recognizes that the inclusion of Indigenous Knowledge into our projects and across all operations at CNL, helps to improve the way CNL does our work, and helps to build trust and understanding between CNL staff and Indigenous Peoples whose traditional territory is in proximity to a CNL-managed site. We also commit to ensuring that our projects are carried out in an environmentally responsible manner. CNL engages in forthright and sincere engagement with Indigenous communities and organizations about CNL projects through processes that are open, transparent, easily accessible, and that seek to achieve trust
4. **Economic Partnerships.** CNL seeks opportunities for mutual economic benefit with Indigenous communities. CNL is developing an *Indigenous Procurement Policy* which continues to evolve. The main objective is to attract more Indigenous businesses to act as contractors or sub-contractors on projects that CNL manages
5. **Journey towards Reconciliation.** CNL is also preparing a *Reconciliation Action Plan*, which is intended as a foundation that guides CNL's decision-making and helps to actively promote the national reconciliation movement through commitments and leadership. Reconciliation is about strengthening the relationships

Canadian Nuclear Laboratories is committed to reconciliation. CNL's commitment is demonstrated by incorporating the principles from the Calls to Action found in the Truth and Reconciliation Commission (TRC) report [60] into our draft *Reconciliation Action Plan*, and thereby, our daily work.

The draft Reconciliation Action Plan undertakes to use the TRC Call to Action #92 [60] to guide its development. Action #92 calls upon the corporate sector in Canada to adopt the principles of the United Nations Declaration on the Rights of Indigenous Peoples and to apply it to our corporate policy and core operational activities involving Indigenous Peoples, their lands, and resources.

Canadian Nuclear Laboratories draft *Reconciliation Action Plan* (in development) acknowledges the United Nations Declaration on the Rights of Indigenous Peoples and its clauses pertaining to Free, Prior and Informed Consent as a framework that recognizes the basic human rights and rights of self-determination of Indigenous people. As a company, CNL commits to meaningful engagement in the spirit of Free, Prior and Informed Consent, long-term sustainable benefits to

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Indigenous businesses from economic development, and education and training for staff and management about the history of Indigenous peoples. Canadian Nuclear Laboratories draft *Reconciliation Action Plan* (in preparation) also includes:

- Developing measures to break down barriers to Indigenous access to jobs, training, and education opportunities in the corporate sector, as well as seeking ways to increase opportunities for Indigenous businesses to gain long-term sustainable, economic benefits from projects that CNL manages
- A commitment to ensure that CNL staff and management are provided training on the history of Indigenous peoples. By better understanding each other, we can continue to move toward reconciliation

These efforts are also guided by CNSC REGDOC-3.2.2 *Indigenous Engagement* [61].

6.4 Dissemination of Information to the Public

In accordance with CNL's *Public Information Program* [59], information is disseminated in a number of ways:

- Canadian Nuclear Laboratories corporate website: www.CNL.ca
- Posts with specific environmental information
- Reports on site environmental performance are posted quarterly
- Community Information Bulletins
- Press releases and media releases
- CONTACT newsletter
- Community meetings
- Community events
- Webinars
- Technical discussions
- Presentations and site tours
- Public engagement activities
- Social media (Facebook, Twitter, YouTube, LinkedIn and Instagram)

Canadian Nuclear Laboratories has established a specific webpage for the Cleanup Function: www.cnl.ca/LUP which includes information on the Land Use Program and a specific webpage for the Community Advisory Panel: www.cnl.ca/CAP. Information will be added to both webpages as it becomes available and webpage activity continues to be tracked.

6.5 Chalk River Laboratories' Community Advisory Panel

The objective of the Chalk River Laboratories' Community Advisory Panel (CAP) is to bring new voices from the Renfrew and Pontiac communities into the dialogue with CNL.

Through the CAP, CNL hopes to increase understanding, grow its appreciation of the communities' diverse perspectives, and enable members of the community to access first-hand knowledge about CNL activities.

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Discussions between CNL and the CAP focus on the activities that are subject to licensing and environmental regulation as well as activities that may affect the social and economic life of the community. This will include an ongoing focus on the ODCP and environmental remediation projects.

Canadian Nuclear Laboratories has hosted CAP meetings on a quarterly basis since September 2021. The CAP meetings are facilitated by independent third-party facilitators.

6.6 Environmental Stewardship Council at CRL

To provide stakeholders opportunities for dialogue and feedback, CNL established the Environmental Stewardship Council (ESC) in 2006. The ESC is independently facilitated and comprised of members of public interest groups, Indigenous communities and organizations, and members designated by local councils and representatives from CNL.

The council openly discusses a broad range of matters of mutual interest to both CNL and the community, to seek input for solutions to remediate and/or continually improve CNL's environmental performance and provides ongoing and consistent two-way interactions with community stakeholders on CNL's business (not just environmental issues). The ESC meets three times a year.

6.7 Key Public Engagement on CRL Cleanup Planning to Date

Key Engagement that has been held up to December 2022 in the development of the ODCP is shown in Table 2.

Table 2: Summary of Engagement Activities to Date

Activity	Input/Feedback
Environmental Stewardship Council Meeting – 2021 June 24	The ESC was introduced to the CAP plans, including the CAP mandate and meeting schedule. Following the updates, members had the opportunity to seek clarification and ask any questions.
Community Advisory Panel Website Launch - 2021 July 07	CNL launched the CAP website and the application process for interested community members to apply for the CAP. The CAP webpage is updated following each CAP meeting with the meeting agenda and notes. The CRL CAP will meet on a quarterly basis.
Community Advisory Panel (#1) - 2021 September 9	Prior to the meeting, CAP members responded to a survey designed to determine their priorities regarding environmental issues. At the meeting, the CAP was introduced to CNL and the ODCP. During the session members had the opportunity to seek clarification and ask any questions.

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Environmental Stewardship Council Meeting – 2021 October 21	The ESC was briefed on the first CAP meeting, including the agenda and key themes from the meeting. Following the updates, members had the opportunity to seek clarification and ask any questions.
CNL Cleanup Function: Land Use Program page Launch on CNL Website- November 2021	CNL launched the Cleanup Function: which manages the Land Use, Decommissioning and Environmental Remediation Programs.
Community Advisory Panel (#2) - 2021 December 2	The CAP was introduced to the basics of radioactivity and the proposed Near Surface Disposal Facility (NSDF) project. Following the presentations, members had the opportunity to seek clarification and ask any questions. The CAP provided input on the ODCP Vision and Mission statements as well as the *Why NSDF?* video.
Community Advisory Panel (#3) **2022 March 10**	The CAP was introduced to waste management practices at CRL and plans for enabling facilities. There was a presentation on environmental characterization and a discussion over potential remedial options that may be used to deal with the presence of contamination at CRL. This was followed by a discussion with the panel on opportunities, risks and challenges associated with these options. The CAP also provided feedback on NSDF hearing communication efforts to date.
Community Advisory Panel (#4) **2022 June 9**	The CAP began with a review of the remediation options from CAP 3. The CAP was introduced to potential next land uses at CRL. There were presentations on the key elements of cleanup planning, cleanup objectives and criteria, and next land uses at CRL by Management Units. The CAP worked through an exercise on the potential land uses at the site and discussed land use considerations.
Community Advisory Panel (#2-1) **2022 September 8**	This CAP meeting was in-person for those who could attend and the others were accommodated virtually. Those present on site were taken on an informative tour of the New Spring B Groundwater Treatment Facility. This was followed by a session with the full CAP where they provided review and feedback on draft Cleanup Function and ODCP communications materials.
Community Open Houses **2022 November 8 – 24**	CNL hosted in-person Public Information Sessions throughout the month of November in the communities surrounding CRL. CNL staff provided the public with information on the plans to restore and protect the environment at the CRL site, answered questions and noted feedback. Each session featured information on CNL's overarching waste strategy program, on plans for the cleanup of the Chalk River site, and on the

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	proposed Near Surface Disposal Facility Project and Nuclear Power Demonstration Closure Project.
Community Advisory Panel (#2-2) **2022 December 8**	This CAP meeting was in-person for those who could attend and the others were accommodated virtually. CAP members were given a presentation on the Nuclear Power Demonstration Closure Project. The Actinium-225 Project was introduced and CAP members completed a workshop to assist CNL in developing an engagement plan. This was followed by a session on the ODCP Principles and Goals, to gather input. The feedback provided insight that will be used to further refine the principles in broader communications products. Some suggested modifications to the language of the current principles are reflected in Section 8.4. CAP members agreed that 'Ensure Safety' and 'Protection of Human Health and the Environment' were the two principles of highest importance but that all the principles identified should be considered in cleanup planning.

6.8 Planned Future Public Engagement

Canadian Nuclear Laboratories priority in all engagement activities is the safety of the public and its employees. Thus, CNL will continue to ensure all stakeholder engagement activities are in alignment with applicable public health guidance and corporate policy related to the COVID-19 pandemic. To this end, CNL continued with virtual engagement activities until it was safe to return to in-person engagement in summer/fall of 2022.

Canadian Nuclear Laboratories will continue to engage the public through a variety of mechanisms–demonstrating transparency and access to information. CNL will continue to promote all revitalization and cleanup plans, including decommissioning and remediation milestones and significant events such as the Environmental Assessment milestones.

Through public information sessions, site tours, meetings of the ESC and CAP, engagement with Indigenous communities and organizations, website updates, and social media, CNL will continue to share information about the ODCP and the cleanup mission.

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7. Environmental Protection Program

The Environmental Protection (ENVP) Program requirements apply to all operations and activities that may affect the environment in and around CNL sites and utilizes a life-cycle approach. The ENVP Program at CRL covers the Environmental Management System for the operation of nuclear facilities, conducting research and development to support science and technology, waste management and decommissioning activities. The CRL site is registered to the ISO 14001:2015 standard for Environmental Management Systems [62].

The mandate of the program is to ensure staff and contractors practice responsible environmental management, to ensure environmental regulatory compliance of all activities on CNL sites and support the implementation of CNL's *Environment Policy* [63].

Focus areas of the ENVP program that support Decommissioning and Environmental Remediation activities include:

- Environmental reviews of non-routine activities to identify potential impacts, identify mitigation measures and ensure no significant adverse environmental effects occur (Section 7.1)
- Management of the natural environment and protection of species at risk (Section 7.2)
- Ensuring sustainability is considered in the operating of the CRL site (Section 7.3)
- Conduct of Environmental Risk Assessment of the CRL site on a five year cycle to evaluate potential impacts of ongoing operations on the environment (Section 7.4)
- Integrated Environmental Monitoring Program to monitor releases to the environment from CRL operations and contaminant concentrations in environmental media and groundwater (Section 7.5)
- Tracking and reporting environmental incidents (Section 7.6)

7.1 Environmental Reviews

Canadian Nuclear Laboratories conducts environmental reviews of non-routine activities in accordance with the requirements of the *Impact Assessment Act* (IAA) [64], CNL's *Environment Policy* [63] and CNL's Environmental Protection Program [30], [37]. These reviews serve to ensure that activities are considered in a careful and precautionary manner to avoid significant adverse environmental effects.

The category of environmental review will be determined through CNL's classification process in collaboration with AECL and will be commensurate with the level of risk presented by the proposed activities.

If decommissioning and environmental remediation activities on the CRL site are subject to the requirements under s.82 of the IAA, the project will be required to disclose the proposed activities on the IAA Registry, providing opportunity for involvement from interested members of the public and Indigenous groups. After the public comment period is over, AECL posts a determination on whether significant adverse environmental effects will be caused by the proposed project.

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7.2 The Natural Environment

Details on the vegetation species (including rare plants), terrestrial wildlife, and fisheries and aquatic habitat at the CRL site are presented in the *CRL Site-wide Environmental Risk Assessment* (ERA) [11], which is updated every 5 years.

The ERA includes a sub-set of environmental values, known as Valued Components (VC), that have been identified as requiring special attention at CRL as CNL carries out its operations. VCs are defined as being "Environmental features that may be affected by a project and that have been identified to be of concern by the proponent, government agencies, Aboriginal peoples or the public. The value of a component not only relates to its role in the ecosystem, but also to the value people place on it. For example, it may have been identified as having scientific, social, cultural, economic, historical, archaeological or aesthetic importance." [65]. Importance may be determined on the basis of cultural values or scientific concern and VCs should be:

- Recognized under International or Federal legislation and afforded protection,
- Recognized as being rare, sensitive or unique,
- Representative of significant food-chain pathways for uptake by biota, and/or
- Recognized by the public as being important

The terms "VCs" and "receptors" are often used interchangeably. All VCs can be receptors, however, not all receptors are VCs. Receptors may be surrogate organisms rather than actual plant or animal species (e.g., a benthic feeding fish species), communities (e.g., a benthic macroinvertebrate community), a specific species (e.g., an endangered species), or a significant ecological feature such as a wetland. Using an ecological receptor to represent the VC allows the potential for adverse effects to be assessed through contaminant pathways. The VCs for the CRL site are listed in the CRL ERA [11].

7.2.1 Species at Risk

Canadian Nuclear Laboratories has developed and maintained a thorough database of plant and animal populations on the CRL site, with a particular focus on species at risk. In 2008, CNL initiated an inventory program for Species at Risk listed under the *Species at Risk Act* [66] and the *Ontario Endangered Species Act* [67] as well as candidate species listed by the *Committee on the Status of Endangered Wildlife in Canada* (COSEWIC) [68]. All of the suitable areas on the CRL site that may have been of importance for candidate species listed under the *Species at Risk Act* have been inventoried and documented.

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The following lists several of the relevant studies and initiatives that have been undertaken at the CRL site in order to protect at risk species:

- Over the years, the presence of a number of vulnerable species have been confirmed on the CRL site, including endangered turtle, bat and bird species. CNL has undertaken a number of mitigative measures to help protect and accommodate these animals and their habitat. These include: The construction of larger concrete culverts to allow safe passage of turtles and other small animals beneath Plant Road, the installation of permanent exclusion fencing along the sides of the road to aid in funnelling the turtles through the culverts, and signage to alert drivers to be cautious of turtles crossing
- A research study in collaboration with the University of Ottawa began in May 2022 as follow-up to a study conducted in 2015 that identified the movement pattern of the CRL Blanding's turtle (*Emydoidea blandingii*). With the installation of the new eco-passages, CNL will assess whether the local population of Blanding's turtle is undertaking longer movement facilitated by the new crossing structures and also evaluate if the road mortality has decreased due to the system of fencing and availability of new nest mounds located in key locations
- Speed limits along Plant Road were reduced and the installation of traffic cameras to monitor and enforce compliance to aid in reducing the potential for road mortality of all wildlife species prone to road crossing
- A study with Trent University examined the roosting behaviours of Chimney Swifts (*Chaetura pelagica*) and determined that ventilation stacks have become essential roosting locations for this species. CNL is working to preserve these structures
- The installation of artificial nesting structures for Barn Swallows (*Hirundo rustica*)
- The installation of bat boxes for endangered bat species, including the Little Brown Myotis bat (*Myotis lucifugus*), the Northern Myotis bat (*Myotis septentrionalis*), the Tri-colored bat (*Perimyotis subflavus*) and the Eastern Small-footed Myotis (*Myotis leibii*) bat. CNL has also completed a research project with Trent University to find other maternity roosting sites for these bats to protect their habitat and developed a Habitat Suitability Index for the CRL site identifying high quality habitat for roosting
- Canadian Nuclear Laboratories is also planning to identify and protect Monarch Butterfly (*Danaus plexippus*) habitats, which are essential to the lifecycle of these endangered insects

The potential for impacts to species at risk are considered prior to all activities and projects at CRL via CNL's Environmental Review process. Preventative and mitigative measures are put in place in any case when species at risk or other wildlife may be affected (such as timing restrictions during bird nesting season, requirements for visual species surveys prior to ground works, etc.).

For detailed lists of species at risk that have been confirmed as present or are considered potentially present on the site from species surveys conducted since 2009 see the CRL ERA [11].

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7.2.2 Sustainable Forest Management Plan

Canadian Nuclear Laboratories has a strong commitment to preserving the natural areas at CRL and is developing a Sustainable Forest Management Plan for the CRL site. The plan will ensure that the forest composition and age structure present on the CRL site is maintained and continues to provide habitat for a wide range of species and species at risk. The Sustainable Forest Management Plan proposes management of the forest at CRL using several management strategies such as selective cutting, shelter wood and clear-cut systems to mimic the natural disturbances of the Great Lakes St. Lawrence forests to emulate natural succession. CNL is developing the Sustainable Forest Management Plan with input from local Indigenous communities.

7.2.3 Vegetation Control

Vegetation control is an integral part of the institutional controls required for the management of wastes currently stored within WMAs as well as legacy contaminated lands. Inadequate vegetation control can result in contamination spread through leaf litter which will ultimately increase the volume of contaminated media that will require disposal when these areas are eventually remediated.

Canadian Nuclear Laboratories has committed to ongoing effective vegetation management via routine inspection, monitoring and surveillance of waste management facilities and legacy contaminated lands.

7.3 Sustainability Plans and Outcomes

As noted in Section 5.2, sustainability strategies and plans will play a core role in cleanup processes, approaches and plans. The *CNL Sustainability Plan* [33] (which aligns with the *AECL Environmental, Social and Governance Strategy* [32]) objectives and outcomes (in particular, those listed in Table 3) will inform the cleanup strategy.

Table 3: CNL Sustainability Focus Areas and Objectives Applicable to Cleanup Planning

Focus Area	Objective
Greenhouse Gas Emissions	Minimize greenhouse gas emissions at sites
Non-radiological waste management	Prevent and minimize the production of conventional waste, wherever possible, while reusing and recycling waste when it is generated
Radiological waste management	Support the Government of Canada's commitment to a clean and healthy environment for Canadians via the Environmental Remediation Management Mission
Biodiversity	Responsibly manage CNL sites and activities to ensure the protection of local wildlife and the environments that surround them
Climate Resilience	Consider climate resilience in decision making for all major infrastructure and operational decisions

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7.4 CRL Site-Wide Environmental Risk Assessment (ERA)

A recent update to the CRL site-wide Environmental Risk Assessment (ERA) was completed in 2018 [11] in accordance with CSA standard, *Environmental risk assessments at Class I nuclear facilities and uranium mines and mills*, N288.6 [69]. The CRL ERA evaluates risks to relevant human and ecological receptors associated with potential exposure to contaminants and stressors as a results of the contamination present on-site, today. It also serves to identify where additional data is required to confirm or reduce uncertainties in the assessment. The ERA primarily assesses the existing data gathered for environmental compliance monitoring and special investigations which is focused on non-operational areas and on groundwater, surface water and atmospheric releases (e.g., soil contamination within WMAs and other areas of potential environmental concern is not evaluated).

The areas of greater concern at CRL for environmental protection are MU 3, 6, 8 and 11, due to the presence of contaminant plumes extending to nearby wetlands and MU 4 due to potential turtle mortality associated with vehicles. MU 1 and 7 exhibit intermediate risk levels while MU 2, 5, 9 and 10 exhibit lower risk levels [11].

7.5 Integrated Environmental Monitoring Program

Chalk River Laboratories *Integrated Environmental Monitoring Program* [70] is part of CNL's Environmental Management System. A summary of the Annual Compliance Monitoring Report on Environmental Monitoring is publicly available on www.cnl.ca. The results of the EMP are considered in developing characterization and environmental remediation plans for the various areas of concern on the CRL site.

The EMP is designed to track radiological and non-radiological contaminants throughout the different compartments of the geosphere, atmosphere, and biosphere and consists of three distinct programs: the Effluent Verification Monitoring Program (EVMP), the Environmental Monitoring Program (EMP) and the Groundwater Monitoring Program (GWMP).

The Effluent Verification Monitoring Program evaluates the quality of both air and liquid discharges to the environment from CRL operations. The Environmental Monitoring Program evaluates the receiving environment, with monitored media ranging from ambient air and surface water, to deposition, fish, and game animals, etc. The Groundwater Monitoring Program evaluates potential impacts on groundwater quality and guides environmental remediation activities. Where there is the potential for environmental impacts remedial measures are undertaken. To date, four groundwater treatment systems have been implemented on the CRL site.

The Groundwater monitoring program includes two types of monitoring activities, operational control monitoring and plume monitoring.

Operational control monitoring is conducted at 32 monitoring sites and includes over 190 monitoring wells. Monitoring sites include nuclear facilities in the developed area, the perimeter of waste management areas and the Ottawa River shoreline. Monitoring serves to identify potential impacts on groundwater quality at these sites. The monitoring is done on an

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annual/semi-annual basis with up to 200 different parameters at a location. Over 1900 samples are collected and over 25,000 analyses are performed each year.

Plume monitoring serves to identify potential environmental impacts from past contaminant releases, to determine the extent of the contamination, contaminant inventories and to project future plume migration. Plumes are monitored on a five or ten year cycle.

The Integrated Environmental Monitoring Program is designed and managed according to the following standards; *Environmental monitoring programs at nuclear facilities and uranium mines and mills*, CSA N288.4 [71], *Effluent and emissions monitoring programs nuclear facilities*, CSA N288.5 [72] and *Groundwater protection programs at Class I nuclear facilities and uranium mines and mills*, CSA N288.7 [73]. Annual reports are prepared for each of these programs and monitoring plans have been prepared outlining the required monitoring for each element of the program:

- Effluent Verification Monitoring Program [74], [75]
- Environmental Monitoring Program [76]
- Groundwater Monitoring Program [77]

In effect, the Integrated Environmental Monitoring Program [70] achieves three main tasks:

a. Direct release monitoring (via the EVMP);
b. Contaminant pathways monitoring (via the combination of EVMP, GWMP, and EMP)
c. Biological effects monitoring (via the EMP).

The Integrated Environmental Monitoring Program is dynamic in nature meaning that it is continually evolving based on various sources of information received as well as requests for information required to plan for cleanup at a site. A depiction of this dynamic nature is illustrated in Figure 6 [70].

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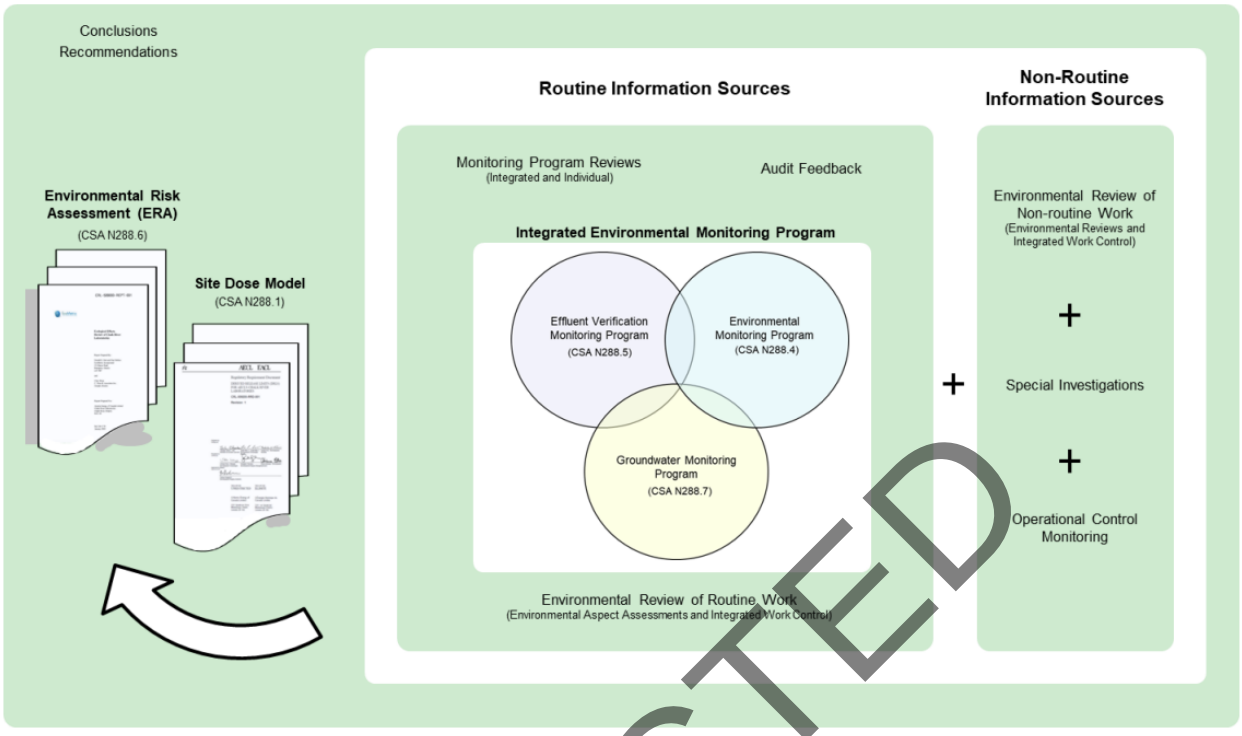


Figure 6: Dynamic Nature of CRL's Integrated Environmental Monitoring Program

Canadian Nuclear Laboratories is committed to maintaining the Integrated Environmental Monitoring Program into the future as part of the verification of progress toward accomplishing the cleanup mission.

7.5.1 Monitoring for Potential Off-site Impacts

Potential off-site impacts are monitored through CRL's Environmental Monitoring Program which includes off-site locations. Monitored media include ambient air, Ottawa River water for the reach of the Ottawa River extending from Rolphton upstream of CRL to Pembroke downstream of CRL, and various foodstuff (e.g., fish, garden produce, large game, and farm animals). Monitoring of beach sand, ground surfaces, local vegetation, small animals and meteorological conditions is also performed.

Historic operations, waste management activities, environmental incidents and process discharges have the potential to impact nearby communities or the surrounding environment. There are currently limited activities which could release significant non-radiological air pollutants, which would include for example greenhouse gases and criteria air contaminants from the Power House and other smaller sources. Discharges to the river from storm sewer outlets and from process water piping are monitored as part of the effluent monitoring program.

Environmental releases from operations and from a number of areas of concern have also occurred. For the most part these are associated with groundwater contaminant plumes and surface water transport. Groundwater plumes on the CRL site have been well delineated and

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characterized through CNL's GWMP. To date, based upon the extensive off-site environmental monitoring program, the impacts from these contaminant releases both in groundwater and surface water have not been observed outside of the site boundaries.

More information on the sources of the contaminant plumes as well as the four groundwater treatment facilities in place serving to reduce the downgradient transport of contaminants, are provided in Appendix A.

7.6 Incident Tracking

Incidents or accidents that could affect cleanup, are tracked via CNL's *ImpAct Process* [79], as well as in lessons learned, annual reports, etc. These records are retained and referenced when the area, building or facility is transferred for management under the Decommissioning Process or the Environmental Remediation Process and are documented in project completion reports.

Any environmental incidents are reported according to the Environmental Protection Program requirements and investigated to determine corrective or preventive actions and ensure that environmental incidents are appropriately mitigated. Incident response and mitigation procedures and capabilities are maintained for all facilities, processes and activities with identified environmental aspects.

Response and mitigative actions to anticipated environmental incidents are addressed in the facility/operation/project/building specific emergency procedures. Equipment required for incident response and mitigation within facilities, for operations and for projects is identified and made available in clearly identified designated locations. Any environmental events/incidents that occur are documented and tracked within the CNL's *ImpAct Process* [79].

Canadian Nuclear Laboratories reporting procedure to Regulatory Agencies [80] describes the requirements, processes, and responsibilities for reporting by CNL to the CNSC as required by the *Nuclear Safety and Control Act* [29] and associated regulations as well as other regulatory agencies, as per the applicable legislation. CNL is required to report to CNSC staff on unplanned situations or events, along with providing annual safety and compliance monitoring reports.

8. Cleanup Vision, Mission, Goals, Objectives and Principles

The previous CRL end-state plan, as documented in the 2018 CPDP [1], was for any contaminated or otherwise unacceptable hazardous infrastructure, soil, sediments, surface water and groundwater to meet risk-based cleanup criteria based upon an assumed future industrial land use with some areas qualifying for unrestricted use. The ODCP proposes a revised approach to cleanup planning that uses a scenario approach to enable optimal cleanup of the site. Site revitalization projects will be optimized through the beneficial reuse or redevelopment of environmentally impacted areas of the site taking into account several factors such as redevelopment potential, compatibility with surrounding land uses, ecological value, community needs, nearby infrastructure and services, and environmental mitigation measures, where needed.

Consequently, CNL has adopted screening criteria for radiological and non-radiological compounds according to three potential future land uses at CRL. The land uses under

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consideration for CRL include unrestricted use (based on a conservative agricultural land use scenario), parkland use (a casual access recreational scenario), and industrial land use - see Section 9.1.2 for detailed descriptions. An area of the site may be released from regulatory control, if appropriate, once a targeted end-state land use is achieved.

Ultimately next land uses and end-states for each of the MUs, or in some cases portions of a large MU, will be discussed with stakeholders and will be integrated from a site-wide perspective (considering the current and future use of surrounding land) and alignment with the ongoing site revitalization and nuclear S&T mission.

Considerations for the future determination of a site wide end-state for CRL will include:

- End-states of adjacent MUs
- Likelihood of currently unaffected lands to remain unaffected for the duration of the operational phase of the site
- Accessibility to various areas on site
- Location of site infrastructure
- Development potential to support the ongoing mission,
- Proximity to military facilities
- Potential industrial corridors
- Values of the surrounding communities/stakeholders
- Indigenous Peoples traditional land and resource uses (see Section 6)
- Critical habitat for species at risk
- Long-term future beneficial use of the CRL site

8.1 Cleanup Vision and Mission

Canadian Nuclear Laboratories has developed the following vision and mission statements for the cleanup of the CRL site. The vision describes the long-term objective while the mission describes what we are doing today in order to reach that objective.

The Cleanup Vision and Mission Statements were developed with input from the CRL Community Advisory Panel (CAP) to ensure they accurately reflect public concerns and values (see Section 6). Ongoing engagement, including that with Indigenous communities, may lead to further refinement of these statements.

CRL Cleanup Vision

Successful mitigation and remediation of impacts from historical operations at Chalk River Laboratories, while protecting health, safety and the environment during operations now and into the future.

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CRL Cleanup Mission

As a world class nuclear research facility, Chalk River Laboratories is committed to the long-term management of waste, the decommissioning of aging facilities, and the environmental remediation of impacts associated with past operations.

All present and future activities will be designed to support day-to-day operational safety and long-term environmental protection of the site and surrounding communities. Science-based solutions along with community, stakeholder and Indigenous values will guide progress towards the desired end-state of the site and the advancement of nuclear science and technology for a clean and secure world.

8.2 Preliminary Site Cleanup Goals

The underpinning requisite for the cleanup of the CRL site is the continued protection of human health and the environment. Environmental protection, human health and safety are CNL's and AECL's highest priorities.

Targeted outcomes applicable to cleanup planning that have been committed to as part of CNL's sustainability focus areas are described in Section 7.3 and Table 3.

Additional SMART—specific, measurable, achievable, realistic, and time-bound – goals for the cleanup of the Chalk River site will be determined as planning progresses. CNL will include engagement with stakeholders and Indigenous communities in the development of the goals and maintain transparency by externally reporting on progress. These goals will be consistent with Canadian regulations and guidance and will be based on the following high-level objectives:

i. Implementing modern solutions to contain and isolate hazards from people and the environment.

ii. Meeting the conditions for interim or end-state land uses that are protective of human health and the environment.

iii. Minimizing the nuclear legacy liability, i.e., risks to human health and the environment, and cleanup costs to today's taxpayer and to future generations.

iv. Making brownfield land available for redevelopment to support the going S&T mission at CRL.

The goal of minimizing the nuclear legacy liability will be achieved by developing and implementing decommissioning and environmental remediation solutions that reduce Monitoring and Surveillance and other landlord costs.

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Minimizing liability can be facilitated by early removal or control of sources of contamination, by implementing risk-based solutions or by consolidating contamination sources into a modern engineered and monitored disposal facility to reduce the contamination footprint on the CRL site. These cleanup actions may also address AECL's business needs by making land available for new facilities at CRL. Land remediation may also yield economic benefits when the cleanup results in an opportunity for another activity on-site (e.g., providing contaminated soil for void space management in the proposed NSDF).

Cleanup activities will not result in the elimination of all radiological or non-radiological contamination on the CRL site. Risk assessment will therefore underpin the determination of the short-term and long-term management strategies and any necessary controls to ensure protection of human health and environmental receptors. These controls will be developed from a holistic perspective, ensuring effectiveness over the long term as site cleanup activities progress.

Pollution prevention efforts and waste minimization programs and targets can also be effective tools in achieving site cleanup goals.

8.3 Recommended Dose/Concentration Cleanup Objectives

The following recommended radiological and non-radiological end-state cleanup objectives are protective of both human health and environmental receptors, (i.e., are aligned with the cleanup goals described in Section 8.2).

The radiological objectives for contaminant exposure are based on International best practice, as recommended in Canadian guidance, and are proposed as:

- 0.3 mSv/yr[4] incremental (above background) maximum effective dose for humans [2]
- 400 µGy/h maximum absorbed dose for aquatic biota (protection at the population/community level) [69]
- 100 µGy/h maximum absorbed dose for terrestrial biota (protection at the population/community level) [69]

Exceeding these objectives for biota in a preliminary quantitative assessment would indicate a potential for adverse effects and a need for further (detailed) assessment based on actual effects monitoring or more realistic exposure data monitoring [69].

Proposed objectives for non-radiological contaminants are either i) concentration limits at or below the most appropriate Federal and/or Provincial soil contaminant standards, after background conditions have been considered, or ii) below site-specific, risk-based criteria developed in accordance with Federal and/or Provincial guidance [31], [81].

The benchmarks to be used in risk assessment for non-radiological contaminants are:

[4] 0.3 mSv/yr takes into consideration potential effects from multiple activities (or 'practices', in accordance with N294-19 Section F.2.4 [2]) ongoing at CRL, of which cleanup is one activity, in order to keep the dose to the public constrained to below 1 mSv/yr.

- An Incremental Lifetime Cancer Risk of one in a million or a hazard quotient of less than 1 for humans [69],
- Lowest Observed Adverse Effect Level (LOAEL) for biota, i.e., protection at the population/community level (e.g., EC20 (20% effects concentration)) [69], and
- Species at risk are to be protected at the individual level (e.g., No Observed Adverse Effect Level (NOAEL)) [69]

8.3.1 Radiation Protection

The Radiation Protection Program (noted in Section 5.3, [20], [36]) applies to the operation and activities that affect the safety of staff and equipment in terms of exposure to ionizing radiation at all CNL sites and applies to all employees and other personnel (e.g., visitors and contract staff) conducting work at CNL sites. The Radiation Protection Program applies to all activities conducted where CNL holds a CNSC issued licence in Canada.

The objective of the Radiation Protection Program is to ensure demonstrable compliance with applicable regulatory requirements, such as the Radiation Protection Regulations and acts, and to maintain doses to workers as low as reasonably achievable (ALARA), taking into account social and economic factors. CNL applies the ALARA principle to all activities involving the use of ionizing radiation. All radiation doses to personnel or members of the public are justified, in accordance with the ALARA principle, and maintained below regulatory limits.

Dosimetry is a necessary component of the Program. It provides a quantitative measure of the effectiveness of the Radiation Protection Program, as it applies to both the individual worker and the collective workforce. Dosimetry is a fundamental requirement for the demonstration of compliance with regulatory obligations mandated by the site licence. Dosimetry services for personnel and visitors are provided by CNL and are managed according to the CNL Dosimetry Program. These services include monitoring, assessing, recording, and reporting doses of ionizing radiation received by all individuals while on-site.

8.4 Cleanup Planning Principles

The goals and plans for cleanup at the CRL site will be guided by the application of science-based principles underlying international best management practices on establishing end-states and executing successful decommissioning and environmental remediation. These principles will be further discussed during engagement with public stakeholders, interested members of the public, and Indigenous communities and are outlined in Table 4.

Table 4: Cleanup Planning Principles to be Applied at CRL

Principle Title	Principle Description	Applicable Section(s):
Ensure Safety	CNL will have the capability to secure and maintain the safety to workers and the public of its undertakings. CNL will demonstrate an effective understanding and control of the hazards posed by a site or facility through a comprehensive and systematic process of safety	Sections 4.5 and 4.6

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Principle Title	Principle Description	Applicable Section(s):
	assessment. Safety assessments, that are kept up to date as work progresses, will be used to demonstrate the safety of the plans for managing and cleaning up contaminated structures and lands and associated controls.	
Protection of Human Health and the Environment	CNL is committed to managing radiological and non-radiological hazards at all sites to ensure the protection of human health and the environment, now and in the future. CNL adopts the precautionary principle whereby, in the absence of scientific certainty, we apply appropriate mitigating measures to prevent environmental degradation.	Section 7
Robust Characterization in Support of Science-Based Solutions	Contaminated lands and structures will be characterized to adequately understand hazards and provide information to support environmental remediation decisions. Robust characterization will facilitate effective planning to enable safe execution of remediation as well as ensuring the characterization will be done following defensible methods to ensure the integrity of the data.	Sections 9.1.1, 9.2, and 9.3
Effective Record Keeping	CNL is committed to effective record keeping and arrangements will be made, implemented, and managed for recording and preserving the information required for the safe and effective control and stewardship of contaminated land now and in the future.	Section 15
Transparent Reporting	CNL is committed to open and honest communications about our activities and performance. CNL routinely reports the results of monitoring and compliance programs through open and transparent communication with stakeholders and to assure the public that CNL makes every effort to keep the impact of our work to a minimum.	Sections 6, 7.6 and 8.2
Meaningful Consultation and Engagement with First Nations and the Public	CNL is committed to visibility and transparency in cleanup decision making and will engage with the public and Indigenous communities appropriately and early in the determination of next land uses, end-states and proposed remedial actions, including the use of institutional controls where residual contamination will remain.	Section 6
Risk to Workers, the Public and the Environment kept ALARA	A balanced approach is required to ensure that the intended benefits from CNL cleanup actions taken outweigh any potential for undesirable effects. Cleanup actions for radiological compounds at any CNL site are deemed reasonably achievable, when overall benefits of the actions outweigh potential adverse impacts to either economics, human health or environmental factors.	Sections 8.4 and 9

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Principle Title	Principle Description	Applicable Section(s):
	Actions taken to reduce risks from one hazard should not result in higher cumulative risks.	
Consolidate Source/Impacted Areas into Modern, Controlled Engineered Facilities	CNL is committed to the minimization and mitigation of environmental impact. Identified contamination sources will be remediated in accordance with the ALARA principle, or identified in an environmental risk assessment, and wastes will be consolidated in designated disposal areas to shrink the contamination footprints within each as well as across all CNL sites.	Sections 1.1, 4.3, and 8.2
Minimize Institutional Controls	Where the risks and impacts to the environment, human health, and the economy are justifiable and feasible, CNL will strive to bring a site to a future condition at which it can meet unrestricted use. Where this condition is deemed achievable, the site should be brought to an interim end-state from which it can eventually be released from radioactive substances regulation, and in a manner which places a progressively reducing reliance on human action to protect people and the environment against radiological and non-radiological hazards.	Sections 9.4 and 12
Reduce Long-term Nuclear Liability	CNL has undertaken the task to responsibly address the legacy waste of the early decades of nuclear research and development in Canada. This work is being delivered with an unwavering commitment to responsible environmental stewardship.	All
Strategic Site Planning/ Integration	CNL teams work to address legacy liabilities and cleanup challenges by planning in collaboration and finding optimal cross-organizational solutions in line with the principles listed in this section. A strategy shall be produced for the control and cleanup of all contaminated land on the site. Next land use will be considered throughout project planning for fiscal responsibility and environmental stewardship.	Sections 4.3.5 and 9.1.2
Sustainability	CNL is committed to sustainable cleanup, which consists of remedial actions that deliver a net benefit and are informed by the short- and long-term impacts on safety and the environment, society and the economy, natural resources and climate change. The *AECL Environmental, Social and Governance Strategy* [32] is applicable to cleanup planning. *CNL's Sustainability Plan* [33] and the *CRL Carbon Neutral Strategy* [34] will also play a role in developing cleanup processes and approaches.	Section 5.2 and 7.3
Support Clean Energy Solutions by Optimizing Land Use	To help the Government of Canada achieve its national target	Sections 4.1, 4.3.5, 8, 9 and 11

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Principle Title	Principle Description	Applicable Section(s):
	of net-zero emissions by 2050, CNL is advancing clean energy technologies for today and tomorrow, including small and advanced nuclear reactors, hydrogen and fusion technologies. CNL will endeavour to reuse previously affected areas of sites prior to considering the use of untouched areas for new development. Cleanup of the CRL site will help support these advancements by providing remediated land areas in the right areas of the site for new builds.	
Continual Improvement	CNL will remain focused on continual improvement through assessment of internal and external lessons learned in environmental stewardship, leadership, organisational capability, the management system, safety decision making, and safety performance.	Sections 5.3, 7.5 and 4.3.5
Pollution Prevention and Waste Minimization	CNL is committed to pollution prevention and waste minimization by minimizing the creation of pollutants and implementing the Waste Hierarchy as part of CNL Environment policy to prevent, reduce, decontaminate, segregate, and recycle, with focus on the management of radioactive, non-radioactive, and hazardous wastes.	Section 7.3 and 9.7
Risk-Based Cleanup Criteria	In line with the sustainability principle, screening and risk-based cleanup criteria should be used as preference. The use of risk-based screening criteria will result in CNL site cleanup being performed as efficiently and cost effectively as possible, with key aims of: • minimization of the amount of waste generated by the environmental remediation process; • minimization of disturbance to the environment; • reduction of risk to workers (ALARA) and the public; and • maximizing cost effectiveness.	Section 9.3.1
Flexible Adaptive Phased Approach	CNL will use an adaptive, phased approach to account for changing conditions, priorities, or objectives as cleanup progresses through the phases, and understanding is improved as additional information is obtained. For example, information obtained through additional characterization as a result of remedy implementation, or as verification monitoring results are obtained will be used in planning next remedial efforts. Industry best-practices will also be used.	Sections 8 and 9

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9. The Cleanup Strategy

The CRL site is to remain operational for the foreseeable future and CNL's mission is to revitalize the site into a state-of-the-art research campus. To accomplish this goal in a safe, sustainable manner, targeted decommissioning and environmental remediation is required in brownfield areas to support redevelopment. Therefore the current cleanup strategy for the Chalk River site is to target select facilities for prompt decommissioning and specific areas of land for environmental remediation to enable effective site revitalization. This cleanup effort is currently focused in the Campus Precinct (MUs 1 and 7) to enable reuse of areas for new facilities in accordance with the Site Master Plan and revitalization priorities. Targeted focus is required in some areas, particularly the Controlled Area and Waste Management Areas, to provide footprint ready for re-use. Upon availability of an appropriate LLW waste disposal facility the strategy will shift to focus on large-scale cleanup to reduce the legacy liabilities associated with historic site operations. The selected decommissioning strategies for legacy facilities and the strategies related to large-scale environmental remediation will be determined at the DDP and Remedial Action Plan (RAP) stages [52], [51], [53]. The cleanup strategy requires further characterization and environmental risk assessment to support the selection of appropriate decommissioning and environmental remediation strategies.

Several strategic plans and priorities are required to support and implement the cleanup strategies. Key near-term priorities to ensure the safe and effective delivery of cleanup strategy include:

- Application of the Land Use Program, Decommissioning and Demolition Program and Environmental Remediation Program
- Planning and delivering enabling facilities and projects, in particular Waste Management solutions, e.g., the proposed NSDF. See Section 9.7.3.
- Development of saturated soil screening criteria to enable assessment of saturated soil (i.e., in the water table), sediments and contamination within wetlands
- Site wide coordination on contaminated soil excavation and soil management
- Sequencing of cleanup actions to align with proposed NSDF operational needs
- Environmental monitoring and planning to ensure remedial actions are not generating negative impacts
- Advancing characterization and risk assessment to evaluate APECs (where potential adverse effects are present) and remediating/mitigating known adverse effects
- Planning to prioritize the remediation of brownfield areas with the greatest redevelopment potential for new builds
- Radiological Protection to ensure safe, ALARA conditions are maintained throughout all decommissioning and cleanup operations
- Obtaining local soil background concentration data to ensure cleanup criteria are not at or below levels that exist naturally (or from unrelated anthropogenic activity) and to enable demonstration of successful cleanup
- Advancing the accuracy of estimates of the waste volumes that may be generated during cleanup

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9.1 Cleanup Function

The Cleanup Function is made up of three programs: the Land Use Program, the Decommissioning and Demolition Program, and the Environmental Remediation Program. The Programs maintain their respective processes and guide these activities across the sites (Figure 7).

The three programs interact throughout the lifecycle of facilities at CNL sites. Records are generated and maintained throughout the lifecycle of a facility in support of the Cleanup Function (Section 15). The function recognizes that design, construction, commissioning, and operations all have requirements for data collection along the way to support the effective and successful cleanup of sites.

The Land Use Program, which defines the *Land Use Process* [51], ensures all CNL sites have a consistent approach to defining next land uses and interim or final end-states and that these are achieved using consistent methods. For planning purposes, the Land Use Process looks at sites as a whole and ensures the whole site is working towards a common goal.

The Decommissioning and Demolition Program guides sites in the *Decommissioning Process* [52] and maintains process documents. The Decommissioning and Demolition Program ensures that each site is decommissioning and demolishing facilities in a consistent and defendable manner that is aligned with site goals in order reach the target next land use and end-state safely and effectively.

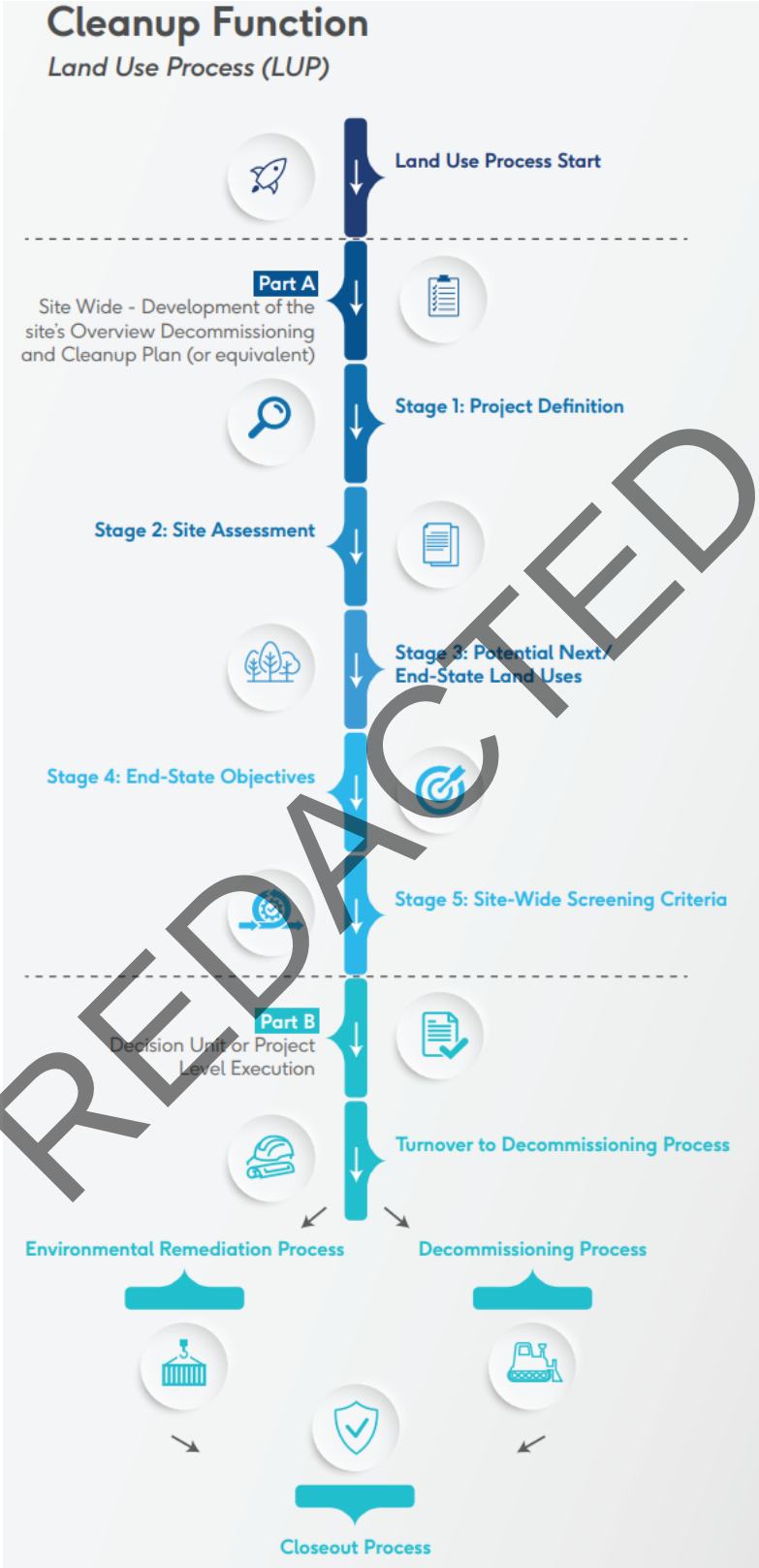
A graded approach is used for the decommissioning activities based on the licence or legal requirements, complexity, level of risk and the residual hazards present, and applies to a variety of facilities, including buildings, systems, and engineered structures (infrastructure). The details of the decommissioning process, sub-processes and grading process are described in the *Decommissioning Process* [52].

The Environmental Remediation Program guides sites in the *Environmental Remediation Process* [53] and maintains process documents. The Environmental Remediation Program ensures that the removal, reduction or control of contaminants from environmental media is conducted in a consistent and defendable manner that is aligned with site-wide goals in order to reach the target next land use and end-state safely and effectively.

The *Environmental Remediation Process* [53] is applicable to all CNL sites. CNL sites refers to CNL managed lands associated with a facility or a standalone site that may have been impacted by previous nuclear activities and by its operations.

An important part of the *Environmental Remediation Process* [53] is environmental characterization (see Stage 1 – Environmental Site Assessment, in Figure 7). Environmental characterization is the systematic collection of environmental data in order to provide a sufficient description of the nature, extent, and variability of contamination of the site under investigation. This allows CNL to make informed decisions about what type of remedial actions should be considered to best reach next land uses and end-states.

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Figure 7: Cleanup Function Overview

9.1.1 Facilities and Capabilities Required to Enable Cleanup

To enable prompt decommissioning and large scale remediation at the CRL site, construction of various support facilities and the establishment of certain enabling capabilities are required, such as the new Sort and Segregation Facilities, for example. Below is a conceptual list of facilities/capabilities that are being considered to support CRL site cleanup and revitalization:

- **Proposed NSDF and other Waste Management Facilities:** Past waste management practices, which met the standards of the day, are no longer acceptable. Specifically, the legacy waste management areas lack robust containment, which in some instances has led to contamination of the surrounding environment. The availability of an engineered, secure waste facility for LLW at CRL is one of the key enablers for prompt site decommissioning and environmental remediation. In addition, several supporting waste management facilities for LLW, ILW and HLW will be required as decommissioning and environmental remediation are progressing. See Section 9.7.3.
- **Support Space**: Various staff will be required to support cleanup work, including but not limited to managers, administrators, engineers, health physicists, planners, schedulers, technicians, technologists, trades, etc. Professional and technical staff will require office space for the duration of cleanup work; the use of temporary trailers will be minimized taking advantage of existing space instead and consolidating support space needs in centralized permanent buildings.
- **Temporary Laydown Areas:** Over the next decade, decommissioning teams will begin dismantling and demolishing large facilities (>900 square meters). Laydown areas will be planned within project sites or on already disturbed land.
- **Heavy Equipment Storage and Maintenance Facilities:** Heavy equipment such as excavators, remotely operated equipment (Brokks), telehandlers, etc. will require construction of weather-proof facilities for both storage and maintenance.
- **Analytical Labs:** It is expected that there will be high demand to analyze samples from the scoping and characterization of legacy facilities. To meet this demand, on-site lab capabilities may require expansion, either by refurbishing existing spaces, creating interim laboratory capabilities, or constructing new facilities.

9.1.2 Potential Next Land Uses at CRL

The proposed next land uses for areas undergoing cleanup at the CRL site will be a key topic of engagement with Public stakeholders and Indigenous Peoples representatives as cleanup planning advances (see Section 6). To date, the proposed target land uses listed in Table 5 and discussed in each MU section (Sections 10.1 through 10.11), have been discussed with the CRL Community Advisory Panel, AECL, and several internal stakeholders.

Next land uses currently proposed as targets for areas being cleaned up at CRL are aligned with site revitalization needs and the priorities in the Site Master Plan (see Section 4.3.5). The land uses being considered may also change over time as stakeholders and regulators are engaged during development of the long-term CRL site cleanup plans. CRL land to be used for ongoing or new missions will be required to meet applicable cleanup criteria for the duration of those

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missions. At a later date, when the mission is complete, other stakeholder considerations may result in a different preferred final land use scenario. Thus, remediating to a particular future land use on an ongoing operational site may carry risks that will have to be managed, conceivably by making conservative assumptions regarding the choice of interim or final end-state land uses. Additionally, AECL may direct that certain land uses are not applicable to the site.

The 2018 CPDP assumed that all land use at CRL would retain an industrial land use with some areas qualifying for unrestricted use [1]. Large portions of the site are, however, covered by natural forests, wetlands and surface water bodies. The ODCP expands the future land use scenarios under consideration to include a parkland land use category in addition to industrial and unrestricted land uses. This scenario emphasizes the protection of wildlife and wildlife habitat during casual human use, primarily involving temporary activities that are recreational in nature (e.g., where people are moving about the property during the course of hiking, hunting, cycling, skiing, or other recreational activity).

The exposure assumptions associated with each of the proposed land use categories being considered for cleanup planning for areas of the site are provided in Table 5. The land use refers to the purpose the land will serve. As per Section 8.3, the dose objectives for the protection of human health and biota remain the same for each land use scenario, however, the receptor(s) and the mechanisms by which the receptor(s) are assumed to be exposed to contamination (i.e., the exposure pathways) differ between the scenarios. For example, the exposure scenarios reflect differences in food and water consumption, time spent on-site, on-site activities and other factors. The assumptions used to determine the exposure scenarios for each land use are consistent with guidance from Health Canada and the Canadian Council for Ministers of the Environment (CCME) and are further detailed in [82], [83], and [84].

This information is used to determine the cleanup criteria necessary to ensure that human health and ecosystem components are protected now and also into the future under the prospective land uses, following the presumed end of nuclear operations at the site.

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Table 5: Exposure Assumptions and Receptors Used in Development of Land Use-Based Screening Criteria for the CRL Site

Land Use	Receptor(s)	General Assumptions
Industrial	Adult industrial workers only	• Industrial facility is located on the designated area, • Receptor's drinking water is from an off-site source (i.e., there is no on-site well), • Receptor does not ingest plant or meat from on-site sources, and • Maximum time spent at the designated area is 2,500 hours per year.
Unrestricted	Adult, infant, toddler, child, and teen[1]	Primarily based on a conservative agricultural scenario, as follows: • Farm and residence are located on the designated area, • Receptor is a self-sufficient resident farming family member that derives a significant fraction of food from the designated area, • Drinking water and irrigation water are derived on site from the assumed primary potable water source impacted by leaching from the designated area (with the well location oriented for the highest well water dose/exposure), and • No maximum exposure time limit (i.e., 100% of time spent at the designated area).
Parkland	Adult, infant, toddler, child, and teen[1]	• Casual human use, primarily involving temporary activities that are recreational in nature (e.g., where people are moving about the property during the course of hiking, hunting, cycling, skiing, or other recreational activity), • Receptor drinks on-site surface water in accordance with examples provided in Health Canada's guidance, as well as a realistic worst-case scenario, • Receptor ingests game, plants and fish from the designated area, and • Maximum time spent at the designated area is 200 hours per year.
All (industrial, unrestricted, parkland)	Representative aquatic and terrestrial biota (see [83] and [84] for details)	• Receptors assumed to spend 100% of time exposed to the designated area (i.e. an area use correction factor based on an animal's home range was not applied), • Conservative literature-based concentration ratios were relied upon, more realistic site-representative bioaccumulation

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Land Use	Receptor(s)	General Assumptions
		factors or concentration ratios can be developed and used in place of conservative default parameter, • Aerial receptors such as birds and bats, are assumed to spend all their terrestrial time on soil, • Aquatic species have been conservatively assumed to spend all aquatic time in water (as opposed to on water), and • The radiological dose rate benchmarks for biota are intended to provide receptor protection at the population or community level for species other than those that are 'vulnerable, threatened, or endangered'. Consideration of Species at Risk at each particular APEC will require explicit assessment at the individual, not population, level.
Table Notes: [1] The receptor age groups used in the analyses are specified by Health Canada and are, in some instances, mapped to slightly different age groups to align the dose factors with the ICRP receptor age groups [82].		

The land areas will be cleaned up to meet to-be-established cleanup criteria for the designated land use category. Using current assumptions on future land use and interim end-states, it is reasonable to suggest that the campus precinct will remain an industrial land use where research activities will continue to take place. Most of the Outer Precinct area remains unaffected by CRL operations.

9.1.3 Interim End-States and Final End-State Agreement

Industry experience has shown that targets for decommissioning and environmental remediation are best communicated using an end-state and/or interim end-states for each area. Interim end-states will be technically defensible and based on systematic understanding of the contamination issue and impact of proposed solutions. Together they describe the journey from the state of the site today through to where it should be.

In some cases, the end-state will not be achieved for many decades. In these cases, interim end-states help to focus delivery on nearer term goals. They typically mark a stepped reduction in risk or hazard on the way to the site end-state [85]. A crucial aspect when planning an environmental remediation project, is to begin with the end-state in mind. The difference between the end-state and the existing conditions will guide what remedial actions should be taken. As such, it will be essential to determine the preferred end uses or interim land uses of all areas of CRL site early in the planning stages of cleanup.

Not all locations on the CRL site may have clear preferred end or future uses determined in the early stages of planning, however, in these cases an iterative process will be maintained to balance the value of the remediated site options against the emerging technical and financial challenges of achieving them.

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For many areas at CRL the end-state is not yet known and the end-state may not need to be achieved for many decades. This does not preclude the cleanup of the CRL, as cleanup targets will be based on next land uses for the continued operation at the site. Land use decisions will inform the end-state for each discrete DDP / RAP developed for cleanup at CRL. As an initial approach, areas in the Outer Precinct surrounded by undisturbed natural forests or wetlands may be preliminarily assessed against parkland land use criteria until a final determination is made as the constraints would be consistent with the surrounding land uses.

Since the clean energy and S&T missions at CRL have been extended indefinitely, it is difficult to determine when an overall end-state will be achieved. As discussed in the previous section, interim end-states for the Campus area will be associated with the operations of a nuclear research facility. The interim end-state for the Outer Precinct will, except in some specific areas such as the centralized Waste Management area or the proposed NSDF, be associated with a return to a more natural setting. These interim end-states may remain in place for decades or longer, in support of the ongoing CRL missions.

9.2 Decommissioning Strategy

Predominantly a prompt decommissioning strategy has been selected for legacy facilities and buildings to enable the revitalization of the Chalk River site. Accelerating CRL's decommissioning to the extent possible will limit Storage with Surveillance costs for the site and provide other benefits. Deferred decommissioning may be considered for certain facilities to allow for decay of relatively short lived nuclides (e.g., half-lives of less than 10 years) or to await the availability of waste disposal facilities. Table 7 in Section 10 provides a summary of the status of the Class 1 and 2 facilities at CRL and the MU sub-sections note priorities related to existing buildings and structures that will be decommissioned in the next 5 years, most of which are in MUs 1 and 7.

The chosen decommissioning strategies are further described in 9.2.2 - 0 for each facility or structure and will be documented in the individual Detailed Decommissioning Plan (DDP) or Building Removal Plan (BRP), as required, prior to dismantling and demolition.

In line with the regulations, CNL applies a graded approach to determine how and to what degree decommissioning strategies and plans will be documented. CNL's graded approach to decommissioning planning can be found within CNL's Standard - *Decommissioning Process* [52], which is based on the requirements in CSA N294-19 [2] and REGDOC-2.11.2 [3].

The facilities within the Management Units are evaluated on a case-by-case basis to ensure consideration is given to each facility's unique characteristics, such as operational history, facility type, scale, complexity, maturity, physical state, radionuclide inventory, uncertainty and reliability of information and risks associated with decommissioning of the facility, location or site.

The current status and any known plans for decommissioning of all buildings, structures and WMAs at CRL is provided for each MU in Appendix A. There is also an ongoing commitment to provide an annual update on the status (also by MU, starting in 2022) to the CNSC.

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In addition to buildings, various tanks are located on the CRL site. The wastes stored in these tanks vary in chemical and radiological composition and require retrieval and processing such that the generated product is suitable for interim storage, reuse and/or disposal. The most likely decommissioning strategy for the emptied underground storage tanks involves excavation and packaging followed by emplacement in an appropriate disposal facility. All opportunities for decontamination, re-use, or recycling will be considered once fully characterized.

As per the *Environmental Remediation Process* requirements [53], systematic soil characterization is required to determine if there is residual contamination in the ground associated with buildings or tanks.

9.2.1 Shutdown Process

The Shutdown process for transferring an operating facility to decommissioning is described in CNL's Standard - *Decommissioning Process* [52]. This process is applied on a facility-by-facility basis and in general the process consists of the following steps:

1. Declare the intent to shut down and decommission the facility based on senior management decision and decommissioning planning
2. Perform Permanent Shutdown and Stabilization Activity Planning
3. Confirm and communicate the decommissioning strategy and interim or final end-state based on the Preliminary Plan and any new information
4. Accept care and maintenance or institutional control requirements which will be used after the facility is shut down
5. Execute the Shutdown Plan to remove materials and hazards following work planning, and control procedures
6. Verify Safe Shutdown State achieved

9.2.2 Requirements for Prompt Decommissioning

Once a DDP or BRP is developed for a facility and approved, decommissioning teams will begin characterizing and scoping the facility to develop an inventory of radiological and hazardous materials and address any identified gaps in facility data, although in some cases characterization takes place ahead of the development of the DDP or BRP. Invasive characterization and sampling plans are written and approved following the *Integrated Work Control Process* [26]. The results of characterization work will drive granular work packages and identify materials (radiological, asbestos, PCBs, etc.) requiring removal prior to demolition.

Prior to the execution of all work, work plans are written in accordance with the *Integrated Work Control Process* [26]. This process includes a review by a team of subject matter experts from the applicable groups and support programs, including but not limited to engineering, health physics, radiation protection, occupational health and safety, waste, industrial hygiene, fire, security, etc.

Prior to building demolition, both radiological and non-radiological hazards are identified and removed from facilities in a controlled manner. Hazardous materials, or waste are removed to a level that allows for traditional demolition methods. These methods typically involve

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demolition with heavy equipment, or a controlled dismantlement depending on facility location and remaining hazards. Generally speaking, as waste is removed it will be sorted, segregated, size reduced, and packaged within the grounds of the facility. Waste is packaged to a level that meets the Waste Acceptance Criteria of current or future waste disposal facilities or storage or transportation requirements. In situations where challenges exist to remove such hazards to acceptable levels, hazards may be left in place for demolition with the use of engineered controls.

Each facility specific demolition strategy is described in the facility's PDP and, where applicable the BRP. The PDP is periodically reviewed and updated until a DDP is prepared. Both the BRP and DDP are respectively reviewed, and in the case of a DDP formally accepted, by the CNSC prior to execution.

After demolition, the entire facility footprint will be removed, which generally includes clean foundations and underground services within a one meter perimeter of the footprint. If foundations are found to be contaminated, a prompt decommissioning strategy may be replaced with a deferred decommissioning strategy (described in more detail under Section 9.2.3), and contaminated foundations could enter a period of Storage with Surveillance until waste disposal facilities are constructed.

9.2.3 Deferred Decommissioning and Storage with Surveillance

Deferred decommissioning with a period of Storage with Surveillance may be preferred over prompt decommissioning for certain facilities (e.g., the NRU and NRX reactors) to allow for decay of relatively short-lived nuclides (i.e., half-lives of less than 10 years) such as activation products produced in reactor components exposed to high neutron flux. By deferring decommissioning for multiple years the activity of these components can be greatly reduced, therefore decreasing the potential dose to personnel during decommissioning activities. In these facilities it is possible that prompt decommissioning is performed on auxiliary structures and systems during the deferment of the higher activity components. In these cases, multiple DDPs may be produced for the facility to separate the strategies for different areas.

Deferred decommissioning may be required over prompt decommissioning due to the availability of waste disposal facilities (e.g., the proposed NSDF). At CRL, several facilities have been demolished, but for those in the Controlled Area, the foundation and underground services remain in place. These facilities enter a period of Storage with Surveillance until a final waste disposal facility is available for the low-level contaminated concrete and soil which may be produced during final foundation removal and area remediation. For these facilities an Interim Storage with Surveillance plans will be prepared to document the interim end-state and the required monitoring activities during Storage with Surveillance.

9.2.4 In situ Decommissioning

Currently, in situ decommissioning has not been identified as a preferred strategy for any facilities at CRL. If in situ decommissioning is identified as a proposed strategy to be pursued for

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one or more facilities at CRL, appropriate stakeholders will be engaged and CNL will meet the requirements outlined in REGDOC-2.11.2 [3] and N294-19 [2], as required.

It is noted that two other CNL-managed sites, Nuclear Power Demonstration (NPD) near Rolphton, ON and the WR-1 reactor in Whiteshell, MB, are pursuing an in situ decommissioning strategy. Therefore, if any of the facilities at CRL pursue such a strategy at a later date, decommissioning teams at CRL can learn from the organizational and process knowledge obtained from these sites. It is important to note that while in situ decommissioning is not currently being considered at CRL, it may be considered for a few waste management areas and several former landfills depending upon the findings of ongoing environmental characterizations and safety assessments.

9.3 Environmental Remediation Strategy

Risk and liabilities associated with the CRL site will be progressively reduced through management, mitigation and environmental remediation of the contaminated sites at Chalk River. Targeted remedial actions have taken place, however, a significant amount of buried waste, soil contamination, and groundwater contamination remains on the site and requires remediation.

Cleanup planning at CRL, with respect to the development of site end-state objectives (Section 8.3) and cleanup criteria, has followed the overarching process outlined in CSA N294-19 [2], as set out within the *Land Use Process* [51]. The *Environmental Remediation Process* is to be followed in any instance where environmental site investigation/assessment or environmental remediation is required [53], including where areas of site are required for reuse for operations.

Additional information that is integral to further progress environmental remediation includes a description of the detailed assumptions applicable to remediation planning (see Section 9.4), as well as the approach used to develop screening/ cleanup criteria (see Section 9.3.1).

Over the next several years, until the proposed NSDF is operational, work will focus on:

- Site Characterization, including:
  - Filling identified gaps in characterization information based on the preliminary assessment of the APECs (see Appendix A)
  - Evaluating new characterization information against site-specific soil screening criteria
- Advancing the cleanup plans for each MU on a priority basis, i.e.
  - Site Assessment (including human health and ecological risk assessments)
  - Remedial Options Evaluation
  - Remedial Planning

9.3.1 Risk-based Soil Screening and Cleanup Criteria

For the purposes of cleaning up the CRL site, risk-based, site-specific radiological and non-radiological cleanup criteria will underpin the cleanup decisions. This method is preferred to the

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use of non-risk based or generic criteria, which may result in required remedial work even though the risk already meets acceptable federal/international standards or background concentrations. This approach has been used at similar facilities, for example at the Hanford site in Washington State, a US nuclear site undergoing decommissioning and environmental remediation, as well as at the Deloro site, a former mining and industrial area in the Municipality of Marmora and Lake, east of Peterborough, Ontario.

The use of risk-based criteria will enable optimal cleanup of the CRL site and the specific benefits include:

- Minimization of the amount of waste generated by the remediation process
- Minimization of disturbance to the environment
- Reduction of dose and risk to workers
- Maximization of cost effectiveness

Screening criteria for soils for the land use scenarios under consideration for the CRL site, described in Table 5, have been derived for radiological contaminants of potential concern by using conservative, risk-based assumptions developed to be protective of both human and ecological health. For non-radiological contaminants, risk-based screening criteria developed by federal and provincial agencies for comparable land use scenarios, will be selected.

The screening criteria will be used as an assessment and planning tool to perform a high-level evaluation of the need for remedial actions in an area and to develop priorities for cleanup planning. The application of screening criteria is an intermediate step in the development of final risk-based cleanup criteria; although it may be appropriate to adopt the screening criteria as the cleanup criteria for a targeted area.

These screening and cleanup criteria will be applied to affected soil, sediments, surface water and groundwater that remains at a location at the CRL site after the removal or management of discrete waste material.

A protocol detailing the applicability and requirements for use, including summary tables, of the unsaturated soil screening criteria has been developed [86]. Work is underway to derive similar criteria for saturated soils and sediments. The protocol details i) how the screening criteria are to be used to evaluate the available characterization data for adequacy (to determine characterization gaps for each MU), and ii) screen characterization data to determine whether concentrations within a specific area meet the appropriate land use criteria. If not, they serve to determine the level of effort required, through a site-specific risk assessment or through remedial actions.

In addition to the above described Integrated Environmental Monitoring Program (Section 7.5), CNL is committed to conduct detailed post-operation surveys in support of DDP development for licensed facilities and RAPs for other non-licensed facilities; and to develop plans and protocols necessary to meet regulatory requirements for the detailed planning stage for monitoring.

Although operations at CRL are scheduled to continue indefinitely, modeling in support of environmental remediation planning has assumed that nuclear operations will cease in the year

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2100, and the final end-state will be achieved by the year 2400, after approximately 300 years of institutional control.

As noted in Section 9, CNL is currently obtaining local soil background concentration data to ensure screening and cleanup criteria are not below naturally occurring levels at CRL to enable effective and successful cleanup. As new science becomes available, screening and cleanup criteria will be reviewed and adjusted accordingly, as required, to ensure the protection levels afforded through remediation are current.

9.3.2 In Situ Decommissioning

There are currently no licensed radiological waste disposal sites at CRL. Clean wastes and radioactive wastes are stored in waste management areas and conventional landfills located in several Management Units at CRL. Most of these facilities were used or constructed before present safety standards were implemented and may not meet all safety requirements listed in the IAEA's *Specific Safety Requirements (SSR)-5 Disposal of Radioactive Wastes* [87] and the CNSC's REGDOC-2.11.1 *Safety Case for the Disposal of Radioactive Waste* [88].

According to CSA N294-19 (clause 6.1.2.2) [2], in situ decommissioning may be considered a viable solution under exceptional circumstances, such as for legacy sites for which decommissioning was not planned as part of the design and which will remain under institutional control for the foreseeable future. In situ decommissioning should not be considered a reasonable option for situations where removal is possible and practicable. On the other hand, this does not preclude the use of risk-based screening levels to guide remediation efforts.

Where waste management facilities at CRL were not constructed to present safety standards and may not meet current safety criteria, reasonably practicable measures have to be taken to upgrade the safety of the facility to mitigate potential risks. Possible options may include the removal of some or all of the wastes from the facility, making engineering improvements and/or putting in place institutional controls. The evaluation of these options has to include technical and social issues.

Three principles have been adopted by the International Commission on Radiological Protection (ICRP) [89] to guide decisions regarding radioactive waste disposal, including whether to dispose of wastes in situ. These principles are:

- *Intervention* (having to supplement existing safety features at closed disposal facilities),
- *Justification* (the intervention is required to have a net positive cost-benefit), and
- *Optimization* (maximize the margin of safety over potential harm, for example through the use of multi-layer protection) [87].

In support of a licence application for any in situ radioactive waste disposal facility at CRL, it will be necessary to submit a safety case to the CNSC for acceptance which will demonstrate that all safety requirements will be met, assess the safety using a graded approach, and describe all safety aspects of the site such as design, construction and operation [88].

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For waste management facilities considered for in situ decommissioning the safety strategy will identify and describe several key elements such as containment and isolation of the waste, multiple safety functions, defence in depth, passive safety features, robustness, demonstrability, feasibility and other elements that contribute to safety.

The environmental viability of in situ decommissioning is largely dependent upon site-specific characteristics feasibility of waste retrieval, dose to workers, and waste transport requirements, and natural site conditions such as hydrogeological conditions.

9.3.3 Monitored Natural Attenuation

Monitored Natural Attenuation relies upon natural attenuation processes to achieve site-specific environmental remediation objectives within a time frame that is reasonable compared to that offered by other more active methods [90]. The natural processes that can attenuate the concentrations of dissolved non-radiological contaminants in groundwater include biological degradation, sorption and dispersion. The main attenuation mechanism for radiological compounds is radiological decay which differs from one radioisotope to another and is represented by the radionuclide's half-life. As the concentration declines over time, it may reach a point when the contaminant level is no longer considered hazardous.

Monitoring, for groundwater and on occasion also for soils/sediments, is required to determine the effectiveness of the technique and determine when monitoring is no longer necessary once levels decrease below the site-specific risk-based screening criteria.

Monitored natural attenuation is generally used where contaminant concentrations are relatively low and where no sensitive receptors would be adversely impacted in or downgradient of the impacted area. Regulatory agencies generally consider three conditions in determining the applicability of Monitored Natural Attenuation:

- Groundwater and soil chemistry data demonstrate a clear and meaningful decreasing trend in concentration over an appropriate time frame
- Hydrogeologic and geochemical data demonstrate that attenuation processes are active at the site at a rate that indicates that contaminant levels will decrease to required levels
- For biological processes, field data demonstrates that conditions are favorable to the development of the active microorganisms involved in biological degradation

9.3.4 Alternative Cleanup Approaches

For complex cleanup projects, it is often advantageous to develop strategies for multiple alternate remediation options to be considered to achieve the desired end land use cleanup criteria. These alternative approaches are then evaluated and refined based on an initial technical feasibility screening. Each alternate strategy is assessed considering its potential value in advancing the site towards achieving its final objectives as well as how it manages residual contamination during that time. Viable strategy alternatives will likely need to be managed and adapted over time as conditions change and as new characterization data becomes available.

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Key performance parameters for each of the interim remedial actions within the overarching strategy will be required to ensure the interim actions are performing as predicted.

Optimization of the various strategic alternatives can be evaluated using guidance from the US EPA [90], [91], the UK Nuclear Decommissioning Authority Value Framework [92], and CNL's *Remedial Options Evaluation Guideline* [93] includes criteria that may be used for high-level screening of all alternate strategies and evaluating options that are deemed viable.

9.4 End-State Requirements

When a decommissioning or environmental remediation project has been completed the following activities will be completed as described in CNL's Standard *Closeout Process* [94]:

- Assemble decommissioning records including:
  - Confirmation that all Engineering Change Controls (ECC) have been closed out;
  - Lessons Learned and OPEX;
  - Confirmation that all Work Plans have been closed out;
  - All applicable documents listed in the *D&ER Closeout Checklist* [95]
- Ensure that all verification of end-state steps have been performed:
  - Confirm that final status surveys and verification sampling has been completed and applicable records of end-state verification have been prepared (e.g., verification reports, survey logs, etc.).
  - Ensure Facility status has been updated in the Facility Information System and EDMS.
- Determine End-State (Interim or Final):
  - Determine whether planned end-state objectives have been met by reviewing verification records and comparing them to the planned end-state as stated in the DDP/BRP/RAP.
  - Provide justification if planned end-state has not been achieved.
  - Determine whether a transfer of incomplete scope (to another planning envelope) is required to close out project DDP/BRP/RAP (in such a case the end-state will be interim by default).
- Identification of Land Use Designation, Land Use Restriction and Institutional Controls:
  - Comparison of target land use designation (as determined in this document) with planned land use designation (as outlined in DDP/BRP/RAP) with the land use designation achieved at the end of decommissioning.
  - If the achieved land use designation is not in alignment with the planned land use as stated in the DDP/RAP, then justification must be provided.
  - Any land use restrictions are determined and must be reported in the end-state documentation;
  - Planned institutional controls as determined during decommissioning or environmental remediation planning are reviewed to ensure applicability and updated if required.

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Note: There may be requirements for some records to be placed on public record (e.g., land registry records) and for CNL Legal representatives to be involved

- Preparation of (Interim or Final) End-State Documentation:
  - End-state documentation is prepared ensuring the information gathered in the preceding steps are included.
- Acceptance of (Interim or Final) End-State:
  - The end-state documentation is submitted to the Authority Having Jurisdiction (AHJ) for acceptance of the achieved (interim or final) end-state;
  - By accepting the end-state documentation, the AHJ accepts any transfer of incomplete scope and justifications provided for failing to meet planned end-state objectives.
- Licensing Changes:
  - Once the end-state has been accepted, any required licensing changes are requested (if applicable).
- Turnover from Decommissioning / Environmental Remediation
  - A final site inspection is performed and the site condition is confirmed;
  - The Transfer Certificate is finalized and turnover is complete.

  Note: The turnover can be for re-use on Licensed Site or for Institutional Control (long-term monitoring).

A graded approach is applied to the decommissioning and environmental remediation process at CRL and a risk grade (Grade 1 or Grade 2) is determined using the Risk Grading Table in Appendix A of the *Decommissioning Process* [52]. For Grade 1 facilities, which are typically Class I facilities, upon confirmation that an interim or final end-state has been achieved an End-State Report (interim or final) [96] will be written and submitted to the CNSC for acceptance.

A *Decommissioning Project Completion Report* form [97] is completed for Grade 2, non-Class I facilities, and includes most of the information found in an End-State Report but with sections omitted commensurate with the building hazard level.

9.5 Cleanup Planning Assumptions

Assumptions and Risks that will guide the development and implementation of the cleanup plan for the CRL site were first identified as part of the development of the *Framework for CRL Site Cleanup* [98]. These were later reviewed and updated with input from CNL and AECL stakeholders in 2019 July and also in 2021 September at a dedicated workshop involving several Functions and Groups at CNL. In addition, associated risks and risk mitigation measures have been developed in support of these assumptions and will be reviewed periodically.

The principal assumptions cover several aspects of the cleanup such as Cleanup Strategy, Land Use, Affected Lands, End-State, Waste Strategy, Regulatory Constraints, Site Revitalization and Stakeholder Concerns. They include, but are not limited to:

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- Operational controls, to ensure the safety of humans and mitigate the potential for ecological risk, will persist throughout the Operation Phase of the site
- Institutional controls, to protect the integrity of the remedy and minimize human exposure, will be incorporated into the environmental remediation process, as required
- Many areas of the site, including many of the affected areas, are wildlands and should be maintained as, or remediated to, parkland use (at a minimum) to protect ecological habitat, except when there is a justifiable near-term operational need (i.e. industrial use) for the land
- Chalk River Laboratories has an enduring operational mission and there is currently no planned closure date for the site (but the date 2100 is assumed for planning purposes)
- Large scale remediation will not occur until on/off-site facilities for the processing and storage or disposal of all retrieved remediation wastes are available, including LLW and ILW, to avoid double-handling of materials or the need for additional temporary storage, where possible
- The on-site interim storage facilities and/or lay down areas for LLW will provide sufficient capacity for currently planned decommissioning and environmental remediation activities until the proposed NSDF is fully operational, based on currently assumed timelines
- Cleanup will occur while CRL is an operating site and will need to accommodate decommissioning and demolition, site infrastructure renewal and normal operating activities occurring alongside environmental remediation activities
- Monitored Natural Attenuation will be the preferred remedial action if predictive modelling can demonstrate that contaminated environmental media is not currently and will not in future pose unacceptable risks and will meet acceptable levels for future land use in the required time frame
- Ongoing and future operational activities will comply with current regulations (those prevailing at the time), including Federal or Provincial soil and groundwater cleanup criteria or guidance levels and seek to minimize environmental impacts on-site and offsite (i.e., the cleanup of the CRL site will be planned based on the current understanding of liabilities)
- The CRL site boundaries and land area will remain constant over time; i.e., there are currently no plans to transfer ownership of any CRL lands to external entities
- The cleanup planning, as detailed in the ODCP is an iterative process, continually being reviewed and improved upon as new information is available to reduce planning uncertainty
- Cleanup will be considered achieved, once the following is verified: Risk-based cleanup criteria for soil are met for the impacted area in accordance with the appropriate land-use category
- Soil will be managed in situ if proven to meet the end-state objectives i.e., risk-based cleanup criteria
- Any waste remaining in situ may trigger additional regulatory and licensing requirements that will be considered

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9.6 Prioritization Tool

The CRL site will be cleaned up according to a schedule informed by a prioritization tool based on Health, Safety, Security and Environmental (HSSE) concerns, waste management availability, and business factors (e.g., revitalization needs, stakeholder concerns).

Past efforts have been made to implement a risk-based approach to support the prioritization of decommissioning and environmental remediation projects (formerly listed under the Nuclear Legacy Liabilities Program) at the CRL site. In 2021, these efforts were examined in detail and benchmarked against an additional two dozen site-ranking and prioritization tools in use at nuclear facilities and other industrial and military facilities in North America and Europe. Contrary to site-ranking tools which simply place sites in an order of risk using simple numerical scores, prioritization tools have the ability to determine which actions should take place, to consider costs and incremental risk reduction and to help identify trade-offs across multiple sites and across the multiple, sometimes competing cleanup objectives (e.g. priority based upon risk, complexity, or the need for redevelopment footprint).

A new prioritization tool is under development and proposed for use at CRL. It uses a multi-criteria, non-aggregating approach (i.e., scores for different parameters are not added to derive a global score) to identify which remediation projects can deliver the greatest benefits for risk reduction and future site redevelopment activities. This approach is also more transparent as it provides a clear link to the original data (contaminant levels for example), while seeking to eliminate bias. This allows for better individual and overall parameter optimization and provides more flexibility in comparing different scenarios and trade-offs, removal versus in situ remediation, for example.

The proposed tool, as shown below in Figure 8, also uses a graphical depiction of each scoring parameter for easier comparison between current and post-intervention scenarios or to assess existing conditions in areas being considered for redevelopment. A site-wide risk-ranking model does not allow for such detailed evaluation.

Wherever possible, the risk parameters are to be determined using measurable and verifiable data instead of relying upon qualitative or default values. The proposed tool has been reviewed and pilot tested and is being rolled out more extensively in 2023. The cost parameters are being revised to align with the overall cost estimates for the decommissioning and cleanup of the CRL site.

For illustrative purposes, an example of a preliminary graphical representation of results is shown in Figure 8. The arrows represent the modified assessment results using a before and after scenario reflecting the risk reduction impact of source removal at a specific waste management area. In this case, the preliminary scenario presented is the removal of wastes from WMA A and its disposal in the NSDF.

The colors reflect the six main prioritization categories (Contamination, Impact, Condition, Revitalization, Uncertainty and Costs) and are used for easier visualization especially when comparing several APECs. Scores are a reflection of current conditions and of the impact or risk

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level for each parameter. A site with significant radiological contamination would score higher, for example, under the radiological contamination parameter.

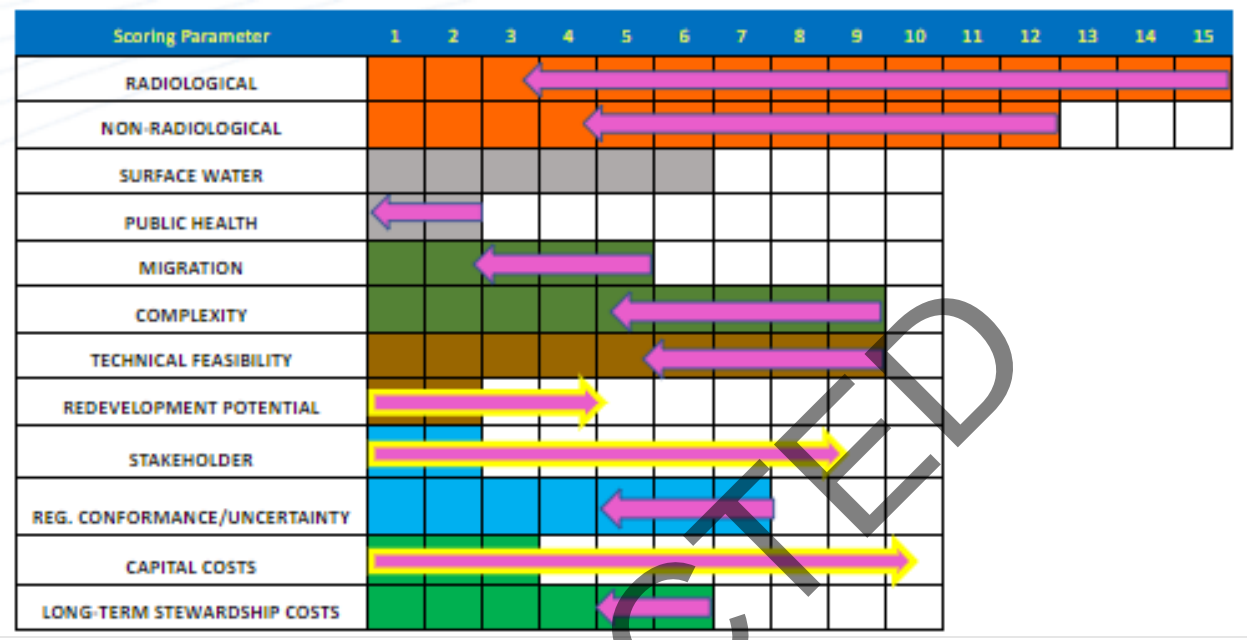


Figure 8: Proposed CRL Cleanup Prioritization tool – Preliminary Graphical Representation

9.7 Waste Management Strategy

A critical factor in dealing with the cleanup of the CRL site is the ability to manage the wastes that will result from the decommissioning and environmental remediation initiatives. CNL has developed an *Integrated Waste Strategy* (IWS) [6] to implement safe, cost-effective lifecycle waste management. The IWS describes CNL's strategic approach to waste management and aims to support integrated management of waste across CNL and ensure alignment with the goals and requirements of CNL's primary business missions [6]. The IWS is currently in the process of being updated and a new revision will be issued in 2023. CNL implements the applicable radioactive waste management regulatory documents and Canadian Standard Association standards, into the Waste Management Program. The *Management System* [35], and *Waste Management Program Requirement Document* [50] identifies and lists all applicable CNL licences and regulatory documents pertinent to the Waste Management Program under applicable Acts, regulations, and standards.

The cleanup plan for the CRL site is based on the assumption that, where appropriate, radioactive waste management capabilities are provided at the CRL site, while other off-site waste service providers are also used as appropriate.

Waste minimization is a key principle applied at CNL (see Table 4). CNL's *Environment Policy* [63] states that waste should be dealt with at the highest practicable level in the waste hierarchy (Figure 9). Effective use of diversion, recycle and reuse routes, including those

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currently supplied by off-site service providers, requires options analysis, inventory and characterization information. Examples of each are:

Prevent:

- Waste Planning: CNL applies a rigorous waste planning process to minimize volumes, and prevent waste generation
- New Build Planning: For each new building, CNL incorporates design features that reduce future waste generation at the operational and decommissioning phases

Reduce:

- Sort and Segregation: This occurs at the source of all cleanup projects. CNL has also invested in a new facility to enable sorting and segregation of legacy and decommissioning LLW. This approach enables physical reduction in volume through processing and segregation of contaminated materials from materials that can be cleared for unconditional radiological release
- Proposed Fuel and ILW Stabilization Facility: CNL is committed to making investments into new facilities that offer improved capabilities for fuel and ILW processing. These processing/stabilization facilities will offer new opportunities to reduce the amount of waste requiring future disposal

Reuse:

- Radiological Clearance and Release: CNL implements a comprehensive radiological clearance process, predominately through the operation of the Waste Analysis Facility. This program enables a significant quantity of waste materials to be dispositioned for off-site reuse
- Source Recycling Program: CNL works with supply chain partners to reuse radiological sources that would otherwise be considered as waste

Recycle:

- Heavy Water Detritiation: Through the use of CNL-developed technologies, CNL will apply a detritiation process to separate tritium from heavy water. This will enable approximately 700,000 litres of heavy water to be used for nuclear and non-nuclear applications
- Off-Site Processing (Metal Melt): CNL utilizes commercial processing facilities, such as Metal Melt offered by EnergySolutions, to melt metallic wastes which are then recycled into metal shielding blocks for reuse in the nuclear industry
- Repatriation: Through repatriation initiatives, CNL works with partner nations to return the material to country of origin for processing for future use or disposal
- Radiological Clearance and Release: Similar to reuse (above)

Dispose:

- Near Surface Disposal Facility: The proposed NSDF will provide an option for disposal of LLW that cannot be diverted

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CNL will continue to operate with the waste hierarchy in mind and with a focus on prevention and reduction of waste generation. The proposed NSDF, in particular, is considered an asset with a finite capacity, and application of the waste hierarchy is important to ensure other waste options are fully explored prior to utilizing disposal capacity. Disposal is the final option after all other means of prevention, reduction, re-use, and recycling are exhausted.

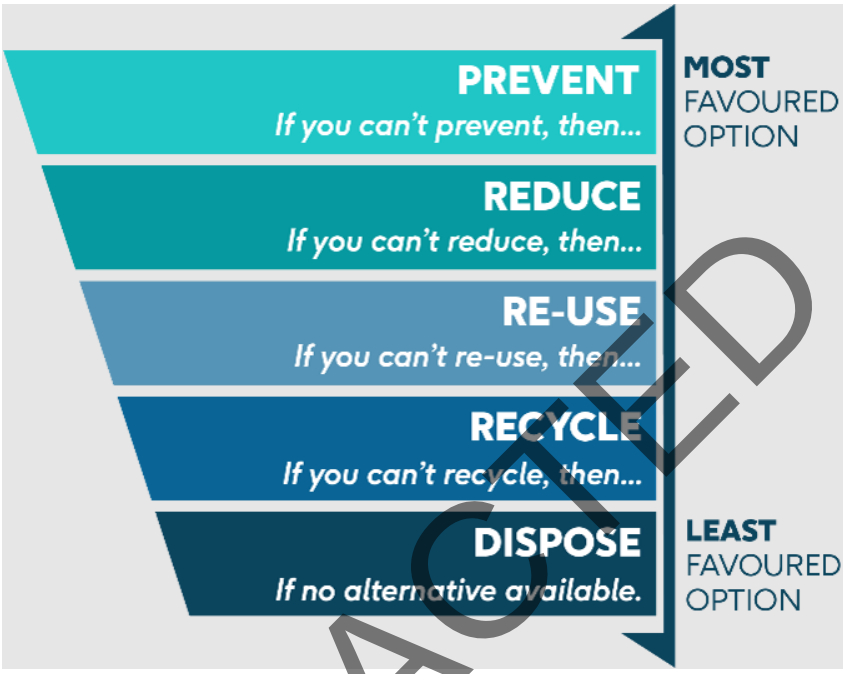


Figure 9: Waste Hierarchy Diagram

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9.7.1 Waste Inventory and Waste Forecast

The baseline waste volume forecast until the year 2100 is provided in the Inventory of Radioactive Waste in Canada 2019 [99]. The year 2100 is an assumed end date of nuclear operations at CRL that has been used for planning purposes and in the modeling efforts in support of the development of screening criteria, however it is important to note that the operational mission at the CRL site has been extended indefinitely.

The waste forecast is used to identify gaps and areas of concern regarding waste storage and plan the logistics of waste receipt, processing and disposition. The waste forecast is live and regularly updated to reflect new characterization data and other planning inputs as information becomes available, and the associated strategies and plans evolve.

9.7.2 Waste Strategies by Classification

The Waste Management Program mandate applies to the full life cycle of waste from the point of generation to its final disposition. This includes all operations and activities that results from the planning, generation, transportation, processing, storage, and/or disposal of waste generated by CNL-managed sites or received from external organizations. The Waste Management Program adheres to CNL's *Environment Policy* [63], which states that waste

should be dealt with at the highest practicable level in the hierarchy. Wastes generated at CRL are divided into waste classifications. Table 6 provides examples of the types of waste within each classification and an overview of the strategies for each. Further detail can be found in the IWS [6].

Table 6: CRL Waste Classifications and Baseline Waste Strategies

Waste Classification		Waste Type Examples	Waste Strategy **(in cases where more than one strategy is presented the optimal route for specific waste is selected)**
Non-Radioactive	Clean	Conventional trash, metal, construction, demolition and decommissioning material, ground material and vegetation	• Identify reuse and recycle opportunities • Manage waste through local municipal landfills and processing facilities
	Hazardous	Chemicals, oils, lead, Mercury, hydrocarbon contaminated soil	• Manage as per Hazardous waste regulations through off-site service providers
Radioactive	Low-Level Waste (LLW)	Solid waste: Personal protective equipment & clothing (PPE&C) , metal, rubble, concrete, wood, equipment, soil & vegetation	• Consolidate at CRL in storage until the LLW disposal (proposed NSDF) becomes available • Process LLW where required to manage hazardous constituents and ensure disposal ready • Manage suitable legacy LLW *in situ*, where agreed • Align decommissioning strategy to waste storage and disposal availability • Defer large scale Environmental Remediation to align to proposed NSDF availability • Manage historic waste through Port Hope Area Initiative program

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Waste Classification		Waste Type Examples	Waste Strategy **(in cases where more than one strategy is presented the optimal route for specific waste is selected)**
		Liquid Waste	• Process to achieve a liquid effluent suitable for release and/or to create a waste suitable for storage in a passively safe condition
	Intermediate-Level Waste (ILW)	Solid Waste: Reactor parts and components associated with reactor operations, isotope production process and decommissioning and environmental remediation wastes, and Cemented Target Material	• Consolidate at CRL in long term engineered storage until geological disposal becomes available • Process appropriately to enable storage in a passively safe condition • Manage suitable legacy ILW *in situ*, where agreed
		Liquid Waste	• Process to achieve a liquid effluent suitable for release and/or to create a waste suitable for storage in a passively safe condition
	High-Level Waste (HLW)	CANDU type and research reactor used fuels	• Consolidate at CRL in long-term storage, as appropriate, until a national used fuel Deep Geological Repository (DGR) becomes available ○ The consolidation of Douglas Point HLW is dependent on the siting decision of the HLW DGR

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9.7.3 Key Enabling Waste Facilities / Capabilities

There are ongoing plans to advance the strategies for new waste facilities and capabilities over the next 5 years.

Current Facilities/Capabilities

To ensure the waste generated is managed effectively, current key facilities/ capabilities at CRL which manage waste at CNL include:

- The Waste Analysis Facility (WAF) which accepts clean solid waste generated or processed at CRL, verifies it is clean, and then sorts and segregates the wastes, as appropriate, prior to routing it through different waste paths for final disposition
- The Waste Characterization Facility which is a centralized facility for characterizing waste
- Concrete crushing capability to enable re-use of concrete material at site
- The Waste Treatment Centre where liquid waste is evaporated and bituminized in drums to produce a stable product [6]
- Above ground storage capability for sealand containers at WMA's D and H in MU 2 (see Section 10.2)
- Storage capability for ILW in various storage structures, including MU 3 below-grade tile holes, concrete bunkers, and the MU 2 Shielded Modular Above Ground Storage (SMAGS) facilities (see Table 1, Sections 10.3 and 10.2)
- Storage capability for HLW storage in below grade tile holes at WMA B (Section 10.3), and above ground storage in canisters at WMA G (Section 10.2) and at the Fuel Packaging and Storage (FPS) facility for storage of selected legacy research reactor fuel rods from tile holes (Section 10.3)
- The Sanitary Landfill accepts clean, solid waste (i.e., non-radioactive and non-hazardous) (see Section 10.7)
- The Sort and Segregation Pilot Facility and the Waste Sort and Segregation Facility began operating in 2020 and 2022, respectively, to address solid LLW that is currently in storage (Section 10.2)
- Planning is underway to repurpose WMA C for the recoverable surface storage of LLW in sealand containers

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New Facilities/Capabilities

A number of new key enabling waste facilities and capabilities which are at various stages within the program of work have been identified which will complement the current capabilities at CRL and address processing, storage and disposal requirements as necessary to ensure the waste strategies can be successfully completed. These include:

- The proposed NSDF:

The NSDF Project is a proposed waste disposal facility using an Engineered Containment Mound (ECM) design built at ground surface that will hold up to 1 million cubic metres (m^3) of LLW (planned to be located in MU 4, adjacent to MU 6 – see Figure 5. The facility will feature ten waste disposal cells built in two phases. The ECM includes a multilayer base liner and cover system, where waste will be placed in between. The waste in each cell is covered after the cell is full. It is similar to an engineered municipal landfill but with much more robust engineering features. The proposed facility will be licensed under the Nuclear and Safety Control Act and thus subject to the associated regulations and independent regulatory oversight from the CNSC. The proposed NSDF is to be comprised of the ECM, the Waste Water Treatment Plant and supporting facilities and infrastructures. The ECM will safely dispose of LLW that meets the NSDF Waste Acceptance Criteria [100]. Disposal space inside the proposed NSDF is to be treated as an asset, and all efforts will be made to use the space efficiently for wastes that cannot be cleared for other disposal options. The proposed NSDF will hold only LLW which contains primarily short-lived radionuclides, and limits the amount of long-lived radionuclides. This material will require isolation and containment for up to a few hundred years. The ECM design life of 550 years has been established to meet the required time period to allow for radiologic decay of the waste inventory. The radioactivity concentration in the ECM is estimated to have decreased by approximately 2,000 times in the first 100 years and begins to approach background levels of concentration shortly thereafter. CNL will be required to undertake a Post-closure Safety Assessment which analyzes the long-term implications and demonstrates that the dose to any future generation which may interact with the disposal facility is within the established dose acceptance criteria, consistent with applicable IAEA and CNSC guidance and requirements.

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- Optimization of Existing Central Waste Management Areas:

CNL is assessing the current land area available within Waste Management Areas B, D, G and H to optimize the re-use of already disturbed lands for proposed new facilities and capabilities, which include:

  - The Sort and Segregation Facilities, which are already operational.
  - The Cask Facility, a planned new nuclear facility, which will be a centralized facility for transportation cask and transfer flask operations, storage, and maintenance
  - Intermediate-Level Waste and High-Level Waste processing capabilities and facilities. Work is currently underway to determine requirements to meet CNL needs including the stabilization/ processing of WMA B inventory.

- Intermediate-Level Waste and High-Level Waste storage capabilities and facilities, including an ILW storage Facility and expanded storage capacities within WMA G to receive and store used fuel (High-Level Waste) consolidated at CRL until the national used fuel Deep Geological Repository (DGR) is available[5].

The advantages of consolidating facilities/capabilities in one area include:

- Planning the renewal of infrastructure and service requirements specific to the WMA needs (i.e., electrical, fire water, process water, roads, support facilities)
- Supporting planning for enabling facility sequencing in connection with IWS and Cleanup Function
- Minimizing impacts on the environment by optimizing the existing WMA footprint (i.e., manages sprawl)

Additionally, a Heavy Water Detritiation Facility (HWDF) will be designed, licensed, constructed and operated to disposition AECL's inventory of tritiated heavy water. This is part of the Tritiated Heavy Water Management Program of work and converts a complex nuclear liability into two assets (Heavy Water and elemental tritium) that can be re-used for nuclear and non-nuclear applications.

Areas that need further assessment and review of options for managing waste include:

- Radioactive Liquid Waste: Liquid waste processing capability is currently being evaluated to assess the options for the longer-term, to ensure future ILW liquid processing capability is sized appropriately and produces a waste form that will meet geological disposal criteria [6]
- Intermediate-Level Waste Disposal: The national draft Integrated Strategy for Radioactive Waste includes a recommendation for a single DGR for ILW in Canada, including the AECL-owned inventory of ILW. The CNL Integrated Waste Strategy includes an ILW Program of work, which monitors the progress of the national ISRW recommendations, while also evaluating lifecycle management options and opportunities.
- Clean Waste Disposal: The estimated remaining life of the Sanitary Landfill, based upon the landfill profile and annual waste volume, is currently assumed to be approximately 7 to 10 years. It is recognized that the capability will continue to be required beyond this timeframe, therefore it is necessary to identify alternative management options
- Soil Management and Disposal: During environmental remediation large amounts of non-radiological impacted soil will be generated, including some classified as hazardous wastes. Options to address the disposal of this material will need to be identified and assessed

[5] The used fuel DGR is being developed by the Nuclear Waste Management Organization (NWMO) as part of the Adaptive Phased Management plan for long term management of Canada's used nuclear fuel. Site selection is currently underway and after starting with 22 communities that expressed an interest, two sites – the Township of Ignace in northwestern Ontario, and the Municipality of South Bruce in southern Ontario being considered as potential host areas for the project.

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Notably, the Federal Government's Integrated Strategy on Radioactive Waste has been drafted by the NWMO and issued for public review. The strategy will not be finalized until after the government's revised Policy for Radioactive Waste Management and Decommissioning is published. The outcome may have impacts on the IWS and cleanup planning.

9.8 Constraints and Limitations

It is also imperative to consider constraints and assumptions within a cleanup options assessment. Constraints act to limit the options that can be implemented. Conversely, assumptions may be required to support the practicality of implementing an option [92]. See Section 9.2.2 and 9.4 for details on the assumptions underpinning cleanup at the CRL Site.

Some examples of the constraints applicable to advancing CRL cleanup planning are:

- The lack of an appropriate LLW disposal facility limits the advancement of the execution of decommissioning and environmental remediation
- Once a LLW disposal facility is available, its capacity will be limited, and therefore will be treated as an asset to be used efficiently for wastes that cannot be cleared for other waste management options
- The continued operations at site limits the areas that can be cleaned up for site revitalization and also adds to the complexity of cleanup, e.g., infrastructure will be re-planned and re-routed, etc.
- The lack of definition on ILW disposal pathways, including the location of a future disposal facility, and the applicable Waste Acceptance Criteria that will need to be satisfied by CRL Waste Generators

Constraints applicable to individual decommissioning and environmental remediation projects will be detailed in individual DDPs and RAPs, respectively.

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10. Current Assessment Status by Management Unit

The CRL site is a highly complex facility where nuclear research and development activities have taken place for more than 70 years. To allow for more efficient planning and tracking of decommissioning and environmental remediation activities the site has been divided into 11 Management Units (MUs), which correspond to areas with similar levels of contamination or similar operational history and which are well defined geographically and physically.

The focus for the next five years is planned to continue as it has for the past five years; on decommissioning activities, mostly the dismantling and demolition of structures in the Campus Precinct (MUs 1 and 7), and progressing characterization of the environmental legacy at CRL. The characterization efforts will be accelerating in the next five years to facilitate remediation execution once the proposed NSDF is approved and is ready to receive LLW generated as part of decommissioning and remediation activities.

Cleanup will support revitalization in accordance with CNL's ongoing S&T mission at the CRL site. The areas with the greatest redevelopment potential are principally in MUs 1 and 7; which are both part of the Campus Precinct. Several areas in the Outer and Entry Precincts have also been designated as development blocks where future facilities may be located.

Several Management Units in the Outer Precinct contain long-lived radioactive and chemical wastes stored below-grade in facilities that do not meet current waste management standards. These along with associated contaminant plumes which have impacted soil, groundwater, surface water and sediments will require remediation efforts.

Outside the footprint of specific waste management areas, the Outer and Entry Precincts at CRL are characterized by natural areas with rolling forested landscape and numerous lakes, rivers, and wetlands that provide critical habitat to several species at risk. The vast majority of these natural areas will be preserved and their usage will not change appreciably in the future once they have been remediated and restored where necessary.

See Figure 5 for the overview map of the CRL MUs.

Description of Each MU Sub-Section:

More than 60 sub-areas, defined as APECs have been identified within the 11 MUs. The eleven MUs are presented in numerical order, and this order does not reflect an order of importance related to either environmental risk or development potential. As cleanup planning progresses, the APECs within each MU will be evaluated using a proposed prioritization tool (Section 9.6) to determine which remedial actions may result in the greatest overall risk reduction or achievement of other goal (e.g. clean up of an area needed for new construction).

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Each MU sub-section includes:

- An overview description,
- A map of the MU,
- Descriptions of any enabling or site revitalization projects within the MU,
- The current and planned status of any buildings/structures or APECs currently undergoing decommissioning or environmental remediation,
- Where sufficient information is available, refined estimated waste volumes associated with the decommissioning and remediation of the MU based on comparison of recent soil characterization results to risk-based soil screening criteria, and
- Preliminary proposed, target next land uses for each MU.

These land uses are considered 'proposed' as engagement with stakeholders is ongoing, and 'target' because CNL has not yet undertaken the assessments and evaluation required to determine if remediation to these levels is feasible or achievable. It is also possible that the various APECs within an MU will be cleaned up to different land uses depending on operational needs.

A table describing the operational or decommissioning status of all buildings/structures and summary information on each APEC within each MU is found in Appendix A.

Status of Class I and II Facilities:

Table 7 summarizes the current and future status of the Class I and Class II Nuclear Facilities at CRL and has been updated to reflect changes since the last iteration of the overview CPDP [1]. The descriptions of the status categories are provided in Appendix A, Table A-1. The Class I and II Nuclear Facilities listed in Table 7 must have facility specific DDPs developed and accepted, prior to the conduct of any decommissioning work, which describe the decommissioning plans for that facility. See the appropriate MU section where details are provided for each facility that is currently in a state of decommissioning (i.e., not operations).

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Table 7: Status of Class I and Class II Nuclear Facilities at CRL

Facility or Equipment	Scope (Building(s) or Area)	Current Facility Status[1] (as of 2022 December)	Plan Forward (expected status[1] in 5 years)	Located in:
CRL Class I Nuclear Facilities				
Recycle Fuel Fabrication Laboratories (RFFL)	[redacted] (part)	Operations	Operations	MU 1
ZED-2 Reactor	[redacted] (part)	Operations	Operations	MU 1
Universal Cells	[redacted]	Operations	Operations	MU 1
Fuels and Materials Cells	[redacted] (part)	Operations	Operations	MU 1
Nuclear Fuel Fabrication Facility (NFFF) – lower level, Fuel Assembly Science & Technology (FAST) – upper level	[redacted]	Operations	Operations	MU 1
^{99}Mo Production Facility	[redacted]	Operations	Operations	MU 1
	[redacted]	Operations	Decommissioning / Building Removal	MU 1
Tritium Laboratory	[redacted] (partial)	Operations	Operations	MU 1
Combined Electrolysis Catalytic and Exchange Upgrade and Detritiation Test Facility	[redacted] (partial)	Operations	Storage With Surveillance (SWS)/ Care & Maintenance (C&M)	MU 1
Waste Treatment Centre and Associated Facilities	[redacted]	Operations	Operations	MU 1
	[redacted]	Operations	SWS/C&M	MU 1
	[redacted]	Operations	SWS/C&M	MU 1
	[redacted] – Emergency Storage Basin	Operations	SWS/C&M	MU 4

REDACTED

Facility or Equipment	Scope (Building(s) or Area)	Current Facility Status[1] (as of 2022 December)	Plan Forward (expected status[1] in 5 years)	Located in:
	[redacted] – Tank Farm	Operations	Operations	MU 9
Waste Management Areas and Associated Buildings and Facilities	WMA A, LDA	Operations (not currently accepting waste)	Operations	MU 6
	WMA B, [redacted]	Operations	Operations	MU 3
	WMA C	Operations (not currently accepting waste)	Operations [2]	MU 8
	WMA J (BML)	Operations	Operations	MU 8
	WMA D, G, H; [redacted] series, [redacted] series	Operations	Operations	MU 2
	WMA E	Operations (not currently accepting waste)	Operations	MU 9
	WMA F	Operations (not currently accepting waste)	Operations	MU 10
	Thorium Nitrate Dispersal, Ammonium Nitrate Plant	Operations (not currently accepting waste)	Operations	MU 11
CRL Class II Nuclear Facilities				
Gamma Beam [redacted] Irradiation Facility	[redacted] (part)	Operations	Operations	MU 7
Gamma Beam Irradiators Model GC60	[redacted] (part)	Operations	Operations	MU 7

REDACTED

Facility or Equipment	Scope (Building(s) or Area)	Current Facility Status[1] (as of 2022 December)	Plan Forward (expected status[1] in 5 years)	Located in:
Van de Graaff Accelerator	[redacted] (part)	Operations	Operations	MU 1
Health Physics Neutron Generator	[redacted] (part)	Operations	Operations	MU 7
CRL Nuclear Facilities in Extended Shutdown State				
MAPLE 1 and 2 Reactors	[redacted]	Operations -Extended Safe Shutdown	Decommissioning / Building Removal	MU 1
New Processing Facility	[redacted]	Operations - Extended Safe Shutdown	Decommissioning / Building Removal	MU 1
CRL Nuclear Facilities Undergoing Decommissioning Activities				
NRX Reactor	[redacted]	Decommissioning / Building Removal	Decommissioning / Building Removal	MU 1
NRX Reactor Ancillary Buildings	[redacted]	End-State Verification Activities	Interim End State - SWS	MU 1
	[redacted]	End-State Verification Activities	Interim End State - SWS	MU 1
	[redacted]	Decommissioning / Building Removal	Decommissioning / Building Removal	MU 1
	[redacted]	End-State Verification Activities	Interim End State - SWS	MU 1
Former Reactor Bay Deionization System	[redacted]	Decommissioning / Building Removal	Decommissioning / Building Removal	MU 1
NRX Fuel Storage and Handling Bays ([redacted])	[redacted]	Decommissioning / Building Removal	Decommissioning / Building Removal	MU 1
Plutonium Recovery Laboratory	[redacted]	Decommissioning / Building Removal	Decommissioning / Building Removal	MU 1
Plutonium Tower	[redacted]	Interim End-State - SWS	Interim End State - SWS	MU 1
Waste Water Evaporator	[redacted]	End-State Verification Activities	Interim End State - SWS	MU 1
Active Waste Disposal ([redacted])	[redacted]	Decommissioning / Building Removal	Decommissioning / Building Removal	MU 1
Building [redacted] including former Tritium Laboratory and Radio Isotope labs	[redacted]	Decommissioning / Building Removal	Decommissioning / Building Removal	MU 1
Nuclear Fuel Fabrication Facility (NFFF) ([redacted])	[redacted]	Decommissioning / Building Removal	Interim End State - SWS	MU 1
Emergency Process Water Cooling - NRU	[redacted]	End-State Verification Activities	Interim End State - SWS	MU 1
	[redacted]	End-State Verification Activities	Interim End State - SWS	MU 1

REDACTED

Facility or Equipment	Scope (Building(s) or Area)	Current Facility Status[1] (as of 2022 December)	Plan Forward (expected status[1] in 5 years)	Located in:
	[redacted]	Decommissioning / Building Removal	End State Complete / Land Re-use	MU 1
	[redacted]	End State Complete	End State Complete / Land Re-use	MU 1
CRL Permanently Shut Down Facilities				
NRU and auxiliary buildings	[redacted]	Operations - Extended Safe Shutdown	SWS/C&M	MU 1
Table Notes: [1] See Appendix A, Table A-1 for descriptions of the Status categories. [2] Work is in progress to return WMA C to service for use as a Recoverable Surface Storage Area.				

10.1 Management Unit 1

Management Unit 1 is part of the Campus Precinct and includes the Controlled Area and the affected shoreline along the Ottawa River which includes the Power House Shoreline Landfill (Figure 10). Operational activities in MU 1 have also left a legacy of hazardous materials both within buildings and in the sub- surface. Contamination sources in MU 1 are the result of spills, leaks and direct emplacements (e.g., landfilling, coal stockpiling). Legacy leaks from both the NRU and NRX reactor fuel storage, or rod, bays have resulted in contamination plumes that extend to the Ottawa River. These plumes are monitored under the CRL GWMP and updates are provided in the Annual Compliance Monitoring Report on Environmental Monitoring.

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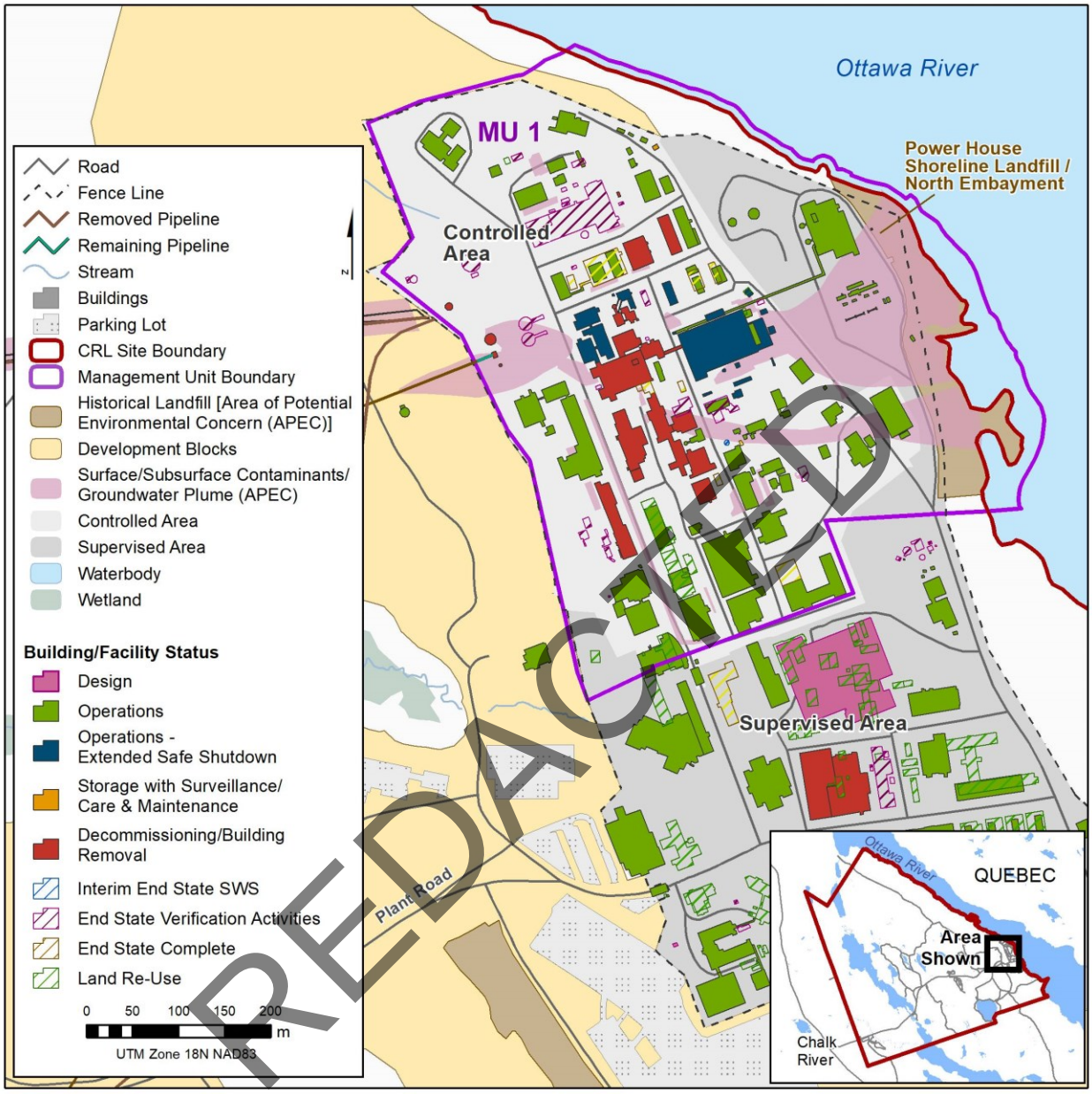


Figure 10: Map of Management Unit 1

No key enabling facilities to support the cleanup mission are currently planned within MU 1, although several development blocks have been identified which are areas that may preferentially be used in support of CNL's missions. Of the development blocks identified for the Campus Precinct in the Site Master Plan, however, approximately half are located in MU 1.

Significant cleanup efforts have been initiated in MU 1 to enable site revitalization and eventual redevelopment of the Campus Precinct. Several of the structures demolished at CRL in recent years were located in MU 1 and the Land Use and Environmental Remediation processes will be executed to deal with remaining contamination and in-ground infrastructure. Since the last iteration of this overview plan a number of major changes within MU 1 include:

- Decommissioning execution is underway in the NRX reactor in accordance with the Detailed Decommissioning Plan (DDP) for Interior Demolition (Stage 1) of Building [redacted], and is forecast for completion in 2031 (see Figure 26). The NRX Reactor will change designation to a Nuclear Facility Undergoing Decommissioning Activities in the next revision of the Site Licences, Certificates, Permits, Building/Facility Contacts, & Licence Representatives document. Routine monitoring, maintenance and surveillance activities have continued on the NRX reactor, building structure and systems consistent with the NRX Reactor Facility Storage with Surveillance Plan as described in Section 4 of the Building [redacted] DDP. A summary of the decommissioning activities undertaken each year is provided in CNL's Annual Compliance Monitoring Report (e.g., [101]).
- The decommissioning of [redacted], the NRX delay tanks, has progressed through demolition and the site has been restored; end-state verification activities are underway.
- The Dedicated Isotope Facilities (DIF), includes the MAPLE 1 and 2 Reactors and the New Processing Facility and remains non-operational, with no fuel in the MAPLE reactor cores. The focus for the DIF has been to monitor and maintain the facilities in Extended Shutdown State, where only systems that are required to preserve assets are operational. DIF is the only nuclear facility on-site in an Extended Shutdown State (ESS). The surveillance and maintenance activities have been continued as outlined in the MAPLE and New Processing Facility (NPF) Operational Limits and Conditions documents. Decommissioning execution is forecast for 2025 - 2031 (see Figure 27). A summary of the decommissioning activities undertaken each year is provided in CNL's Annual Compliance Monitoring Reports (e.g., [101]).
- The permanent shutdown of the NRU Reactor occurred on March 31, 2018. The facility is currently de-fueled and de-watered. Work continues to progress the NRU reactor to a Storage with Surveillance state followed by of the development of the DDP Stage 1 with decommissioning execution planned to begin in 2029 (see Figure 28). A summary of the decommissioning activities undertaken each year is provided in CNL's Annual Compliance Monitoring Report (e.g., [101]).
- The decommissioning of the Active Laundry Facility, [redacted], has been undertaken and the area is undergoing end-state verification activities.
- As part of the Active Liquid Waste Project, all legacy radioactive liquid waste was removed from the storage tanks in Building [redacted] and decommissioning planning has been initiated.
- The decommissioning of the Emergency Process Water Supply, [redacted], and associated structures, has also progressed to the stage of end-state verification.

Over the next five years, significant decommissioning activity within MU 1 will continue to remove legacy buildings to enable eventual progress toward additional redevelopment space for the site revitalization in the Campus Precinct. Some of the major projects planned include:

- Decommissioning and demolition of [redacted] and various others (Appendix A)
- The turnover of approximately 30 NRU-related ancillary buildings to Facilities Decommissioning and their subsequent decommissioning activities

REDACTED

- Environmental remediation activities will be initiated when suitable support facilities are available (i.e., proposed NSDF). In the meantime, environmental site assessments (Phase 1 and 2) will be developed for discrete areas of MU 1 to gain the appropriate knowledge to develop refined waste volumes estimates and remediation plans

The areas within MU 1 will be cleaned up to a proposed target of industrial land use to meet the needs for the revitalization of the campus. Of the development blocks identified for the Campus Precinct in the Site Master Plan, approximately half are located in MU 1.

10.2 Management Unit 2

Management Unit 2 is within the Perch Lake Drainage Basin and includes three active Waste Management Areas located in the Outer Precinct along Plant Road:

- Waste Management Area D, where sealand containers are stored above ground and where mixed wastes are stored and processed in the [redacted] series buildings;
- Waste Management Area G, where used nuclear fuel is stored in above ground concrete canisters; and
- Waste Management Area H, where Sort and Segregation Facilities are located and where LLW is stored in sealand containers or in one of the available storage or processing facilities (Figure 11)

These three facilities are scheduled to continue operating and ongoing operational monitoring will continue to ensure that stored materials are not releasing contamination to the surrounding environment.

The WMA's within MU 2 are currently undergoing capacity expansions and are being considered for the construction of new facilities to support the CNL cleanup mission. The areas will, therefore, not be available for decommissioning and environmental remediation for the foreseeable future. As a result, detailed cleanup planning for MU 2 is not a near term priority. In addition, a secondary plan is being prepared for WMAs D, G and H (as well as WMA B in MU 3, Section 10.3) which will consider holistic needs for new builds, roads and services, as described below.

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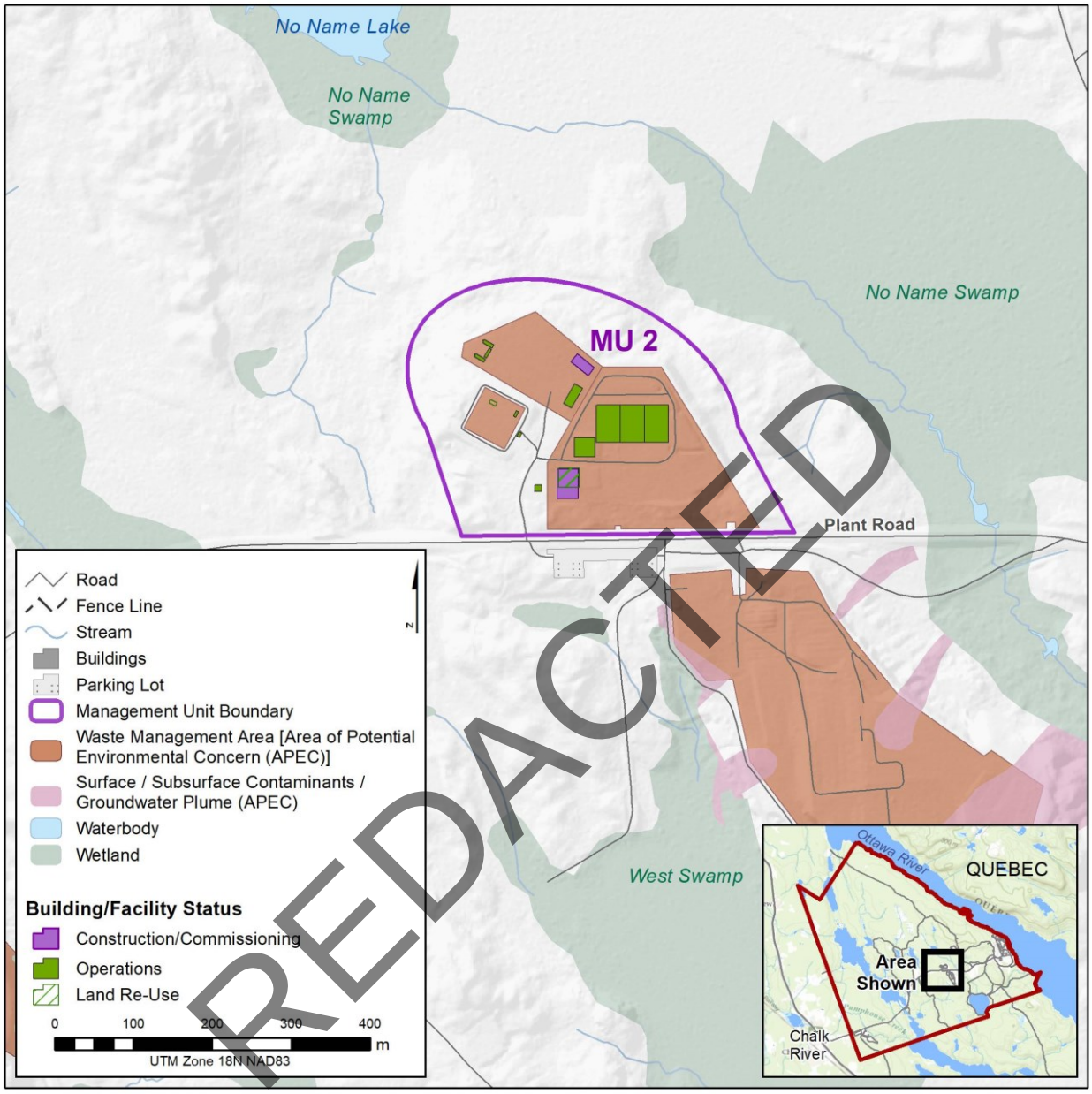


Figure 11: Map of Management Unit 2

To support the long-term Waste Services mission at CRL which parallels ongoing operations of the site, CNL is assessing the current land area available within Waste Management Areas B, D, G and H to optimize the re-use of already disturbed lands for proposed new facilities and capabilities.

In addition to the existing waste management facilities this area would house several enabling waste facilities which are planned to support the ongoing Cleanup Mission. Waste processing facilities, the Cask Facility, ILW and fuel storage facilities, and a stabilization/processing facility for inventory removal at WMA B could be located within MU 2 along with a permanent building for centralized support functions.

There are no facilities slated for decommissioning within MU 2 in the immediate future. The Environmental Remediation process and decommissioning plans will be implemented once these facilities no longer serve a useful purpose and in the interim, the proposed target land use will remain industrial.

There are no downgradient contamination concerns associated with WMA G or WMA H operations, historical or current. There is currently minimal evidence of contamination to soil or groundwater from WMA D operations within MU 2. Tritium and nitrate levels have periodically been observed above surrounding background levels in a few groundwater monitoring wells in MU 2. The source of this contamination is unconfirmed, but it is believed to be related to past operational spills from drums of liquid waste formerly stored at WMA D. The contaminated waste volumes that may require remediation in MU 2 cannot be estimated at this time.

10.3 Management Unit 3

Management Unit 3 is operational and has been used since 1953 for the long-term storage of radioactive waste. It is scheduled to remain operational until disposal facilities become available. The area includes all of WMA B, all structures, facilities, and plumes emanating from the aging waste management facilities within this area and includes West Swamp.

A portion of MU 3, directly southeast of WMA B, has been identified as an area of high development potential in the Outer Precinct (see Development Block identified in Figure 12), this area is one option being considered for a proposed extension to WMA B in an undeveloped natural area for the construction of new large-scale waste management facilities. The boundaries of MU 3 may therefore require adjustment in the future.

To upgrade and replace the original system, the modernized New Spring B Groundwater Treatment Facility pump and treat system ([redacted]) has been constructed and began operating in 2020 to continue to mitigate the ^{90}Sr groundwater plume along the west perimeter of WMA B which discharges in West Swamp. This new facility is designed to treat the entire plume emanating from the Unlined Sand and Asphalt Trenches toward the south-west of WMA B.

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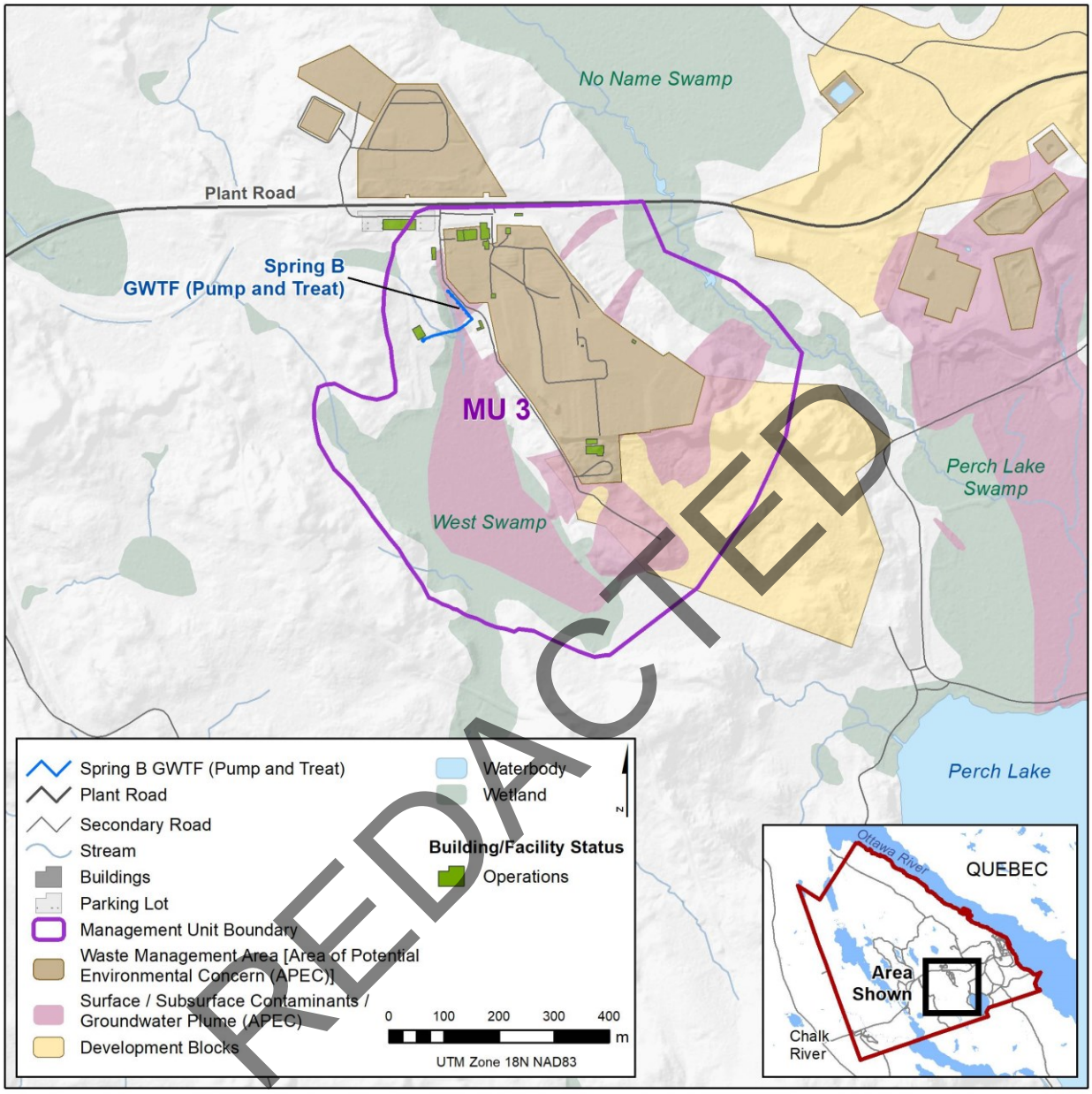


Figure 12: Map of Management Unit 3

Aside from the former change room at WMA B ([redacted]) and the original Spring B groundwater treatment system ([redacted]), no other buildings or structures are slated for decommissioning within MU 3 for the foreseeable future. Some aging waste containment structures are no longer in use while others may need to be replaced. A summary of the WMA and currently operational buildings within MU 3 are provided in Appendix A.

Assessments will be undertaken to ensure cleanup is not required to provide redevelopment space for any expansion. A development block has been identified for an area south of WMA B.

Although WMA B has been safely managing radioactive waste at the CRL site, past waste management practices were not designed and operated in line with modern day containment and confinement for radioactive waste storage. Subsurface contaminant migration at WMA B results from the storage of solid wastes in a variety of waste storage facilities, including unlined sand trenches and specialized engineered structures over the last five decades [78].

The Environmental Remediation process and decommissioning plans will be implemented once these facilities are no longer in service and in the interim, the proposed target land use will remain industrial for the facilities and parkland or unrestricted will be considered for the plumes. The contaminated waste volumes that will need to be managed upon closure of the areas within MU 3 cannot be estimated at this time.

10.4 Management Unit 4

Management Unit 4 covers most of the Outer Precinct except for several Waste Management Areas located within their respective Management Units. The outer areas of the CRL site have been host to a variety of experimental installations and include numerous site support areas such as firing ranges, a fire fighting training facility and snow dumps, as well as areas where waste has been landfilled or stored on surface. Some of these areas have already been remediated but will need to undergo verification to demonstrate that they meet the environmental screening criteria associated with the future land use at each location, once determined. Few facilities in MU 4 are operational but several exhibit evidence of local contamination.

Development blocks have been identified at both extremities of the Plant Road corridor. It is anticipated that outside of the development blocks, most other areas in MU 4 will be preserved as natural areas and will see limited change over the next few decades aside from any remediation required to meet the yet to-be-determined next land use. MU 4 includes several areas that are considered as ecologically sensitive such as wetlands, surface water bodies, and species at risk habitat (e.g., Blanding's turtle critical habitat).

The proposed NSDF (and its supporting facilities) is the primary enabling facility currently proposed to be located in MU 4 to support the cleanup mission.

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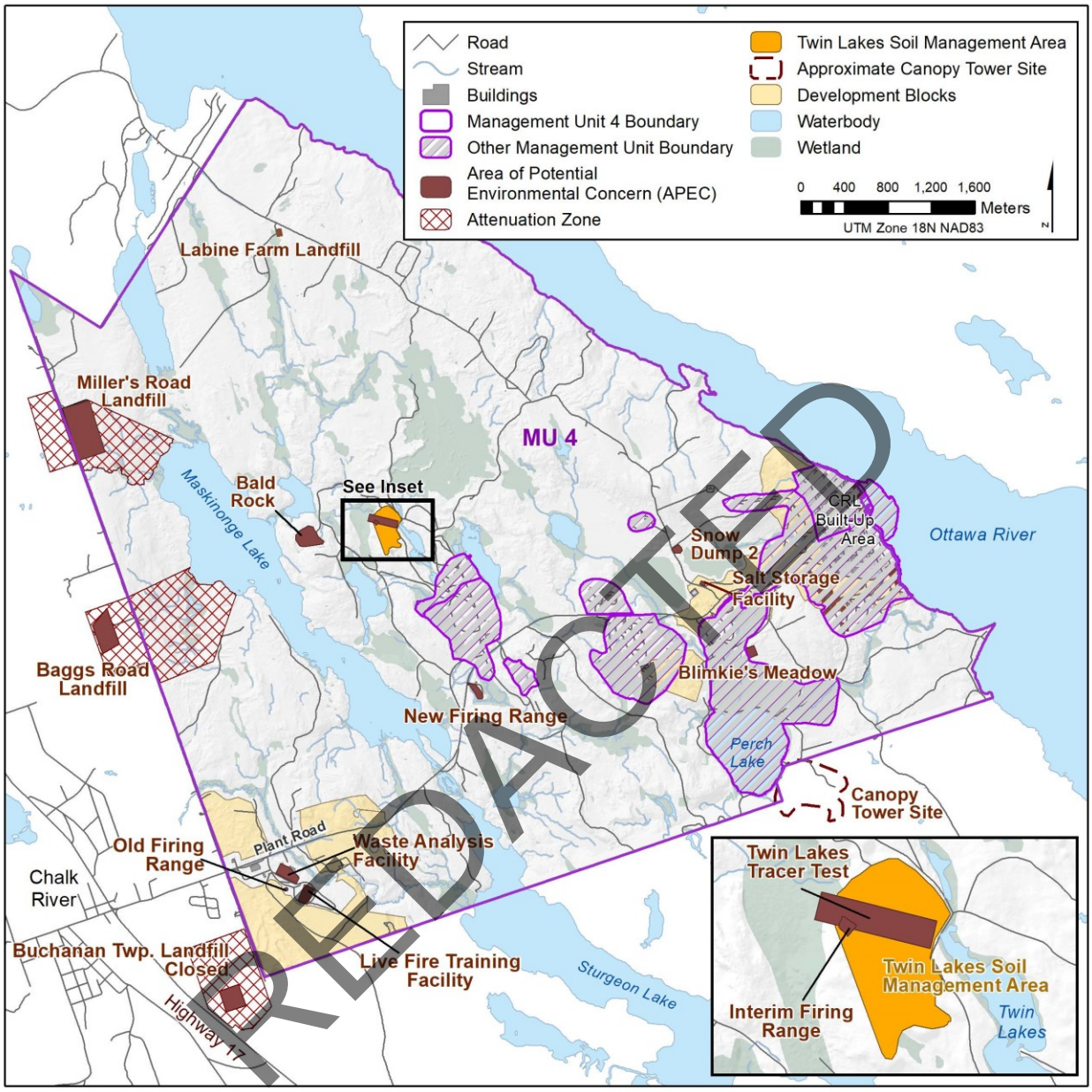


Figure 13: Map of Management Unit 4

Since the past iteration of this overview CPDP, changes have occurred at the Waste Analysis Facility and at the Live Fire Training Facility areas. A concrete and asphalt storage and processing facility became operational in 2021 which will allow for on-site reuse of aggregate material. There is also a facility under construction which will be comprised of a Waste Characterization Services Lab and Fire Training Classrooms.

Other projects completed since 2018 include several buildings such as [redacted] (Emergency Equipment Storage), [redacted] (Document Shack), and [redacted] (Outer Gate House) which have undergone decommissioning within MU 4, have reached end-state and in some cases the area is being reused, e.g., the widening of Plant Road at the site entrance is occupying the former

footprint of [redacted]. The new logistics warehouse facility at the CRL site entrance, the Minwamon building ([redacted]), was commissioned in 2021.

In 2021 and 2022 all 37 of the deep exploratory boreholes were decommissioned. Twin Lakes Soil Management Area was expanded in 2021 to include two formerly affected lands: the Twin Lakes Tracer Test Site and the Interim Firing Range. Supporting documentation for the appropriate management of soil is under development to ensure any soil being stored for reuse is of appropriate environmental and physical quality.

Most of the affected lands in MU 4 exhibit no, or only limited, localized evidence of contamination. Several of these APECs are currently operational or are being redeveloped as part of ongoing operations. Other APECs, located in the Outer Precinct, away from current operations are not currently candidates for redevelopment and may be allowed to return to nature following the necessary confirmatory characterization and closure process.

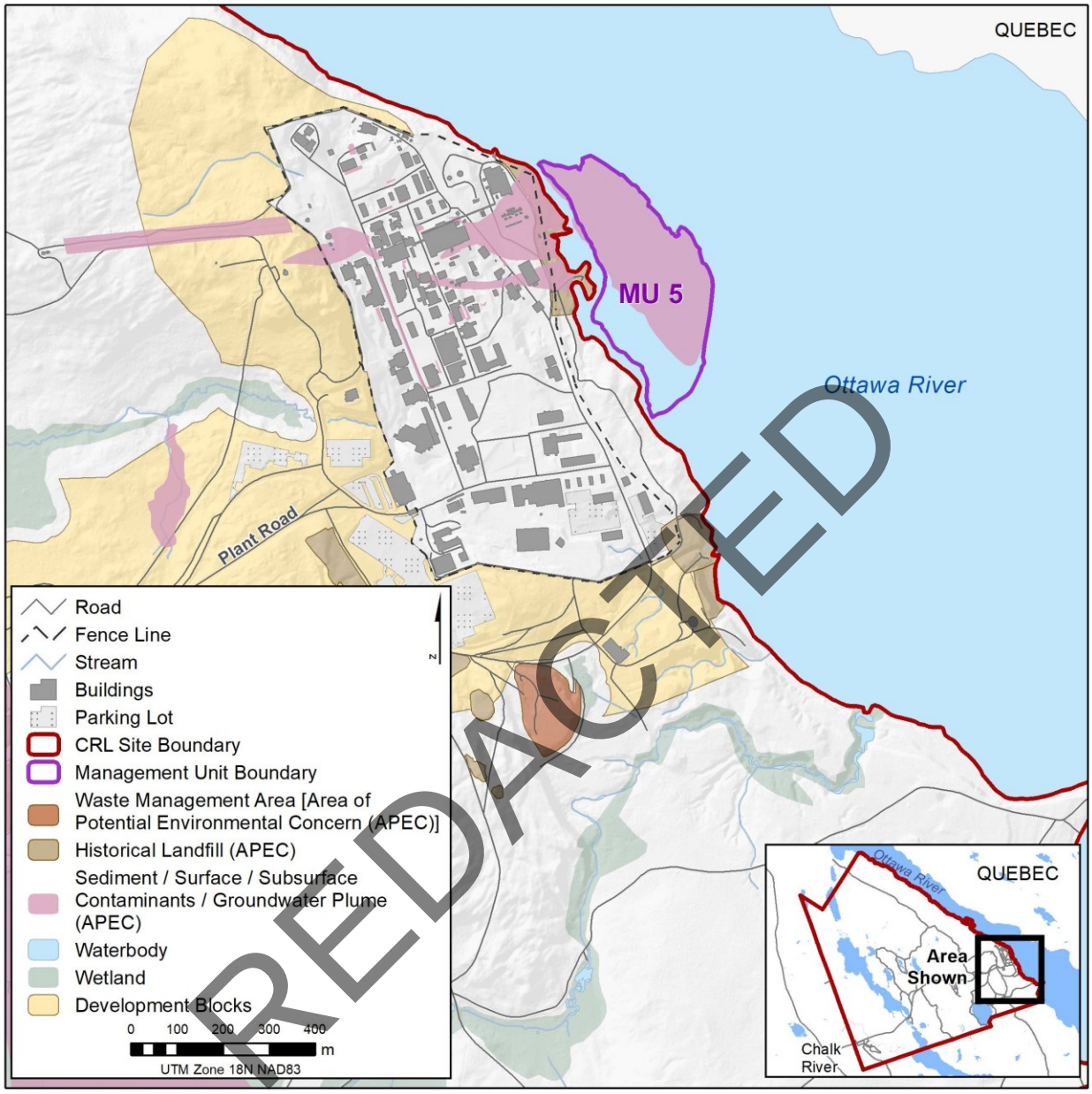
Contaminated areas within MU 4 will be remediated to the lowest level reasonably achievable and the majority of the final land use following cleanup activities will likely meet a proposed target of unrestricted or parkland land use. Affected areas within MU 4 that are selected for site revitalization purposes may instead be remediated to a proposed, target of industrial land use to support the ongoing CNL missions. A list of the APECs within MU 4 is provided in Appendix A.

10.5 Management Unit 5

Management Unit 5 consists solely of the area of contaminated sediment in the Ottawa River adjacent to the CRL Campus Precinct area that has been affected by CRL operations. The CRL shoreline areas along the built-up area are considered as part of MU 1 (Section 10.1) and MU 7 (Section 10.7).

Human health risk assessment confirms a low risk to the public from the contaminated sediment and that the river in this area remains safe for recreational use. In addition, multiple lines of evidence presented in the Ottawa River sediment Ecological risk assessment showed that there is negligible and declining risk to the Ottawa River biota from this historical sediment contamination [102]. Numerous downstream beach and shoreline surveys on both shores of the Ottawa River have not detected any radioactive particles and comprehensive studies have indicated that even under extreme scenarios, the contamination is highly unlikely to be transported toward beaches and shorelines. A robust effluent monitoring program continues to monitor for changes and indicate that discharges to the Ottawa River meet all regulatory requirements [74], [75].

REDACTED



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Figure 14: Map of Management Unit 5

A detailed summary of the Ottawa River sediment contamination and the extensive work done to assess the area is provided in Section 4.7 of the 2018 CRL ERA [11], also see Appendix A. The management goal is to maintain low and acceptable risk to human health and the environment under a Monitored Natural Attenuation approach. An ongoing sediment verification monitoring program is being implemented in order to monitor the riverbed and verify that the underlying assumptions and conclusions made with respect to the contamination situation remain valid [103]. The results of the monitoring program to date have shown that the critical assumptions remain valid and river sediment deposition is further burying the contaminated sediments under clean more recent sediments while allowing radiological contaminants to decay [104],

[105]. The Ottawa River Sediment verification monitoring program will continue to assess Monitored Natural Attenuation progress. A forward plan to determine, and work toward, an appropriate end-state for this area requires development.

10.6 Management Unit 6

Management Unit 6 in the Outer Precinct lies within the Perch Lake Basin, which drains to the Ottawa River (Figure 15). MU 6 includes WMA A and the Liquid Dispersal Area (LDA), Reactor Pit 1, Reactor Pit 2, Laundry Pit and Chemical Pit, where radiological wastes have been dispersed and buried and significant contamination has been observed. MU 6 also includes former experimental sites where lower levels of contamination may remain present. Wetlands, generally to the south of WMA A and the LDA toward Perch Lake which drains to Perch Creek, have been impacted by waste disposed in MU 6. Both a Pump and Treat system and a permeable reactive barrier treatment system are used to intercept and remove ^{90}Sr from the groundwater before migration to the East Swamp and South Swamp, respectively.

There are currently no near-term plans for additional enabling facilities to be located in MU 6 to support the cleanup missions. The former disposal area valve house ([redacted]) is currently undergoing decommissioning in MU 6 and will enter an interim end-state. The other buildings in MU 6 house the groundwater treatment facilities which will remain operational (see Appendix A).

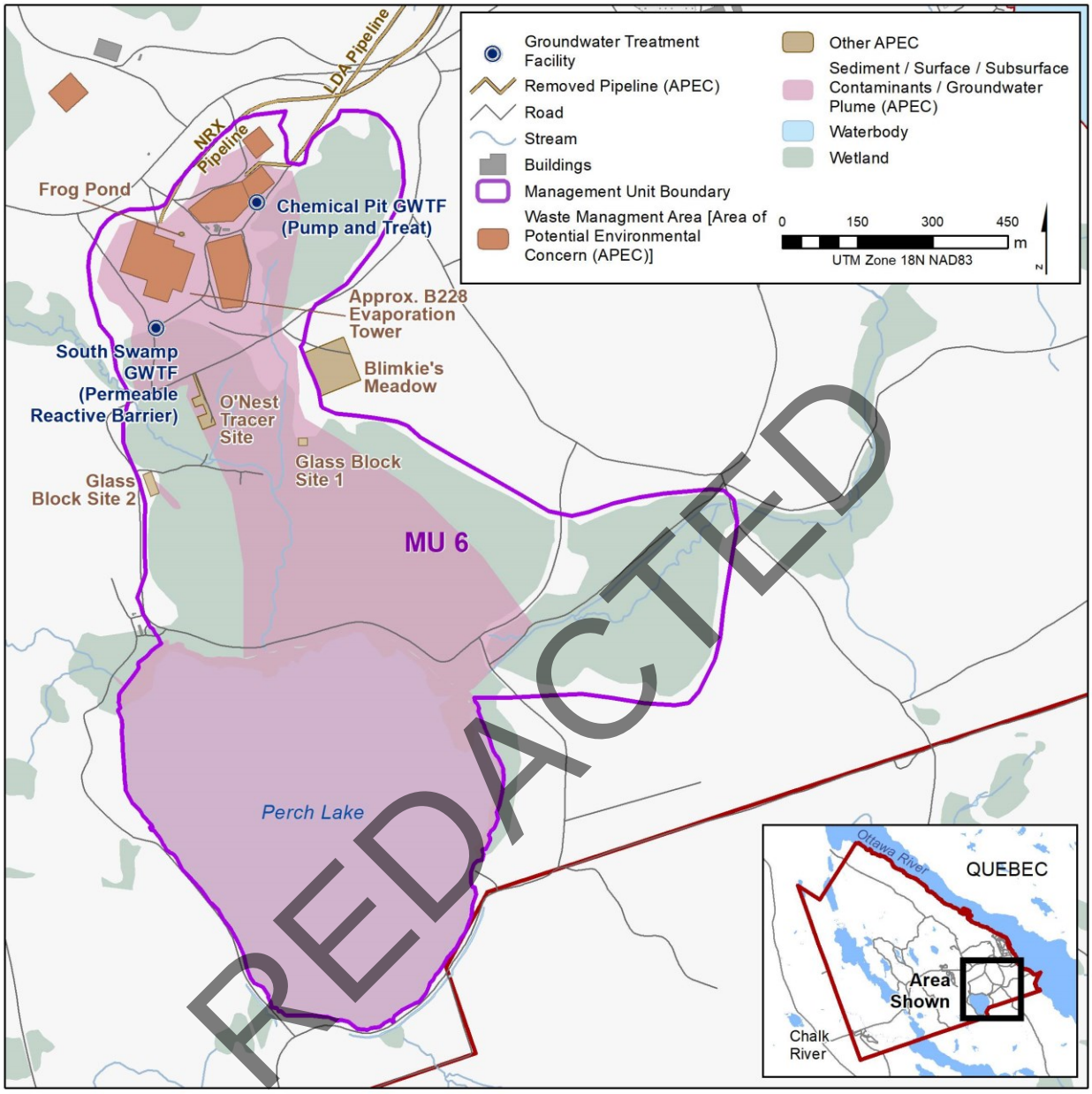
Management Unit 6 is a key priority area for cleanup activities due to the potential environmental risk associated with the waste contained in WMA A and the LDAs and because the portion of MU 6 that runs adjacent to Plant Road has been identified as a potential area for redevelopment. Appropriate enabling facilities will be required to support the cleanup of MU 6 due to the large quantities of contaminated waste and soil that will require remediation which most likely will include removal prior to site restoration to meet future land use requirements.

In 2017, an environmental characterization effort was focused on the unsaturated soil across the WMAs within MU 6 to determine if the soil would meet the proposed NSDF waste acceptance criteria. The analytical results from samples in and around the Areas of Potential Environmental Concern within MU 6 suggest that the contaminated soil in the unsaturated zone will meet the proposed NSDF waste acceptance criteria. The buried waste materials will be characterized during environmental remediation.

Over the next five years, additional environmental characterization efforts at the Waste Management Areas within MU 6 will be undertaken to assist in remedial planning and help delineate LLW areas from clean areas to reduce the amount of waste generated. Treatment options will be assessed for any waste that may not be suitable for disposal at the proposed NSDF.

Screening criteria for radionuclides in saturated soil are required to assist in the development of the remediation plan for any contaminated soil below the water table within MU 6. Detailed Decommissioning Plans and Remedial Action Plans will be prepared for the Nuclear Facilities within MU 6 (see Table 7) following the characterization activities.

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Figure 15: Map of Management Unit 6

The source areas (i.e., WMAs) within MU 6 will be remediated to the lowest level reasonably achievable. For instance based on the current understanding of the spatial and temporal distribution of the contaminants within MU 6, the Laundry Pit will likely meet a proposed target of unrestricted land use following remedial activities, however alternative land use scenarios (e.g., parkland) may be considered for the remaining areas. Areas within MU 6 that are selected to enable the cleanup mission or for site revitalization purposes may be remediated to a proposed target industrial land use. The Remedial Plans will also consider future land use scenarios beyond the period of institutional controls for the site. Wetlands impacted by groundwater plumes attributable to the contamination sources in MU 6 will be evaluated to

assess the effectiveness of natural attenuation as a potential remediation option. A list of affected lands within MU 6 is provided in Appendix A.

Based on comparison of recent soil characterization results to risk-based soil screening criteria, the total waste volume of contaminated material to be remediated from MU 6 is currently estimated to be 144,000 m^3. This volume is considered adequate for preliminary planning purposes, however it does not consider reuse of any soil material. For example, reuse of the clean, unsaturated soil cover over WMA A may be possible and would reduce the amount of soil to be sent for disposal. The disposal estimate also does not include soil within the saturated zone since the screening criteria for saturated soils are yet to be developed. These estimates are based on the most recent characterization results available, additional characterization in MU 6 is currently underway and this will lead to refinements in estimated volumes.

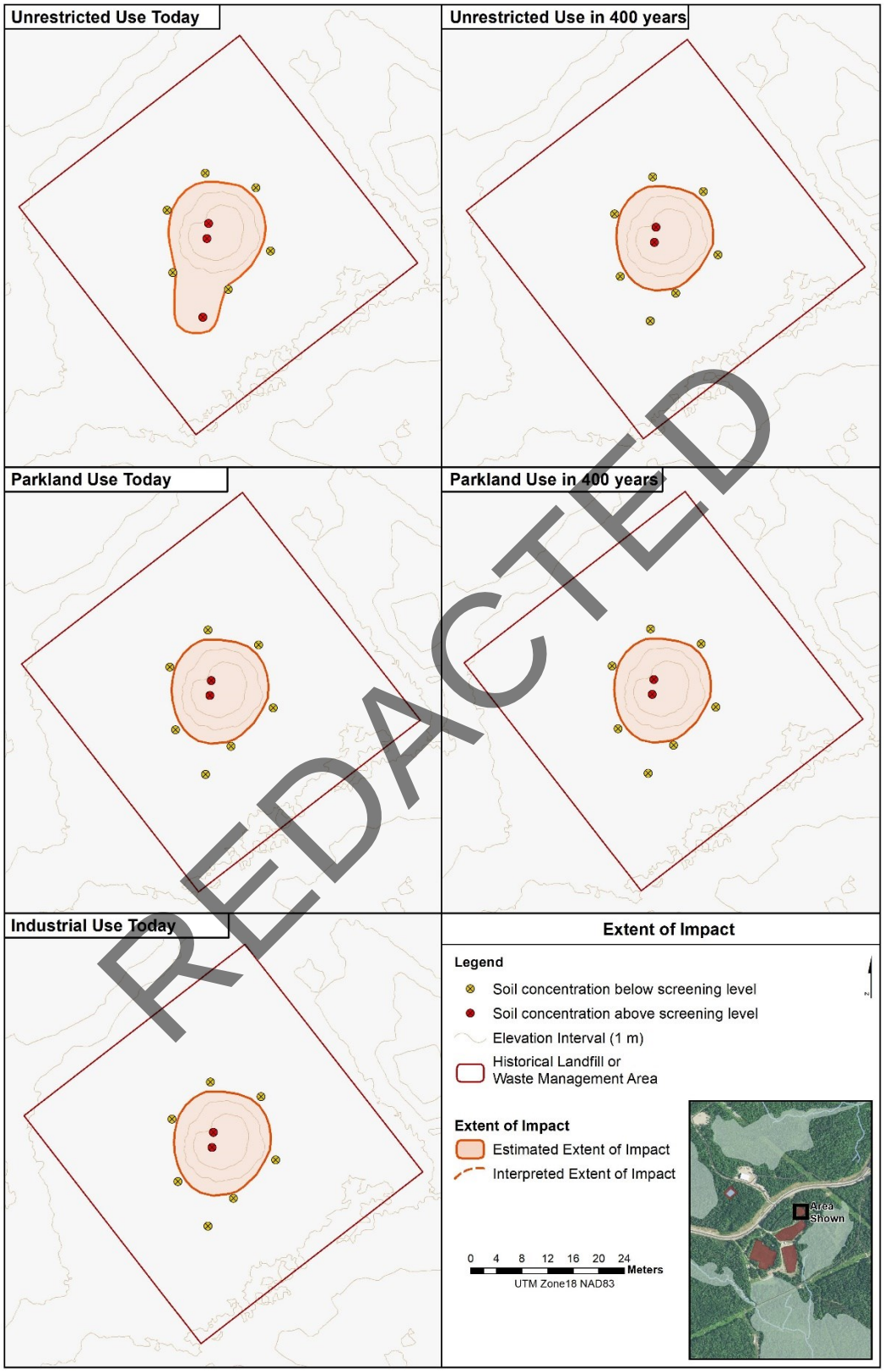
The preliminary estimated breakdown of waste from MU 6 is as follows:

- Approximately 101,326 m^3 of low-level contaminated soil,
- Approximately 19,390 m^3 of aggregate/rock,
- Approximately 3,500 m^3 of vegetation, and
- Approximately 20,000 m^3 of solid waste

For the areas with sufficient characterization data available, figures delineating the preliminary estimated extent of contamination in the unsaturated soil zone were created using the risk-based soil screening criteria (Section 9.3.1). These were developed based on the potential next land uses at CRL (Section 9.1.2) for two specific reference time periods which correspond to today (if the site was reused immediately following remediation) and 400 years from now which is the assumed end of institutional controls used for modelling purposes. The preliminary estimated extent of impact for the Laundry Pit, Chemical Pit and RP 2 are shown in Figure 16, Figure 17, and Figure 18, respectively. The estimated and interpreted extent of impact differ in that the estimated extent of impact is confirmed (i.e., the polygon is closed in) based on the evaluation of sufficient characterization data, whereas the dashed line showing the interpreted extent of impact indicates where CNL requires additional characterization data in order to fully define the boundaries of where the contamination exceeds the soil screening criteria for the particular land use and time period (indicated by a red dot), and where it is below the applicable criteria (indicated by a yellow dot). For example, in Figure 18: Reactor Pit 2 – Preliminary Estimated Extent of Impact, there is sufficient characterization data in order to determine the preliminary estimated extent of impact for both parkland use in 400 years and industrial use today, but additional soil sampling and analysis would need to be completed to fully delineate the extent of impact for unrestricted use today, unrestricted use in 400 years and parkland use today.

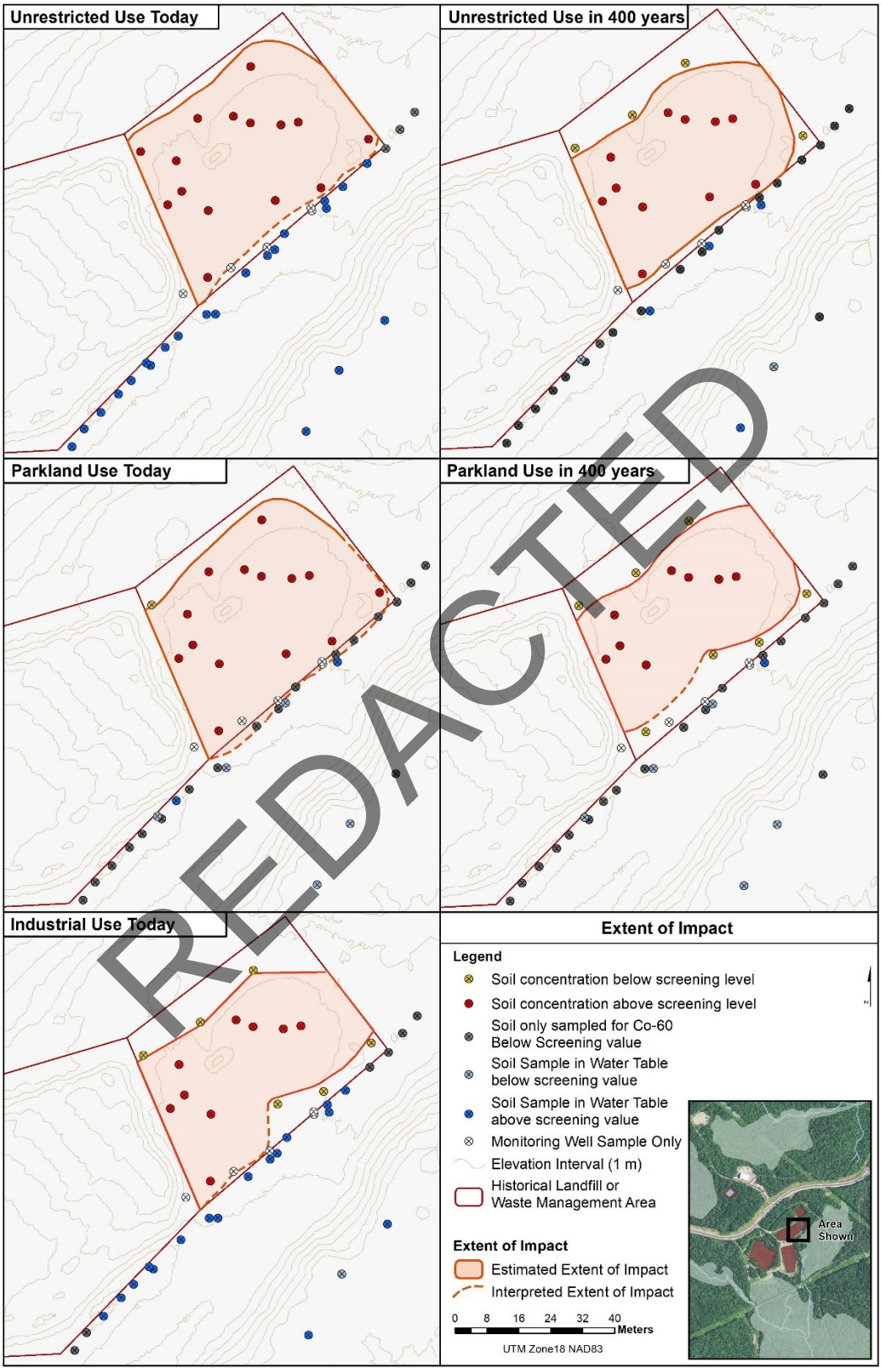
These interpretations will be used to determine the estimated contaminated waste volumes within MU 6 and serve as an important tool for the detailed decommissioned and remedial planning. Within MU 6, characterization activities initiated in 2022 and planned within the next 5 years will be used to further refine these volumes.

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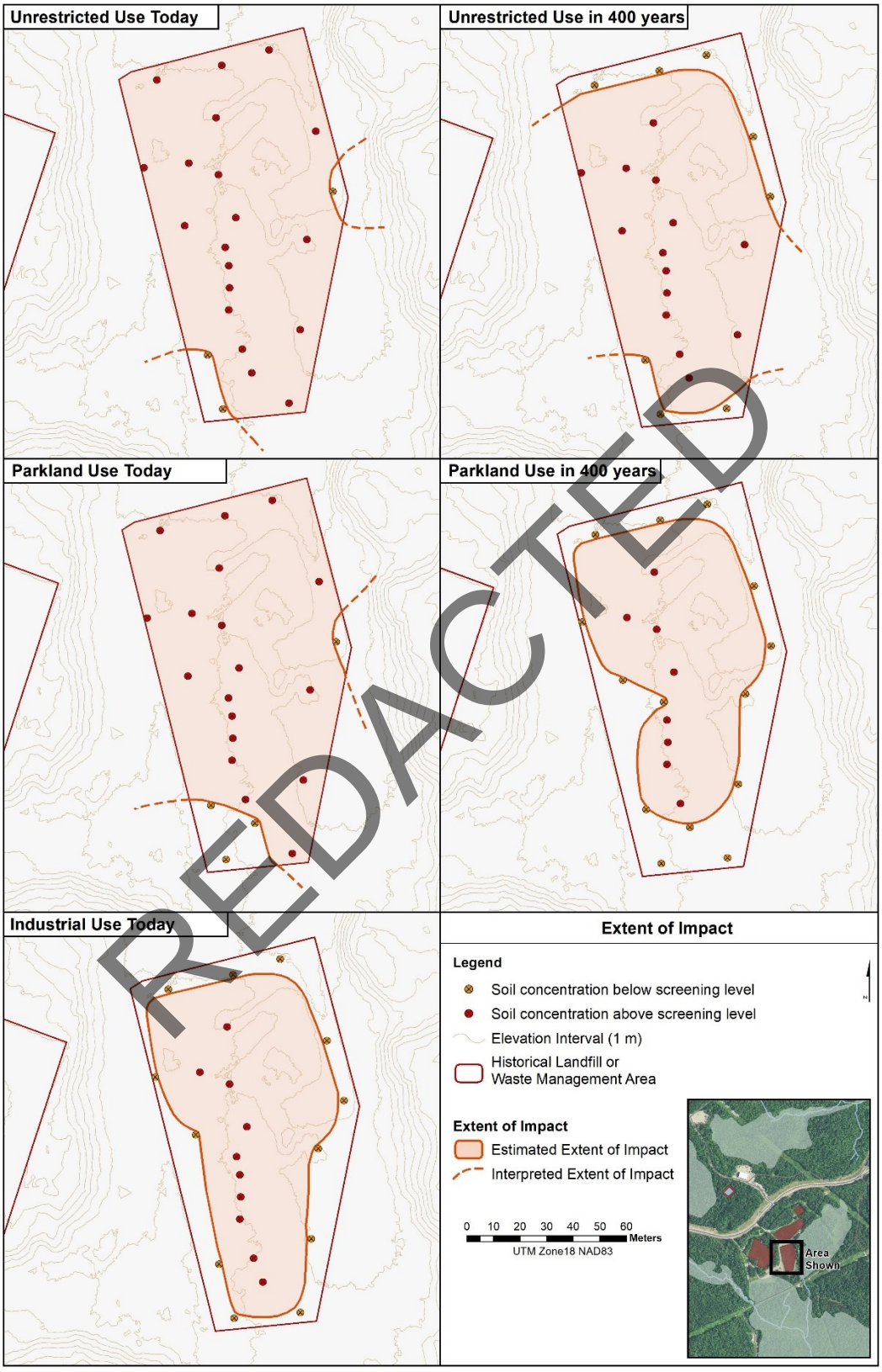
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Figure 16: Laundry Pit – Preliminary Estimated Extent of Impact



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Figure 17: Chemical Pit – Preliminary Estimated Extent of Impact



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Figure 18: Reactor Pit 2 – Preliminary Estimated Extent of Impact

10.7 Management Unit 7

Management Unit 7 is located in the Ottawa River Direct Basin and includes the southern [redacted] portion of the Campus Precinct, also known as the inner Supervised Area (SA) (Figure 19). The inner SA is undergoing a period of major redevelopment as part of site revitalization. The developed area of the SA is currently and has historically been occupied by predominantly non-nuclear facilities, office buildings, industrial facilities (e.g. water and sewage treatment facilities, machine shops, vehicle maintenance shops, petroleum supplies). There are some Controlled Area islands in buildings inside the SA (e.g. [redacted]). MU 7 also includes the immediately adjacent portions of land within the Outer Precinct to the south and west which are portions of land that were used in various operational capacities during earlier years of site development and operation. The historic uses consisted of landfilling, waste burning, equipment lay-down/storage, and winter snow dumping. This area also contains the operational sanitary landfill. This MU also includes the LDA Pipeline; 1953 NRX Emergency Pipeline and Above Ground Reactor Ventilation Duct Routes. In general, low to moderate levels of radioactive contamination have been observed at these facilities, except in the Foundation Road Landfill and the Electrical Yard Landfill where hazardous and radioactive wastes are known to be present.

Management Unit 7 contains numerous buildings and structures, some of which are undergoing accelerated decommissioning, while others will continue to be operational for many years. MU 7 is a priority area for site redevelopment to support continued operations at the CRL site into the future. Since the last iteration of the CPDP [1], a number of buildings have been decommissioned and demolished in MU 7. A partial list of the more significant buildings decommissioned in MU 7 since 2018 includes:

- The Vehicle Maintenance Shop [redacted]
- The Library [redacted]
- The remaining portion of the Glass Blowing Shop [redacted]
- The Carpentry Shop [redacted]
- The Sanitary Waste Water Plant [redacted]
- The National Research Council Technology Lab [redacted]

Several new builds have been commissioned and are now occupied including the Harriet Brooks Building ([redacted]) and the Support Facility ([redacted]). The Science Collaboration Centre ([redacted]) is under construction. Additional buildings are planned to continue the transformation of the Campus Precinct including a Small Modular Reactor, a Heavy Water Detritiation Facility, and a new switchyard and energy centre. The focal point of the Campus Precinct will be the Central Quad, a large greenspace area which will be framed by the Advanced Nuclear Materials Research Centre (ANMRC) and the Harriet Brooks buildings. The Support Facility is one example of a recent new build in MU 7 (another is the Minwamon Building in MU 4) which is built sustainably to align with the Government of Canada's Federal Sustainable Development Strategy plan to promote clean growth, ensure healthy ecosystems and build safe, secure and sustainable communities.

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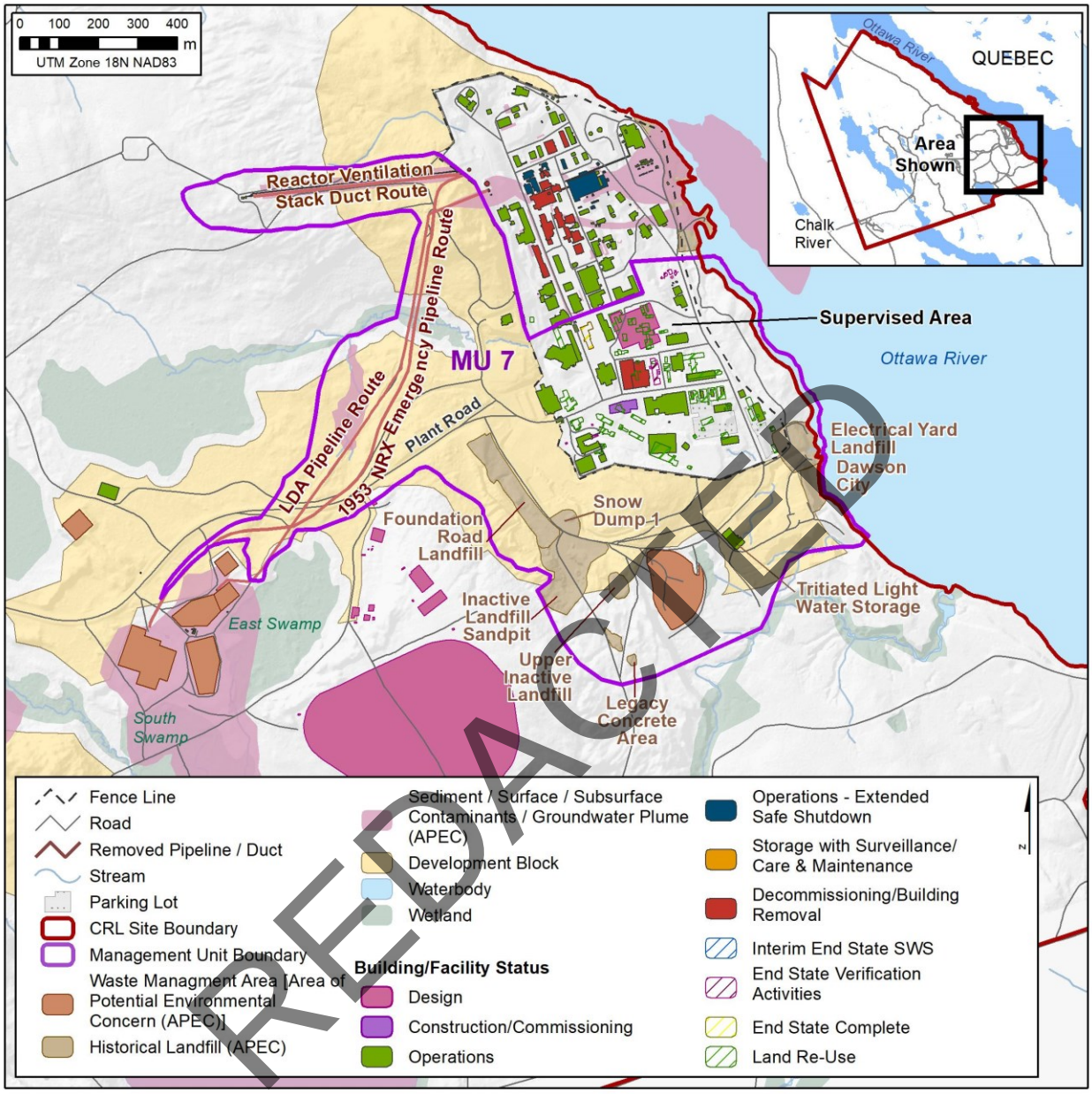


Figure 19: Map of Management Unit 7

The Support Building opened in 2021 to provide a base of operations for approximately 140 people and consolidates roughly 20 different trade shops from the inner SA. The new building also contains storage facilities and offices to streamline maintenance and manufacturing activities. Prior to the development of the Support facility a small remedial project was undertaken to remove hydrocarbon contaminated soil resulting from the vehicle maintenance building ([redacted]), which was located in the footprint used for the new Support building.

Environmental Site Assessments have been conducted to support cleanup efforts at a number of areas within MU 7 in advance of decommissioning, new building developments, utility upgrades, and characterization of some APECs where development projects have been

contemplated (e.g., Dawson City, Electrical Yard Landfill, and the Foundation Road Landfill). Aside from the hydrocarbon contamination identified at the [redacted] (building demolished and area cleaned up), contamination has not been identified in the new build footprints or the utility project corridors in MU 7.

To enable the redevelopment of MU 7, several decommissioning and environmental remediation projects will take place over the next few years. The decommissioning of legacy buildings will include [redacted] to continue to make space for site redevelopment. In addition, MU 7 is the prime candidate area to host the development of the Small Modular Reactor project. Some temporary structures may be removed if the development blocks in which they are located are required for priority new build projects. A summary of the current buildings within MU 7 that are destined to be kept for the long-term and those that are slated for decommissioning is presented in Appendix A.

Much of the area surrounding the SA consists of impacted lands, including several landfills. It is considered prime redevelopment land to support the revitalized research campus. Should new development or revitalization projects require land that has been impacted, the environmental remediation process will be followed to ensure appropriate industrial land use criteria is achieved prior to development. Thus, over the next few years a number of Environmental Site Assessments will be required to help plan and develop remedial action plans to guide the cleanup of these impacted areas to proposed target industrial land use. Other affected areas within MU 7 that may not be suitable or desirable for industrial reuse, may alternatively be cleaned up to proposed target parkland or unrestricted land use.

Upcoming environmental remediation work within MU 7 includes the delineation of contamination along some sections of the LDA pipeline contamination, delineation and project closeout activities, and assessment of legacy sites. The southern portion of the Foundation Road Landfill and the Inactive Sandpit Landfill will be remediated to provide space for a parking lot expansion in support of the Small Modular Reactor project.

The APECs within MU 7 with known or probable contamination are listed in Appendix A. Conditions at most of the APECs in MU 7 are monitored and stable although further environmental characterization is needed at several locations to adequately delineate contaminated areas and establish the most appropriate remedial path.

The estimated waste volumes of the APECs are important for the planning of cleanup activities across the site. Further environmental characterization is required to delineate the full extent of the impacted areas and to refine expected volumes of waste generation for a given land use or end-state.

10.8 Management Unit 8

Management Unit 8 is located within the Outer Precinct, north of Plant Road between Lake 233 and Duke Swamp and south of MU 11. It includes WMA C and WMA J, and two tritium plumes which extend from WMA C westward to Duke Swamp and south to Bulk Storage Swamp. Lake 233 has not been impacted by operations at MU 8, as confirmed as part of the annual compliance monitoring program, as it is located upgradient of the Nitrate Plant, the Thorium Pit

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and the ACS Pits. No significant changes are anticipated at WMA J (Bulk Material Landfill), which is planned to remain operational for the long term. The plumes from WMA C, a long-term waste storage facility, are partially mitigated by an impermeable geomembrane cover.

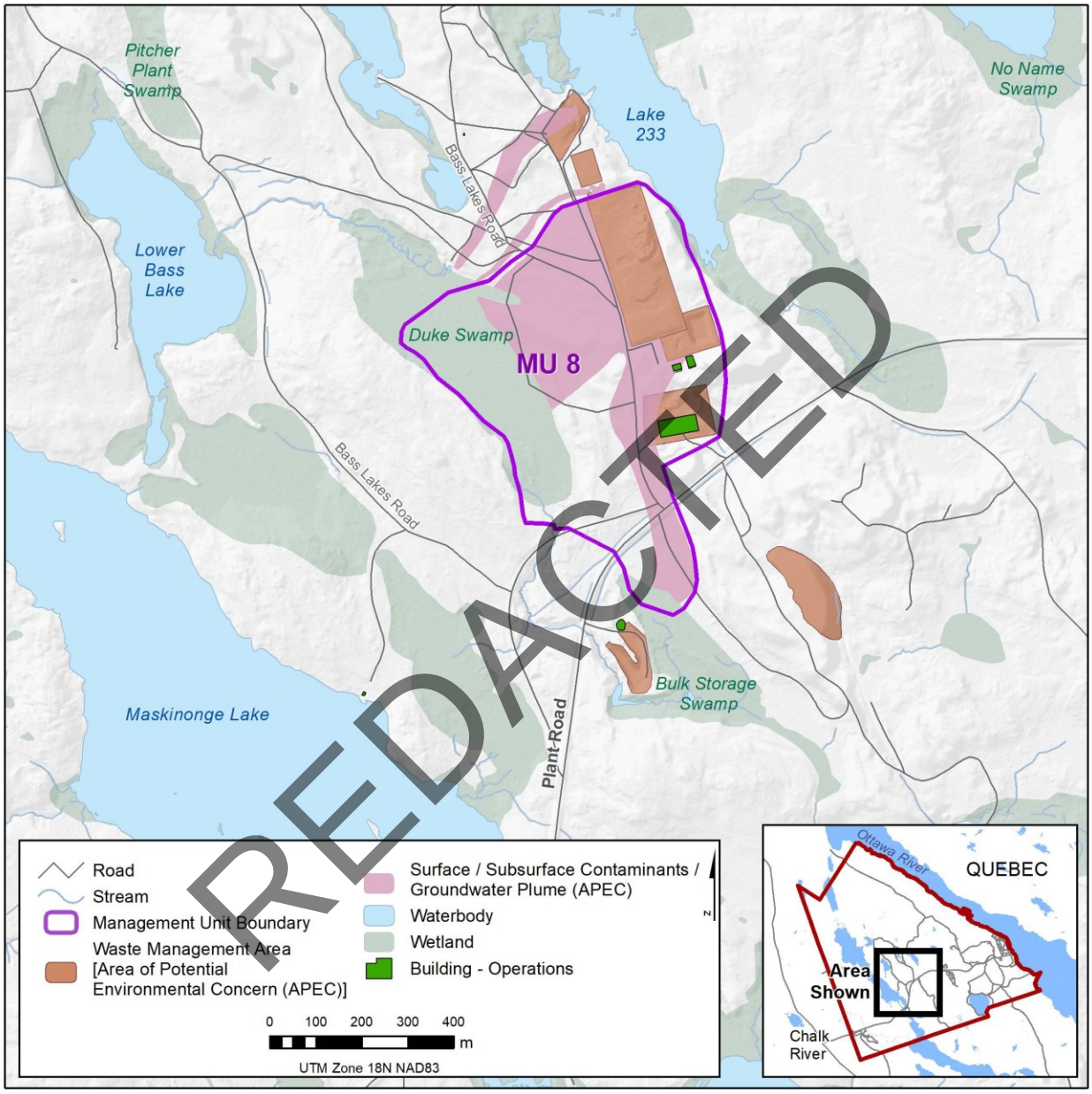


Figure 20: Map of Management Unit 8

There are presently no new development plans within MU 8, however, WMA C is planned to be repurposed for the recoverable surface storage of LLW in sealand containers. As such, WMA C will retain its current function as a waste storage area.

The impermeable geomembrane cover over WMA C (installed in 2013) was designed with a 100-year life expectancy and CNL committed to monitoring of up- and down-gradient

groundwater, annually, as well as plume updates every 10 years. The installation of the impermeable geomembrane cover has been an effective improvement, indicated by decreasing tritium trends in contaminant migration since 2015.

Two storage buildings were recently built outside of the WMA C fence line for the storage of equipment and supplies for environmental monitoring, characterization and remediation work ([redacted]). There are no structures currently slated for decommissioning within MU 8 (Appendix A).

Waste Management Area C has not been characterized, therefore the waste estimates available have not yet been updated based on comparison to risk-based soil screening criteria. The waste inventory estimates for MU 8 range between 113,000 and 119,000 m^3. This volume may be a low estimate as it currently does not consider any contaminated media outside the footprint of WMA C that may require remediation or the impact that the application of saturated soil screening criteria (to be developed), may have on the volume. Characterization in support of an environmental site assessment, risk assessment and a safety case assessment would be required to determine if the wastes at WMA C may be allowed to remain in situ with appropriate institutional controls.

The ER process and facility specific decommissioning plans/remedial plans will be implemented to determine forward plans for once these facilities are no longer in service and in the interim, the proposed target land use will remain industrial for WMA C and J, and likely will be parkland or unrestricted for the plumes.

10.9 Management Unit 9

Management Unit 9 is located in the Outer Precinct and is within the Perch Lake Drainage Basin. It includes WMA E, the Waste Tank Farm, and the former Lysimeter Research Facility.

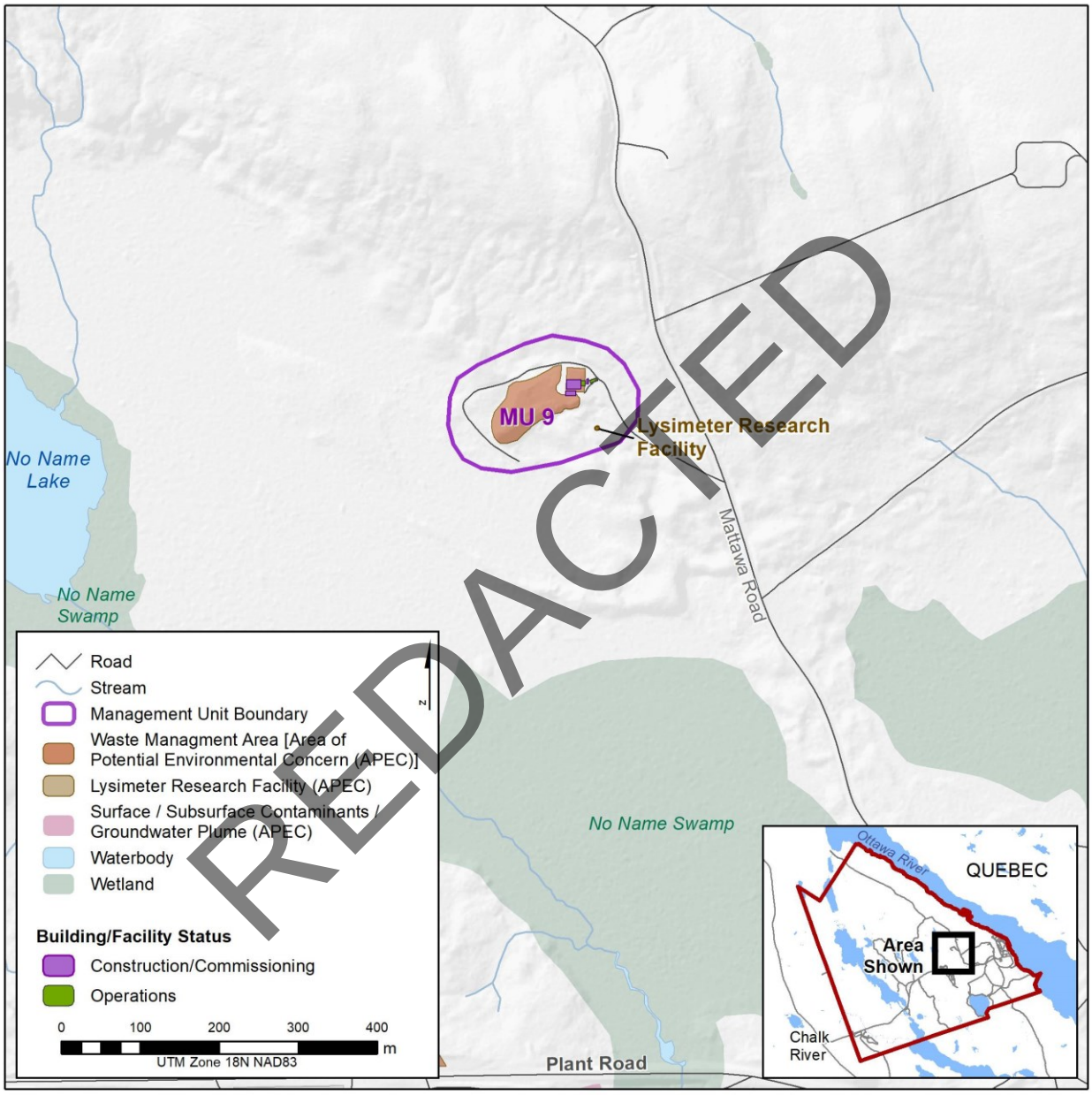
The Waste Tank Farm is operational but has not accepted waste transfers since 1968. The Waste Tank Farm area within MU 9 is undergoing expansion in order to support enabling facilities to achieve cleanup of the area. The key enabling facilities to support the cleanup of the Waste Tank Farm include a tank farm weather enclosure, a legacy waste processing intermodal container, and a whole body monitoring building. There are currently no future development plans for MU 9.

Waste Management Area E accepted waste until approximately 1984. WMA E has been considered a candidate for in situ disposal in various planning assumptions. The latest characterization was completed in 2018 when monitoring wells were installed and soil and ground samples were collected to provide data for future evaluations. Limited contamination has been observed in MU 9, mostly around small pockets of construction waste. No significant groundwater contamination has been detected in the area.

A summary of the buildings and structures and APECs currently within MU 9 are provided in Appendix A. The total waste volume of MU 9 is not known at this time. There is an estimated 22, 000 to 24,000 m^3 of waste within WMA E. No estimate has been made for potential contamination around the Waste Tank Farm area. Overall waste volumes associated with the eventual cleanup of MU 9 will be further detailed as the ER process and facility specific

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decommissioning plans/remedial plans are progressed once these facilities are no longer in service. A safety case assessment would be required to allow in situ disposal of the wastes found at WMA E. Alternatively, cleanup to the proposed target land use of industrial, parkland and/or unrestricted will also be considered under the remediation options evaluation process.



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Figure 21: Map of Management Unit 9

10.10 Management Unit 10

Management Unit 10 is located in the Maskinonge Drainage Basin. It includes WMA F where radiologically contaminated soils and wastes were brought from four historic off-site Ontario facilities and buried in the late 1970s. WMA F is monitored annually to assess possible

migration of radioactive and chemical contaminants. All environmental monitoring indicates that the waste is stable and contamination is not migrating from the WMA.

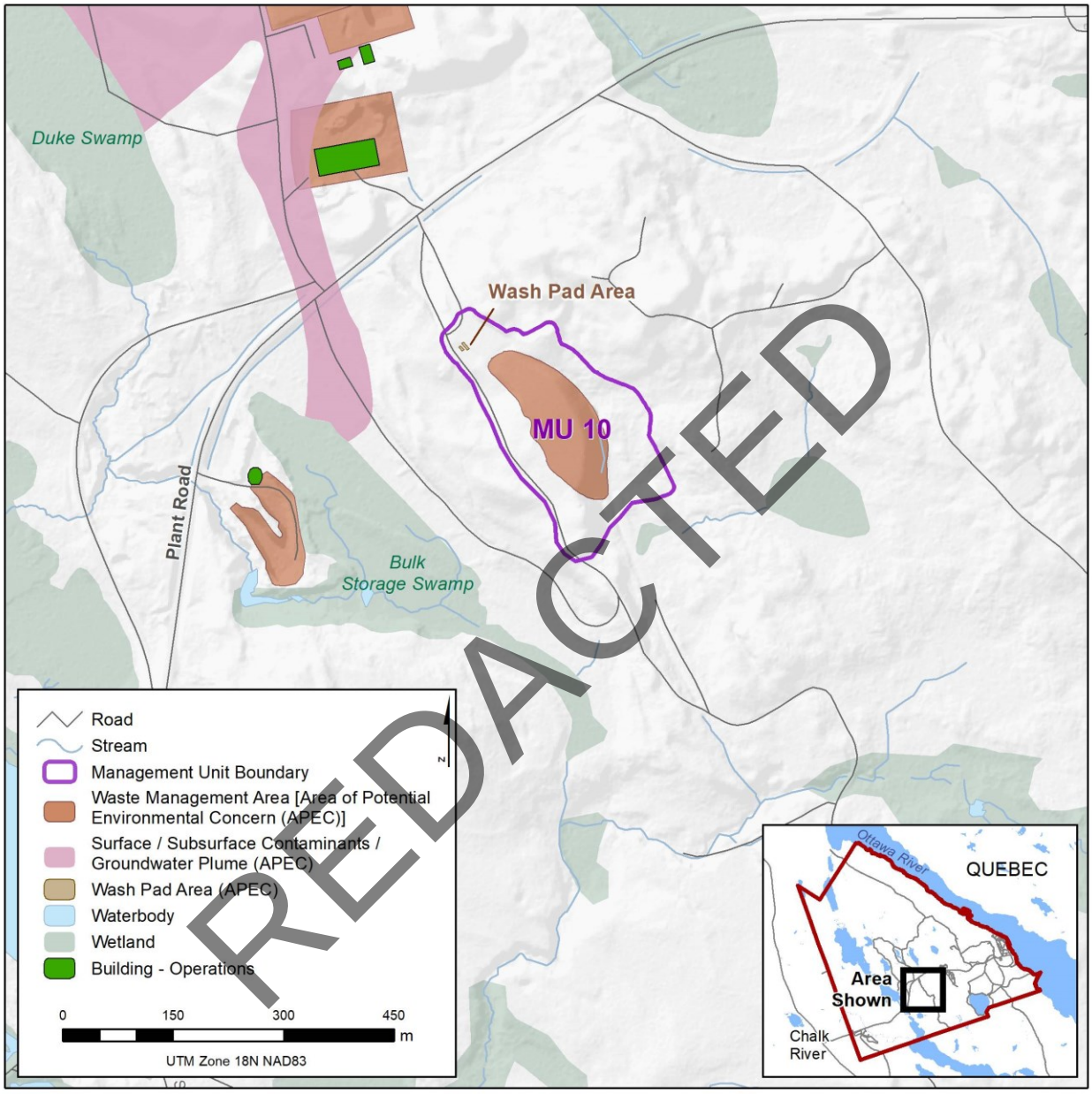


Figure 22: Map of Management Unit 10

Cleanup enabling facilities to support the cleanup mission or site revitalization are not planned for MU 10 and no new facilities have been planned in this area. Since the last iteration of the CPDP [1] the concrete pads for the truck wash bay were decommissioned and verification sampling and limited remediation was undertaken to remove contaminated soil. A detailed environmental characterization is being planned at WMA F to fill key knowledge gaps on missing data for contaminants of potential concern. This data will be used to support the RAP for WMA F. See Appendix A.

The contaminated waste volume associated with MU 10 is estimated to be 60, 500 m^3, based on records of the amount of waste that was emplaced, with an additional 24,900 m^3 of clean cover that will require management. Notably, the waste volumes requiring remediation remain the same regardless of the future land use selected since the contaminants have stayed within the waste mound. Proposed target land use for MU 10 could be either parkland or unrestricted based on location and current assumptions.

10.11 Management Unit 11

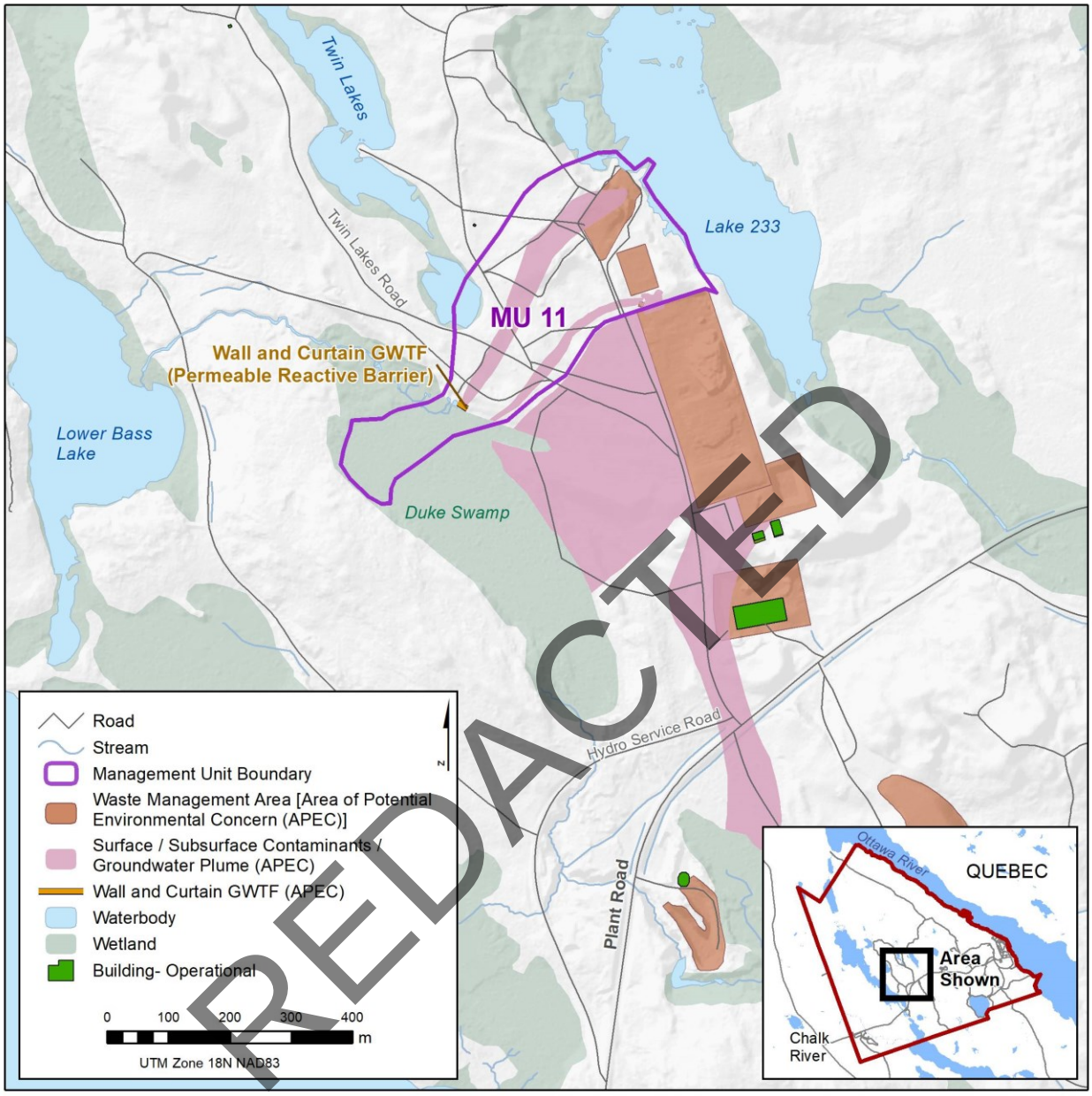
Management Unit 11 is located within the Outer Precinct, north of Plant Road between Lake 233 and Duke Swamp and north of MU 8. It includes the Nitrate Plant, Thorium Pit, Acid-Chemical-Solvent (ACS) Pits, and groundwater plumes within the associated footprint. A ^{90}Sr plume originating from the Nitrate Plant infiltration pit is currently treated with a passive permeable reactive barrier near Duke Swamp, referred to as the "Wall and Curtain".

There are no cleanup enabling facilities to support the cleanup mission or new developments for site revitalization planned within MU 11. Since the last iteration of the CPDP [1], initial environmental characterization was completed within each facility in 2019.

There are no buildings remaining to be decommissioned within MU 11 other than a small, dilapidated pump house ([redacted]) associated with the former operations of the Nitrate Plant. All other Nitrate Plant associated buildings and supporting structures have been buried in situ under a large sand mound. Over the next few years, additional environmental characterization activities will be conducted to gain an understanding of the spatial and temporal distribution of the contaminants and to delineate the contamination within MU 11. This information will be used to support cleanup plans including consideration of the appropriate remedial options, development of facility specific DDPs, and to refine anticipated waste volumes.

A brief summary of the areas of concern within MU 11 are provided in Appendix A. The conditions at the WMAs in MU 11 are monitored regularly. Lake 233 has not been impacted by operations at MU 11, as confirmed as part of the annual compliance monitoring program, as it is located upgradient of Waste Management Area C. Based upon surrounding areas, the most likely future proposed target land use would be either parkland or unrestricted as the site has not been identified as an area with significant redevelopment potential.

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Figure 23: Map of Management Unit 11

10.12 Swamps and Wetlands Affected by Groundwater Plumes

Several historic, non-engineered WMA facilities (within MUs 3, 6, 8 and 11) are the source of radiological and chemical substances releases which have migrated to the surrounding environment, primarily via groundwater transport. This has led to several plumes that are the subject of characterization and monitoring programs, most of which have impacted swamps and wetlands in the outer Supervised Areas. There are also plumes resulting from historic facility operations in the Controlled Area which are migrating toward the Ottawa River (see Section 10.1).

Plume monitoring, conducted as part of CNL's Groundwater Monitoring Program, provides confirmatory data that the plumes are behaving as expected. Plume monitoring will continue for the indefinite future and will guide intervention and environmental remediation programs designed to ensure continued public safety.

These plumes do not represent a potential direct external exposure hazard to operating personnel or the public. The risk to non-human biota and the environment is being managed by CNL. Where risks to non-human biota are identified, mitigative groundwater treatment systems are implemented. Four groundwater treatment systems have been implemented to date.

The annual discharges into the relevant drainage basins have been, and are projected to continue to be, well below annual Derived Release Limits for CRL.

In general, at present, the strategy for the plumes will be continued monitoring, treatment in several cases, and assessment of the need for capture. The purpose of continued monitoring is to confirm whether the plumes are evolving as expected and determine if impacts are acceptable. In order to preserve valuable wetlands that may include species at risk habitat, media impacted by groundwater plumes will be evaluated to assess the effectiveness of natural attenuation as a potential remediation option. Annual updates on plume monitoring results and affected downgradient wetlands are provided in the Annual Compliance Monitoring Report: Environmental Monitoring in 2020 at CRL (e.g., [106]). Screening criteria for radionuclides in saturated soil are required to assist in the development of remediation plans for any contaminated soil within the water table.

The wetland areas affected by contaminant plumes will be characterized in detail and new information will be incorporated into future ODCP revisions.

10.13 Existing Site Infrastructure

The infrastructure listed below are currently operational and are located in various areas of the site, in some cases across several or all MUs (e.g., meteorological stations and roads). Long-term plans (see Section 4.3.5.1) for either ongoing maintenance or removal of this infrastructure from service will be considered in future iterations of the ODCP and the Site Master Plan (e.g., in the case of roads and distributed services), as applicable.

10.13.1 Roads and Parking Lots

The CRL site includes approximately 52 km of roads, approximately 20 km are paved, while 32 km are gravel or dirt paths. There are also several parking lots, with the largest ones located in MU 7 (Figure 24). In terms of area, the roads provide access and therefore impact a significant portion of the CRL site.

Two primary environmental concerns regarding roads and parking lots on the CRL site are the use of road salt (year round access roads and parking lots) and historically, the application of dust suppressant oils (sub fraction of the gravel roads). Several areas near the Plant Road have elevated chloride concentrations resulting directly from winter road salt application. Since 2018 CNL has reduced the amount of road salt being used on CRL roads by incorporating more sand

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into the mixture and since that time several locations, particularly in both MU 1 and 6, have observed significantly decreased road salt impacts [78].

Blanding's turtle road mortality is also a concern from the road network. If the road mortality continued at the rate observed in 2015, a Population Viability Analysis concluded that the population would be extinct in less than 60 years. CNL has implemented new measures to protect turtles and other species from vehicles circulating on Plant Road and other roads at CRL (see Section 7.2.1).

Canadian Nuclear Laboratories is currently developing a cohesive strategy for the site's road network. A traffic study was completed in 2022 to assess the current transportation network, regular operational movement of people and vehicles on-site along with mission requirements for truck and material movement in order to recommend transportation network improvements for the site. This may result in the eventual decommissioning or reconfiguration of some existing roads.

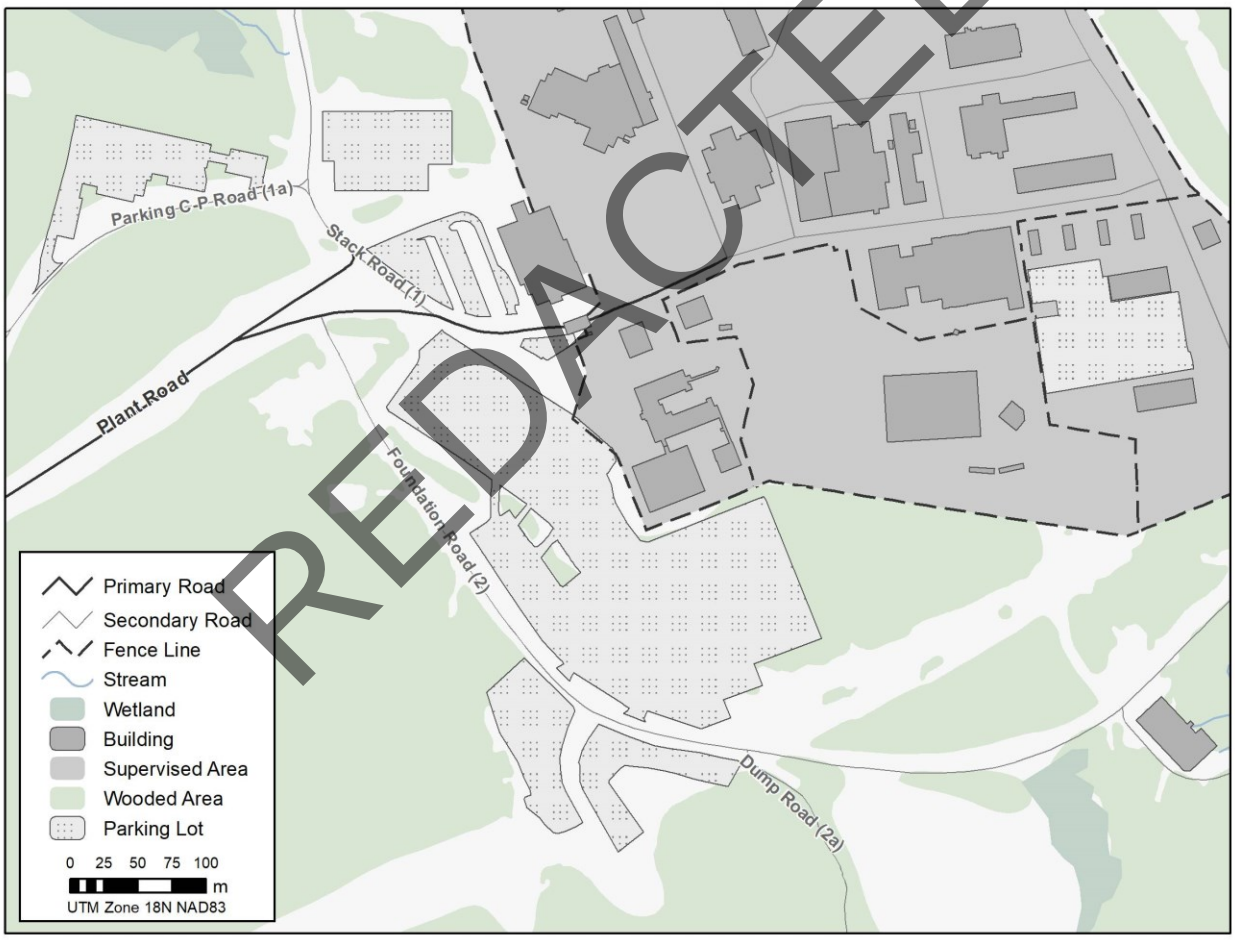


Figure 24: Map of the Main Parking Lots at CRL

10.13.2 Aggregate Borrow Pits

Aggregate extraction on the CRL site has taken place from the earliest days of site development (the start of some of these activities pre-date both AECL and the initial development of CRL). This has resulted in the presence of several sand pits on the site. All the pit areas are considered to be in operational use, but the frequency of their use depends largely on their proximity to current operations requiring aggregate. The total land area under use as aggregate borrow pit is less than 19 acres (8 hectares) most of which are located in MU 4.

Although currently considered to be in operational use, as site operations no longer requires them, several steps will be taken to provide for pit reclamation such as; stabilizing slopes, filling in excavations that extend into the water table; re-vegetating areas, as required (e.g., areas larger than 2 acres (0.8 hectares)).

10.13.3 Forest Slash Areas

Several areas on the CRL site have been used to accumulate forest slash, course and fine woody debris, from site and road development activities. These areas continue to be in operational use and there are no plans to cease these operations in the next 25 years. Over time, the accumulated vegetation degrades to a mulch/organic layer. The Forest Management Plan will be implemented to deal with the accumulation of forest debris in managed areas.

10.13.4 Meteorological Stations

The CRL SA is host to several types of meteorological stations. The primary station consists of instrumentation to provide data on several meteorological aspects including wind speed/direction and air temperature. Others provide data on either wind speed/direction, precipitation, temperature maximum/minimum or air quality. There is also a network of 20 ambient radiation measurement installations on the CRL site, although only 5 are currently in use with the non-operational stations planned to be turned over to decommissioning by 2022. The stations require ongoing maintenance and periodic equipment upgrades over the lifetime of the CRL site.

10.13.5 Boreholes

Boreholes are present across the CRL site and are present in several MUs. They can be subdivided into two categories: deep bedrock boreholes and shallow overburden boreholes. The deep boreholes are exploratory/experimental in nature as opposed to the shallow holes, which in many cases, have been installed for monitoring contaminant migration (e.g., in sub-surface soil and groundwater) from a variety of facilities. No radiological or non-radiological contamination issues are known to exist with respect to the boreholes.

Thirty-seven of the approximately 50 deep boreholes at CRL were decommissioned in 2021 and 2022; the remainder will remain operational for the time being (see Appendix A. The closure of these deep boreholes involves sealing of the boreholes to prevent cross-linking of aquifers.

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There are approximately 2,000 shallow overburden holes across the CRL site. Closure of the shallow boreholes occurs as required.

In general, all boreholes will be decommissioned following Ontario Regulations and industry standards. Decommissioning will involve the removal of as much equipment as possible (i.e., existing internal monitoring wells and packer systems), filling the annular space with a cementitious grout and casings will be extracted or terminated as close to the surface as practical.

10.13.6 Distributed Services

Table 8 and Table 9 summarize the status, decommissioning and/or upgrade plans for distributed civil and electrical services on the CRL, respectively.

Table 8: Distributed Civil Services on the CRL Site

Service	Description/ Current Status	Plans for the Next 5 Years
Underground Thermal Column Exhaust Duct	1.2 m diameter shielded active duct. In FY 22/23 this system is planned to be permanently shut down and replaced with a reactor ventilation system that is local to NRU. Ducts feed [redacted]. A common exhaust header delivers exhaust to the remote stack.	Permanent shutdown of the NRU reactor ventilation system (does not include physical component removal)
Active Drain System	Active drain replacement project is ongoing. The new Active Drain System consists of the Reactor Drain (100% in service), the Decontamination Centre Drain (100% in service) and the Chemical Active Drain (30% in service) with chemical waste collection via overland transfer. The design of a replacement of a section of the new (chemical) ADS was prepared in 2019.	The design and construction was progressed as far as economically feasible. No work is currently planned over the next 5 years, however a templated design is available should replacement of Active Drain Lines be desired.
Acid Waste	A single 2” (5.1 cm) plastic line running from [redacted].	No plans.
Condensate	A network of lines running from buildings that use plant steam to return condensate to the Power House. A mix of below- and above-ground lines, 2” (5.1 cm) to 6” (15.2 cm) diameter, mostly steel.	No plans.
Disposal Sewer	54” (1.4 m) diameter steel pipe from the Power House to the river.	No plans.
Fire Water	Distributed below-ground throughout the plant site from the Power House. Mostly cast iron, diameters starting at 12” (30.5 cm) and reducing to 4” (10.2 cm) or 6” (15.2 cm) for entry into buildings. A portion of the supervised area underground infrastructure has been updated to new PVCP piping.	No plans.

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Service	Description/ Current Status	Plans for the Next 5 Years
Heating Water	Mostly PVC, 12” (30.5 cm) to 3” (7.6 cm) diameter. System is now largely out of service.	To be determined as part of future decommissioning strategy.
Helium	Two lines, 1½” (3.8 cm) stainless steel and 1” (2.5 cm) copper. Serviced several buildings in the CA and is out of service (cut and capped).	To be determined as part of future decommissioning strategy.
Heating Drain	Return lines for old heating water system. 21” (53.3 cm) to 2” (5.1 cm) diameter PVC. Now largely out of service.	To be determined as part of future decommissioning strategy.
Pneumatic	Below-ground system to transfer samples from NRU to [redacted] and the Universal Cells ([redacted]).	No plans.
Process Sewer	10”, 12” and 36” (25.4 cm, 30.5 cm, 91.4 cm) cast iron, vitrified clay and steel lines leading to 48” (1.2 m) pipe to the river. System includes 26 manholes.	No plans.
Process Water	Distributed to NRU and associated buildings from the Power House. Starts off as 48” (1.2 m) diameter steel pipeline and smaller diameter as required for entry into buildings.	No plans.
Raw Water	One 54” (1.4 m) and two 30” (76.2 cm) intakes from river to the Power House plus one 24” intake to [redacted].	No plans.
Refrigeration	Dedicated insulated line serving [redacted].	No plans.
Sanitary Sewer	Mainly vitrified clay, cast iron and Transite, 4” (10.2 cm) to 12” (30.5 cm) diameter, distributed throughout the plant. System includes 80 Manholes, 2 pumping stations & a single sewer system for both Supervised and Controlled Areas.	No plans.
Service Air	Distributed throughout the plant from the Power House. Starts off at 6” (15.2 cm) steel and reduces to as small as ¼” (6.4 mm) for entry into buildings.	No plans.
Potable Water (Service Water)	The entire water system has been split into two subsystems; drinking and non-drinking water systems. It consists of a wide variety of materials (including cast iron, steel and PVC) and diameters from 1” (2.5 cm) to 16” (40.6 cm). System has been extensively modified and updated over the life of the plant site. Many lines replaced and old ones left in place. System includes 165 shutoff valves, 13 hydrants and an underground Backflow Preventing Chamber. CRL’s new drinking water supply line became operational in 2019 and originates from the Town of	An Aeration System will be added in the Water Reservoir.

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Service	Description/ Current Status	Plans for the Next 5 Years
	Deep River. A water booster pumping station pumps potable water via a single discharge line or feeder main 300 mm diameter, PVC pipe from the town to a newly constructed 2,000 m^3 capacity Water Reservoir located at a high point. From there, water flows through a pressure reducing valve station, to reduce the water pressure to match the operating conditions required at site, then via gravity through a single supply 300 mm diameter pipe line to the existing distribution system on site.	
Steam	Distributed throughout the plant site from the Power House. Mostly steel, 3" (7.6 cm) to 16" (40.6 cm) diameter and includes approximately 1,220 m of overhead line. Note: Steam/air/condensate system incorporates 40 manholes, 40 steam meters, 215 m of underground steam tunnel & 23 expansion joints.	No plans.
Storm Sewer	Surface drains feed into several below-ground culverts (mostly concrete up to 72" (1.8 m) diameter). The drains discharge to storm-water management ponds with the exception of one line on the south side of site that discharges directly to the river. The system consists of approximately 195 catch basins.	Upgrades ongoing.
Active Exhaust Duct	0.45 m diameter buried stainless steel vent from Building [redacted].	No plans.
Miscellaneous	Assorted lines such as weeping pipes, distilled water, nitrogen, conduit etc.	No plans.
Natural Gas	The CNL site has 6.8 km of 6" steel Natural Gas pipeline running from the main gate down the Plant Road to the CRL Site where a metering and regulating (M&R) station is located near Parking Lot C. From this point it is distributed via 2.1 km of 6" plastic piping throughout the supervised area to select buildings. An additional 1.8 km of 6" steel pipe (not included in the total length) runs from the nearby high-pressure TransCanada Pipeline system, west along Highway 17 to the outer gate.	No plans.

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Table 9: Distributed Electrical Services on the CRL Site

Service	
13.8 kV Overhead Cable Run	Fire Signal Cable Run
13.8 kV Underground Cable Run	Telephone Cable Run
Class 4 (Normal) 600V Cable Run	Fibre Optic Cable Run
Class 3 (Emergency) 600V Cable Run	Ethernet Cable Run
Plant Ground Run	Security Cable Run
Common Control Cable Run	

11. Features in The Natural and Social Environment that Could be Affected by Cleanup

Canadian Nuclear Laboratories has identified over 60 operational and non-operational areas of the CRL site where current or past activities impacted the natural environment, including soil, sediments, surface water and groundwater quality which have been summarized in Appendix A. The presence of contaminants in these areas have had an impact, although limited, on vegetation and biota at the site.

A large portion of the CRL site is covered in generally healthy forests, wetlands and water bodies, even in areas that were previously used as part of site operations. Future remedial actions will undoubtedly have an impact on the ecosystem, including locally on some sensitive species or habitats. This would include, for example, impacts associated with clearing vegetation for new development surface water control and impacts from other construction-type activities.

These impacts will be minimized during the planning (PDP, DDP for Class 1 nuclear facilities and BRP, RAP, for non-Class I facilities, as appropriate) and implementation of environmental remediation. This is especially significant where more fragile ecosystems such as wetlands, shoreline habitats, nesting areas and critical habitat for species at risk are present.

Noise, vibration, dust and traffic will lead to local disturbance which will be assessed for potential impact to breeding birds and roosting bats as part of the permit application under the Species at Risk Act and mitigation measures will be implemented as required. Impacts to biodiversity will also be assessed for each project.

It is important consequently to determine where risk-based, less disruptive approaches, such as bioremediation, natural attenuation or radiological decay may be preferred to excavation which has the potential to disturb these ecosystems, at least on a temporary basis.

It will be necessary to establish during the planning stage whether damages caused during remediation would be significant and whether they would be reversible or not as some species are more sensitive to land disturbance and transplantation than others. In rare cases it may be necessary to limit access or even relocate land-based animals or wetlands-based amphibians for the duration of the work. Where this is not possible, compensatory measures may be required.

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In addition, projects that enhance biodiversity may be considered based upon an ecosystem needs assessment. Following remediation, this could include, the selective planting of species at risk, the creation of grasslands or other beneficial habitats. Each remedial work package will be reviewed and permit applications will be filed with Environment and Climate Change Canada under Section 73 of the *Species at Risk Act*, as required (see Section 7).

A socio-economic benefit of the cleanup of the CRL site is that it will most certainly result in local employment for a number of years during cleanup and as supported by the Science and Technology research mission at CRL.

In addition, once remediation and site revitalization is completed, it may lead to the release of presently restricted land to other future land uses by providing recreational space or a return to a more natural setting benefiting the local ecosystem.

11.1 Technology Development and Transfer

An important mission for the CRL site is the development and application of new environmental remediation techniques and practices. Technology transfer, under ideal conditions, is a two way relationship. CNL will benefit from the experience of other nuclear facilities which have undertaken similar decommissioning and remediation operations, mostly in Europe and in the United States. CNL has been working with world-class experts in developing its own program, including groundwater modeling associated with radiological compound migration, the development of site-specific, risk-based cleanup criteria (see Section 9.3.1) and safe decommissioning techniques.

Lessons Learned and Operating Experience (OPEX) from CNL's Port Hope and Port Granby Projects are being reviewed and recommendations will be incorporated into the development of cleanup planning for CRL.

A number of basic science experiments have been conducted at CRL to obtain useful site specific data regarding groundwater recharge, movement, evapotranspiration and other physical processes. Also, short-lived radiological tracers have been used effectively at CRL as part of several groundwater characterizations. New remediation techniques are being implemented at the site, in particular, passive radiological contaminant plume control. CNL will continue to share the results of these studies with the nuclear and environmental community.

The retrieval of specific wastes from waste management areas will require the development of new tools and techniques designed to perform the work effectively, safely and in some cases remotely. For example, we will continue to build upon experience with the retrieval of the experimental glass blocks. Many characterization and remediation techniques have already been used at CRL which were not available a few decades ago. It is anticipated that the remediation of the site will allow for the testing and use of new tools and techniques that will be piloted at the site and may benefit the environmental community for decades to come allowing Canadian experts to export this knowledge to other parts of the world.

Canadian Nuclear Laboratories has developed a Systematic Approach to Training that provides a standardized approach to staff training and qualification and ensures that CNL complies with conditions in the applicable licence and may serve as a model for other similar facilities. The

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purpose of the Systematic Approach to Training process is to provide a structured, documented, and auditable set of processes that, when implemented, will provide management with the assurance that personnel are trained, competent, and qualified for the assigned work. A graded approach, commensurate with risk, is used in the application of the Systematic Approach to Training.

11.2 Environmental Nuisance Issues

Since the areas that may require remediation are within the controlled and supervised areas, access to these areas will be limited to authorized personnel. For the most part, these areas are also several kilometers from the nearest neighboring residences. It is unlikely that on-site work will have a measurable impact on neighbors with the only exception being the movement of vehicles associated with the cleanup. This additional traffic should be limited as it is anticipated that the majority of the remediated wastes will remain on-site for final waste disposition. Clean material (e.g., soil) may be reused on-site as well.

Environmental nuisance issues, such as noise and dust are not expected to be significant issues to local neighbors at the CRL site as part of the decommissioning and environmental remediation operations due to the distance between the various areas that will be remediated over the years and the buffer offered by the dense forest surrounding the various operations at the site. Visual impacts from the river or the banks of the Ottawa River could also be expected, but should not be significant.

Development planning for new facilities will be required to consider viewscapes, both looking out from the proposed structure and looking towards the proposed structure. Building designers will consider and leverage the natural setting and ensure that spaces are planned to optimize the integration of the nature environment with the work environment. Already, the decommissioning of unused or outdated structures, the construction of visually attractive buildings and the greening of the site with lawns and other green space has gone a long way to improve the visual appearance of the site from the river.

Also the periodic inspection and removal of small volumes of waste materials, mostly demolition wastes, which occasionally wash out from areas bordering the site along the Ottawa River, such as at the Power House Shoreline Landfill or east of Dawson City, will also improve the visual appearance of the site to boaters on the river.

Increased traffic may be an issue as waste and other materials are either imported or exported from the site. The development of the proposed NSDF may significantly increase traffic on site during construction in the short-term, but will greatly reduce the need to transport materials on and off of the site as part of future remedial actions. The traffic study completed in 2022 assessed the current transportation network for continued operations in parallel with planned construction and decommissioning/demolition activities and found the current network to be acceptable with some recommended localized improvements.

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12. Long-Term Stewardship

Environmental remediation may result in radiological or non-radiological contamination exceeding the applicable screening criteria while remaining below risk-based objectives. Thus, long-term monitoring programs and institutional controls are used to monitor residual risks at a site after it has been decommissioned or remediated and will allow CNL to identify areas where additional interventions may be required.

The purpose of a Long-Term Stewardship Program is to:

- Support the safe, environmentally-sound decommissioning of facilities and sites;
- Ensure the ongoing monitoring and maintenance of sites;
- Provide a funding mechanism to cover costs associated with long-term monitoring and maintenance of sites; and
- Ensure that records and information on the sites are preserved through the establishment of a registry

Environmental risk assessment will underpin the determination of the short-term and long-term management strategies and any necessary controls to ensure protection of human health and environmental receptors. Criteria and exit strategies will be developed for determining when engineering controls such as groundwater Pump and Treat systems can be terminated or when changes to monitoring may be warranted. The implementation of institutional controls should represent the start of a long-term remedy, not the conclusion of the environmental remediation process.

The CNL Environmental Monitoring Program that is in place during operations (see Section 7) will be reviewed and revised to ensure that the requirements for the remaining stages of the cleanup are covered. During the transition period between shutdown and decommissioning, surveillance, monitoring and maintenance will be conducted to ensure the health and safety of persons and the protection of the environment. When decommissioning of facilities are to take place in discrete phases, the removal of radioactive materials, the dismantling of structures or the remediation of the site, or both can be deferred. A plan for surveillance, monitoring and maintenance of the facilities will be developed and implemented.

Monitoring to confirm cleanup criteria are met will be conducted during the course of or at the conclusion of the decommissioning or any period of storage with surveillance prior to the transfer to institutional control. In some cases, a period of follow-up monitoring might be necessary to validate end-point assumptions to ensure that the final end-state objectives remain satisfied.

The land use designation of waste disposal facilities, including buffer or attenuation zones as applicable, will require controls upon closure to limit land usage. These controls may include fencing, signs, surveillance and legal instruments such as deed restrictions.

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13. Conceptual Schedule

Figure 25 shows a short-term timeline of the revitalization, decommissioning and environmental remediation work scheduled at CRL over the next 5 years.

Decommissioning projects have been proceeding with the demolition of 114 structures since September 2015 with the objective to reduce risks, reduce the footprint of the built environment and allow for the development of a modern research campus.

Until the proposed NSDF is accepting waste, projects will be advanced while minimizing the need to temporarily store waste that would require additional handling at some point in the future.

A strategy is being developed in particular for the sequencing of LLW going to the proposed NSDF. Long-term storage and disposal options for ILW are also being investigated.

Various planning and optimization tools are being developed to allow for effective sequencing of decommissioning and environmental remediation activities, such as the prioritization tool (Section 9.6) which may be used in support of such planning efforts. New infrastructure and refurbishment of existing infrastructure to support the ongoing S&T mission will be extensive. Cleanup planning will support these missions at CRL by providing a safe and effective framework to reduce the environmental liabilities through decommissioning and remediation allowing for the development of the new, revitalized S&T campus (Section 4.3.5)).

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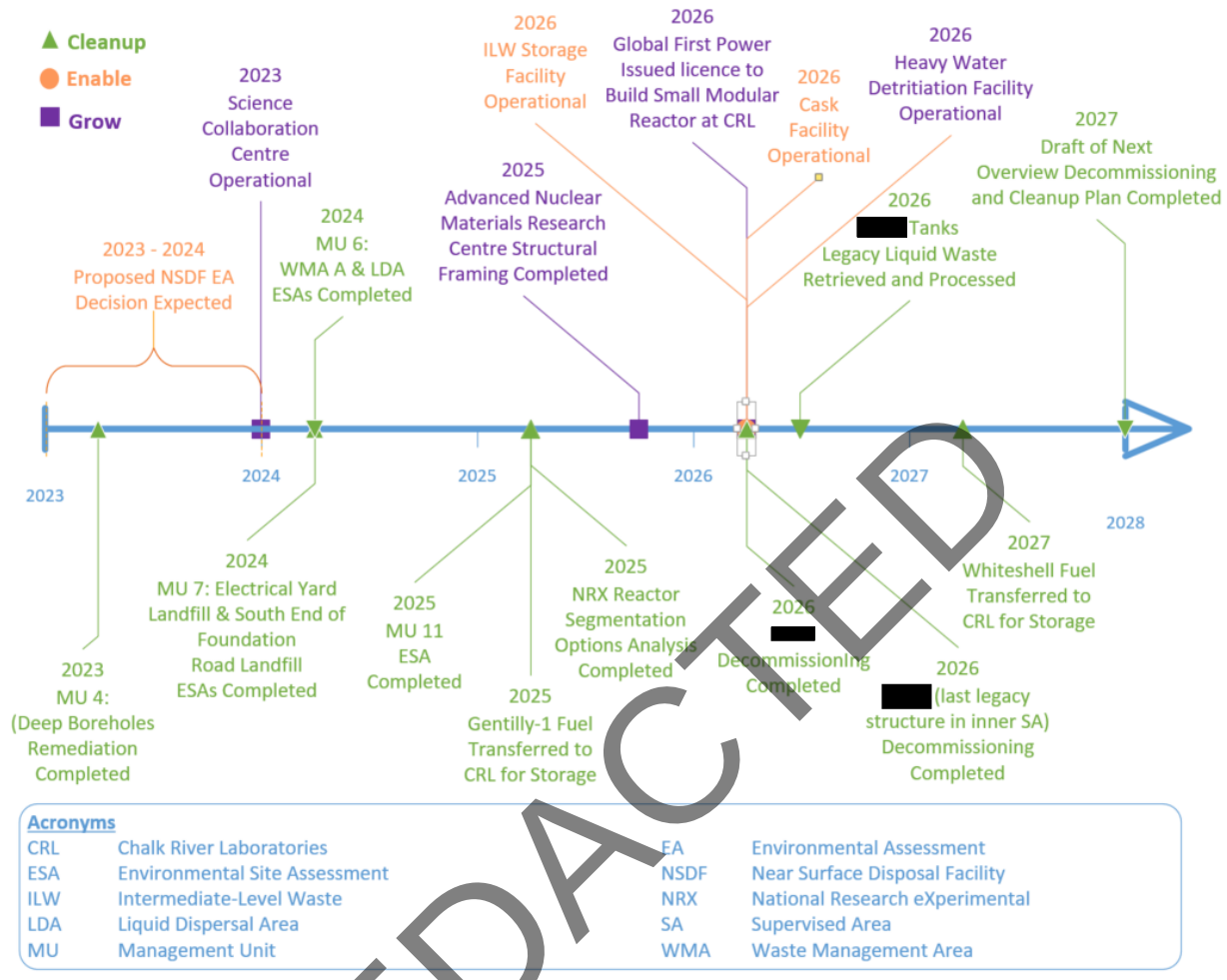


Figure 25: Near-Term Cleanup-Enable-Grow Timeline for 2023 through 2028 (current as of 2022 December)

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The preliminary schedules showing forward plans for the NRX, MAPLE I & II and NRU reactors for the next ten years are presented in Figure 26, Figure 27, and Figure 28, respectively. These schedules will be updated in each of their respective DDPs. For more details on the current status of the of the reactor facilities undergoing decommissioning at the CRL site see Section 10.1. Annual updates are provided in CNL's Annual Compliance Monitoring Report (e.g., [101]).

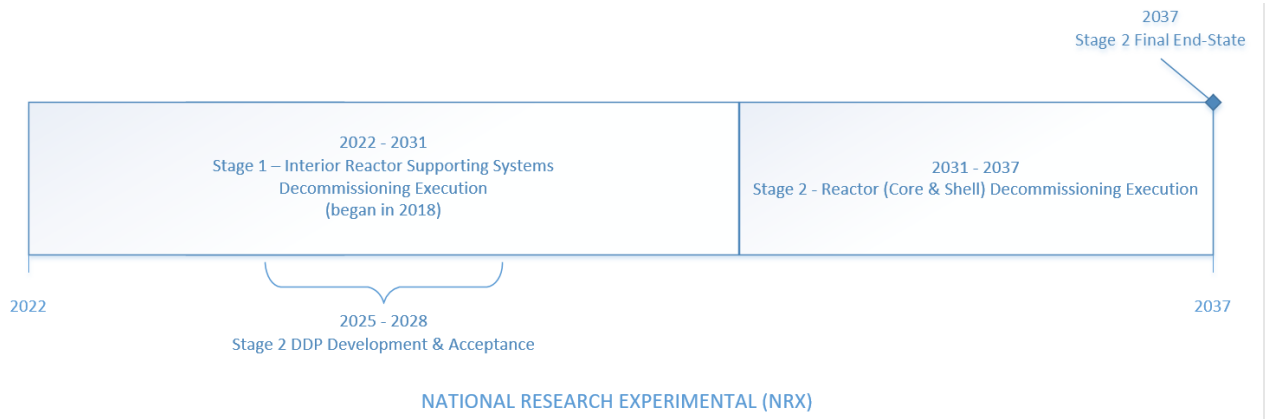


Figure 26: Forward Plans for the Decommissioning of NRX



Figure 27: Forward Plans for the Decommissioning of MAPLE I & II and New Processing Facility



Figure 28: Forward Plans for the Decommissioning of NRU

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13.1 Long-Term

The primary long-term decommissioning objectives include; the disposition of redundant facilities, the remediation of environmental contamination to the extent required to meet end-state objectives, or in some cases interim end-states, and the processing and disposal of the wastes are scheduled to take place over the next 50 years. Scheduling is based on priorities determined in part by:

- Health Safety Security & Environment risks;
- Availability of enabling/storage/disposal facilities;
- Advantage of sequencing of similar activities (to allow advantages to be taken of lessons learned);
- Life span and continued use of buildings and other infrastructure;
- Need for land for new development;
- Cost effectiveness of scheduling work to be concurrent with other linked work;
- Stakeholder concerns; and
- AECL/CNL business decisions.

14. Cost Estimates and Funding

Canadian Nuclear Laboratories and the nuclear industry recognize that in the course of operating a nuclear site, contaminated facilities/land and radioactive waste are produced that require long-term management. These facilities, land and waste constitute decommissioning, remediation and waste management liabilities that are acknowledged and owned by AECL. At CNL, the liability is referred to as Environmental Liability.

14.1 Cost Estimate

In 2013, CNL undertook a comprehensive review of the decommissioning, environmental remediation and waste management liability cost estimate. Strategies, technical approaches, assumptions, timelines, risks, cost methodologies and estimates for addressing the liability were carefully examined and confirmed or revised to reflect changes to program policies and base assumptions. This information was presented in the *2013 Basis of Estimate: Chalk River Laboratories Decommissioning Liability* [107].

The information put forward in 2013 remains the basis for the current estimate. Additional factors impacting the total estimate include: i) the re-estimation of near-term work; ii) the re-profiling of future-year scope to align with strategy revisions; and, iii) the retirement of liability through the completion of work. Section 14.1.2 identifies the process for managing change to the liability estimate.

In developing the original cost estimates for cleanup, the CRL site was divided into seven planning envelopes which are listed below. Decommissioning costs are covered by planning envelopes 1 to 5, and environmental remediation by planning envelopes 6 and 7. The planning envelopes categorize the CRL cleanup activities by facility type whereas the MU boundaries include buildings/structures as well as APECs delineated based on the combination of criteria

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outlined in Section 4.3.4:

- Planning Envelope 1: Nuclear Facilities
- Planning Envelope 2: Radiochemical laboratories
- Planning Envelope 3: Low hazard contaminated structures
- Planning Envelope 4: Non-contaminated structures
- Planning Envelope 5: Distributed Services
- Planning Envelope 6: Affected Lands
- Planning Envelope 7: Waste Management Areas

As of 2023 March, the cost for decommissioning AECL's liabilities at CRL has a Net Present Value of $6.7 Billion as reported in AECL's Annual Report, which is audited by the Office of the Auditor General of Canada. Cost estimates will undergo future revisions as required by CNL Subject Matter Experts, AECL and CNSC requirements.

14.1.1 Types of Project Estimates

Depending on the timing and the type of work involved, several cost-estimating models or approaches were used in the development of the Basis of Estimate [107]. The estimates have been compared to the determination of "Grade" as defined by the CNSC Regulatory Guide, G-206 Financial Guarantees for the Decommissioning of Licensed Activities [108]. The ongoing revisions of project estimates are undertaken as work packages have matured through rolling-wave processes to attain greater accuracy and reliability.

CNL has completed a gap-analysis and is implementing a plan for achieving compliance to the updated version of G-206 and REGDOC-3.3.1 *Financial Guarantees for Decommissioning of Nuclear Facilities and Termination of Licensed Activities* [109]. While the present ODCP has been designed to meet CSA's N294–19 [2] and the associated REGDOC-2.11.2 [3], the current ODCP is compliant with the updated REGDOC-3.3.1, and going forward CNL will ensure cost estimate revisions meet REGDOC-3.3.1 requirements [109].

14.1.2 Change Management

The Project Change Control procedure [110] defines the process by which CNL provides auditable documentation for repairing, reviewing, approving and controlling changes to the environmental liabilities life-cycle cost. All change proposals will clearly identify the impact of the proposed change on the scope, schedule and cost of the environmental liabilities baseline.

The decommissioning and environmental remediation liabilities estimate is reviewed and updated annually [111] to reflect the actual expenditures incurred and the changes in the estimated future costs and timing thereof. The annual review process assists in ensuring that the value of the liabilities is fairly stated in AECL's Annual Report and on the Public Accounts of the Government of Canada.

While detailed cost estimates and schedules are developed to support the planning and execution of individual D&D projects, a generic cost model is used for long-term strategic planning purposes such as the development of cost estimates for the CRL ODCP and supporting documentation.

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14.1.3 Cost Model

The Site Structures Decommissioning and Demolition Cost Model was initially designed as a Microsoft Access database known as the CRL Site Cost Model, which was later converted to a Microsoft Excel spreadsheet to facilitate information transfer and ease of use. As described in the Basis of Estimate [107], the cost model was developed using building and room information from two databases available at the time: Space Information Management System database (now the Facility Information System database), and the Ontario Lands Assessment database. Unit-cost and waste-volume estimates for decommissioning and demolition were derived from industrial estimating standards, AECL experience, and judgment factors. This model was used for the majority of the buildings on the CRL site, including the NRX and NRU reactors and was expected to produce a Grade C estimate [107], [108].

The model produced an output that included the following elements of cost [107]:

- Documentation and Planning – This includes all the activities leading to approval to decommission. This includes activities such as planning, engineering, design, safety analysis, environmental reviews and regulatory approvals. It is typically assumed to be performed by CNL personnel;
- Activities to Achieve Storage with Surveillance (SWS) – After a post-operational closure, these are activities such as inspections, maintenance, removal of Health, Safety, Security and Environment (HSSE) hazards such as asbestos and mercury, stabilization of longer-term hazards, electrical isolation, service water closure and fire alarm or ventilation upgrades to meet current building codes,
- Prepare for Demolition – The underlying assumption is that all radiological hazards will be removed so that the structure or systems can be removed using conventional building demolition techniques and companies; and
- Demolition/Final Report – All activities involved with conventional demolition and removal of waste, close-out reports and regulatory submissions

14.1.4 Remedial Action Cost Engineering Requirements (RACER) Model

As described in the Basis of Estimate [107], the RACER model is a tool that was used to estimate costs for all phases of environmental remediation including those specifically chosen for the work to be done at CRL at the time: Remedial Investigation/Feasibility Study, Remedial Design, Remedial Action, Project Closeout and Long-Term Monitoring, and long-term care and maintenance. RACER was developed in 1992 by the U.S. Government (Air Force, Army, Department of Energy and the Environmental Protection Agency), and has been peer reviewed by numerous organizations and industry professionals, validated, verified, and accredited in accordance with the U.S. Department of Defense Instruction 5000.61b [107].

Site specific parameters and location modifiers were used to reflect project specific conditions. These parameters were then translated into specific quantities of work which were then priced using current cost data. Direct costs developed by RACER included all costs that could be directly attributed to a particular work package required to complete a project, including direct labour costs, direct materials costs, direct equipment costs and contractor costs. A contingency

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of 17% was added to the direct costs obtained by RACER. Labour classes and hourly rates, available at the time, were provided by AECL for input to the model. The parametric model, using current labour rates and standardized cost elements was expected to be Grade C [107], [108].

14.1.5 External Comparators

External comparators are cost estimates reported or used by other organizations for similar work. The comparators were used in the Basis of Estimate [107] to provide a level of assurance that the estimate from a current cost model or estimating group (internal or third party) had a degree of reasonableness and did not appear to be widely different, given the variables and differences associated with the estimate.

External comparators were identified through on-line sources or obtained through cooperative agreements with other countries and nuclear programs. These estimates were also expected to be at Grade C estimate level [107], [108].

14.2 Funding Source

Canadian Nuclear Laboratories understands the requirement for an acceptable financial guarantee. While ownership of CNL has transferred to the contractor Canadian National Energy Alliance (CNEA) Limited, AECL retains ownership of the lands, assets, and liabilities associated with CNL's licences including CRL.

The liabilities associated with the CRL site are those of AECL. As a federal Crown corporation and an agent of the Government of Canada, AECL's accounts are consolidated with those of the Government of Canada. As such, AECL's liabilities are those of the Government of Canada. Funding to undertake decommissioning activities is provided to CNL by AECL. These liabilities were officially recognized by the Minister of Natural Resources in a letter dated July 31, 2015, as per the CRL Licence Condition 16.3 (Financial Guarantee) and re-affirmed by AECL in 2020 [112].

15. Record Retention

Storing and handling information is a controlled activity at CNL. Information Management develops and maintains processes to ensure the authenticity and integrity of records so that CNL can meet its long-term information requirements. Important information will be retained as a permanent record to be used by future generations.

Canadian Nuclear Laboratories *Information Management Program Description* [113] ensure records are categorized, registered, retrievable, and properly managed in a controlled environment. This process ensures that essential and non-essential records are identified, maintained, stored, retained, and routinely inspected to ensure their preservation and protection from loss, deterioration, or destruction [114]. As well retention periods that meet regulatory requirements, are assigned to each record and these determine whether a record is a permanent or non-permanent record [115].

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Site Operational Records, which are maintained in accordance with required standards for decommissioning, environmental, waste and project management and execution, include:

- Operating Records, such as Operating Logs, Fuel Records, Waste Records, Operations Manuals/Procedures/Limits/Conditions, and Maintenance Records;
- Configuration Records, such as Maps, Drawings, Photographs, Engineering Records, Design Records, Technical/Materials Specifications, and Change Control Information; and
- Environmental/Radiological/Incident/Regulatory Records, such as Annual Reports, Unplanned Event Reports, Radiation Zone Surveys, Survey Logs, Hazardous Materials Inventory/Control/Surveys, Licensing Reports, Compliance Reports, and Safety Analysis Reports
- Environmental Remediation Records, such as Historical Site Assessments (Phase I), Environmental Site Assessment or Characterization Reports (Phase 2), Environmental Risk Assessments, Remedial Action Plans, Remedial Verification Reports, and Project Close Out and End-State Reports
- Decommissioning Records, such as Detailed Decommissioning Plans and Storage with Surveillance Plans for Class 1 and Class 2 facilities. In addition, Detailed Work Plans, Building Characterization Reports, Assessment Reports, Project Plans, Schedules, Institutional Controls and End-State Reports; shall continue to be managed throughout the decommissioning process and beyond as required

Records will be managed throughout the land use planning, decommissioning, and remediation processes according to those requirements, to the extent applicable, to ensure consistency and transparency throughout the lifespan of the CRL site. The Information Management processes are outlined in the Program standards [51], [52], and [53] detail which records are important to the success of the Cleanup Function and work closely with interfacing functions.

Environmental data will be managed in the Environmental Data Management System (EDMS) using a Geographical Information System interface. Historical data in the EDMS includes groundwater monitoring data, plume updates, characterization data and other pertinent environmental data. Current and future data will be entered during characterization and final site surveys to demonstrate compliance with site cleanup criteria.

Both the records and records management systems are continually maintained, and will be periodically reviewed to ensure that the records are protected, managed and accessible and to take advantage of any new advances in records storage, practices and technologies. Records management for the CRL site is an ongoing process and as the site is cleaned up, information storage will continue to be protected and may be relocated at the appropriate time as required.

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Appendix A Detailed Information on the Status of Buildings Structures, and Areas of Potential Environmental Concern in each Management Unit

Status of Buildings and Structures on the CRL Site

The status of all buildings, structures, WMAs and services on the CRL site (as of 2022 December 31) is summarized in tables within each MU sub-section. The tables present each structure/area's "building" number, name/description, and current and forward looking D&D status.

It is also important to note what types of facilities and buildings are included and purposely excluded from the lists. Portable trailers that are currently on the site are included, while portable trailers that have been removed from the site are excluded or may have a forward looking status indicated as 'to be removed from site' if removal is pending. Waste Management Areas (WMA) associated facilities and buildings are included. Some underground infrastructure, including manholes, ductwork and electrical substations across the CRL site are assigned a building number and are also included in the lists. In some cases infrastructure components, e.g., gas storage tanks, may have a forward looking status indicated as 'to be removed from site'.

The status categories are described in Table A-1, including a reference to CSA N294-19 [2], as appropriate. For non-nuclear buildings and structures, the same general description applies, although the prescriptive requirements for a Nuclear Facility apply using a graded approach, described in CNL's management system [35].

These status categories only apply to the D&D process. The forward plans do not currently include information on the status of environmental remediation which may be required to deal with potential contamination beneath some structures.

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Table A-1: D&D Status Categories

D&D Status	Description	CSA N294-19 Phase
Design	A phase intended to include the overall planning and philosophies that go into ensuring that every aspect of the physical design will consider safety, security and safeguards under all scenarios it may encounter during its lifecycle.	Planning for decommissioning (Phase 1)
Construction/ Commissioning	A phase intended to demonstrate that installed structures, systems and components (SSCs) perform in accordance with their specifications before the facility is placed in service or before the SSCs are returned or placed in service.	Planning for decommissioning (Phase 1)
Operations	A phase, in which all activities that are performed to achieve the purpose for which the facility was constructed.	Preparation for decommissioning (Phase 2)
Operations - Extended Safe Shutdown	A phase in which the facility is in an extended safe shutdown state but has not been formally transitioned to decommissioning.	Preparation for decommissioning (Phase 2)
Storage with Surveillance (SWS) / Care & Maintenance (C&M)	Storage with Surveillance consists of a planned phase within the decommissioning program, in which the remaining contaminated materials, equipment and site(s) are placed under controlled surveillance for a specified period of time. Care & Maintenance consists of a phase within the decommissioning program, in which the facility is maintained in a safe state.	Execution of decommissioning (Phase 3)
Decommissioning/ Building Removal	A phase, in which planned actions are executed to retire a facility permanently from service and render it to a predetermined end-state condition.	Execution of decommissioning (Phase 3)
Interim End-State - SWS	This is a planned phase within a decommissioning program, in which there is completion of a defined set of decommissioning activities and re-entry into a Storage with Surveillance phase.	Execution of decommissioning (Phase 3)
End-State – Verification Activities	This phase involves verifying that all decommissioning activities have been completed satisfactorily, the final end-state has been reached, and all documentation has been completed.	Completion of decommissioning (Phase 4)
End-State – Complete	This phase is defined by verification and acknowledgement by the appropriate regulatory authority that the end-state is confirmed to be achieved.	Completion of decommissioning (Phase 4)
Land Re-use	This phase is identified when a defined area of land or building footprint of a previous structure is ready for or has been taken over, fully or partially, by a new building or structure, infrastructure or laydown area.	N/A

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Status of the Remediation process at CRL

An Environmental Remediation Process Standard has been introduced by CNL and applies to all sites managed by CNL [53]. The CRL site has been used as the pilot facility where this process is being developed and tested. Each of the Areas of Potential Environmental Concern presented in this Appendix are working through the phases of the process, as required. Many of the Areas of Potential Environmental Concern have progressed to the Environmental Site Assessment stage, either at the Phase 1 or Phase 2 stage. At this stage site characterization is progressing which involves soil, surface water and groundwater sampling and waste characterization.

Where ongoing monitoring has identified the potential for risks to receptors, interim mitigative remedial actions have been taken, more specifically in the installation of passive and active groundwater treatment systems, in MU 3, 6 and 11 and the installation of the impermeable geomembrane cover over WMA C in MU 8.

In the Campus Precinct, especially in MU 1, some buildings and structures are undergoing the decommissioning process and will also be taken through the Environmental Remediation Process, more specifically the Phase 1 historical review and preliminary sampling associated with a Phase 2 characterization. The development of a remedial action plan may be deferred or in some cases, be accelerated, in order to sequence the work to better align with site revitalization efforts and the overall site mission.

Environmental Remediation Status for Areas of Potential Environmental Concern at CRL

More than 60 sub-areas, defined as Areas of Potential Environmental Concern (APECs) have been identified within the 11 MUs at the CRL site. These include seven waste management areas, six solid waste landfills, former supporting infrastructure such as pipelines, snow dumps, security firing ranges, and various other legacy sites. Each MU section includes a brief description of each APEC including summary of known contaminants, wastes present, environmental impacts where known and current and forward looking remediation status. Where sufficient information is available, information regarding estimated waste volumes associated with the environmental remediation of the APECs within each MU. In some cases, it may be noted that an area has no known contamination or may have not been operationally used for its intended purpose. These areas are considered to have been affected by CNL, however, and therefore must be put through the phases of the Environmental Remediation Process in order to verify that they are clean and meet next land use requirements.

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Table A-2: Environmental Remediation Status Categories

ER Status	Description	Reference
Operations	A phase, in which all activities performed to achieve the purpose for which the facility was constructed.	CSA N294-19 Phase 2
Area of Potential Environmental Concern (APEC) Identified and Monitored	Land/media is identified as an Area of Potential Environmental Concern (APEC) / Planned for ER (currently or post-Decommissioning Process)	N/A
Environmental Site Assessment	A full characterization of a site; includes soil, groundwater, surface water, soil vapour, air quality, sediment, biology, and background levels. CNL's Environmental Remediation Process recommends using Phase I and II ESAs to fulfill site characterization.	CSA N294-19
Risk Assessment	The systematic process used to identify, quantify, and characterize the risk posed by contaminants and physical stressors in the environment on biological receptors, including the magnitude and extent of the potential effects associated with a facility.	CSA N288.6-12
Remedial Planning	Determining the appropriate remedial solution(s) to remediate or cleanup a site to the degree required to meet the end-state criteria.	CSA N294-19 and REGDOC-2.11.2
Execute Remedial Action	Executing the selected remedial option(s) to cleanup a site to meet the end-state criteria.	CSA N294-19 and REGDOC-2.11.2
Remediation Project Closeout	Completion of the environmental remediation work and verification that the predetermined end-state has been achieved.	CSA N294-19
Land Re-use	This phase is identified when a defined area of land or building footprint of a previous structure is ready for or has been taken over, fully or partially, by a new building or structure, infrastructure or laydown area.	N/A

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A.1 Management Unit 1

Table A-3: Status of Buildings/Structures within MU 1

Building #	Name / Description	Current D&D Status (December 2022)	Plan Forward (expected status in 5 years) [3]
[redacted]	NRX Reactor	Decommissioning/ Building Removal	Decommissioning/ Building Removal
[redacted]	NRX Annex – Office Space	Decommissioning/ Building Removal	Decommissioning/ Building Removal
[redacted]	NRX Reactor Effluent Exp. Building	End-State Verification Activities	Interim End State - SWS
[redacted]	NRX Reactor Fan House	Decommissioning/ Building Removal	SWS/C&M
[redacted]	NRX Reactor Exhaust Air System	Decommissioning/ Building Removal	SWS/C&M
[redacted]	Mixed Waste Storage – Former Heavy Water & Drum Cleaning Building/ Former Change House	End-State Verification Activities	SWS/C&M
[redacted]	Delay Tank No.1 For NRX	End-State Verification Activities	Interim End State - SWS
[redacted]	Delay Tank No.2 For NRX	End-State Verification Activities	Interim End State - SWS
[redacted]	Former Phy. & Gen. Chemistry Lab	Land Re-Use (occupied by [redacted])	Land Re-Use
[redacted]	NRU Maintenance Offices	Removed from site; Land Re-use (Available for re-use/vacant)	Land Re-Use
[redacted]	MAPLE-1 Reactor	Operations - Extended Safe Shutdown	Decommissioning/ Building Removal
[redacted]	MAPLE-2 Reactor	Operations - Extended Safe Shutdown	Decommissioning/ Building Removal
[redacted]	Legacy Radiation Protection Offices	Land Re-Use (occupied by [redacted])	Land Re-Use
[redacted]	Legacy Radiation Protection Offices	Land Re-Use (occupied by [redacted])	Land Re-Use
[redacted]	Legacy Radiation Protection Offices	Land Re-Use (occupied by [redacted])	Land Re-Use
[redacted]	Legacy Radiation Protection Offices	Land Re-Use (occupied by [redacted])	Land Re-Use
[redacted]	Reactor Exhaust Stack	Decommissioning/ Building Removal	SWS /C&M

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Building #	Name / Description	Current D&D Status (December 2022)	Plan Forward (expected status in 5 years) [3]
[redacted]	Process Water Valve House	End-State Verification Activities	Interim End-State - SWS
[redacted]	Effluent Monitoring Equipment For Loops	End-State Verification Activities	Interim End-State - SWS
[redacted]	Former Emergency Change Room *(Slab Remains)*	End-State Complete	N/A
[redacted]	Class III Emergency Power House	Operations	Operations
[redacted]	Former Beta-Ray Spectrometer Building	Land Re-Use (Available for re-use/vacant)	Land Re-Use
[redacted]	Offices/Change Room For NRX/NRU/MAP	Decommissioning / Building Removal (Above Ground Only)	SWS/C&M
[redacted]	NRU/QA Storage Fab & Pressure Vessel; maintenance shop; storage; pipe rack enclosure	Decommissioning/ Building Removal	SWS/C&M
[redacted]	Former Helium Supply Tank For NRX	End-State Complete	Land Re-Use (Available for re-use/vacant)
[redacted]	Pool Test Reactor	End-State Complete	N/A
[redacted]	Multi-Use Facility: ZED-2 Reactor, Deformation Technology, Facility Operations, Fuel and Fuel Channel Safety, CTL-1 Facility, reactor physics research, machine/electrical shops, Burst Test Facility and offices	Operations	Operations
[redacted]	NRU Reactor	Operations – Extended Safe Shutdown	SWS/C&M
[redacted]	NRU Rod Bay	Operations – Extended Safe Shutdown	SWS/C&M
[redacted]	NRU License Extension Project	Land-Reuse (occupied by [redacted])	N/A
[redacted]	Service Tunnel	Operations	SWS/C&M
[redacted]	54" Intake From River	Operations	SWS/C&M
[redacted]	48" Cooling Water	Operations	SWS/C&M
[redacted]	Pipeline Building, [redacted]	Operations	SWS/C&M
[redacted]	Overhead Passage to NRU	Decommissioning/ Building Removal	SWS/C&M
[redacted]	Passage Duct	Operations – Extended Safe Shutdown	SWS/C&M

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Building #	Name / Description	Current D&D Status (December 2022)	Plan Forward (expected status in 5 years) [3]
[redacted]	Steam Trench Tunnel	Operations	Operations
[redacted]	NRU Emergency Filter System and Exhaust Air Filtration System	Operations	SWS/C&M
[redacted]	Steam Trench North From W.End	Operations	SWS/C&M
[redacted]	NRU Exhaust Air Filters	Operations – Extended Safe Shutdown	SWS/C&M
[redacted]	NRX/NRU Booster Fan House	Operations – Extended Safe Shutdown	SWS/C&M
[redacted]	Duct Work	Operations – Extended Safe Shutdown	SWS/C&M
[redacted]	Emergency Ductwork	Operations – Extended Safe Shutdown	SWS/C&M
[redacted]	Sump & Pumping Equip. FOR [redacted]	Operations – Extended Safe Shutdown	SWS/C&M
[redacted]	Waste Disp Sorting/Temp Storage	Land Re-Use (occupied by [redacted])	N/A
[redacted]	NRU 25-Ton C02 Tank	Storage with Surveillance/Care & Maintenance	Removed from site (tank)/ SWS/C&M (pad)
[redacted]	NRU Instrument Maintenance Shop	Operations	SWS/C&M
[redacted]	Decontam Skid Strge For NRU	Storage with Surveillance/Care & Maintenance	Decommissioning/ Building Removal
[redacted]	NRU Misc. Equipment Storage	Operations	SWS/C&M
[redacted]	NRU Oil Products Storage	End-State Verification Activities	Land Re-Use (Available for re-use/vacant)
[redacted]	NRU Carpenter Shop	Land Re-Use (occupied by [redacted])	N/A
[redacted]	NRU Operational Storage	Operations	Operations, new use as waste processing
[redacted]	NRU Hazardous Storage	Operations	SWS/C&M
[redacted]	Carpenter Storage Facility	SWS/C&M	SWS/C&M
[redacted]	NRU Waste Collect & Characterization	Operations	Operations
[redacted]	Steam Generator Cleaning Skid Storage For NRU	Storage with Surveillance/Care & Maintenance	Decommissioning/ Building Removal

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Building #	Name / Description	Current D&D Status (December 2022)	Plan Forward (expected status in 5 years) [3]
[redacted]	FORMER REACTOR BAY & CA2 DEIONIZATION	Decommissioning/ Building Removal	SWS/C&M
[redacted]	Former MAPLE & Decommissioning Offices	End-State Verification Activities	Interim End-State - SWS
[redacted]	Former Refr/Air Cond Shop/Filter St	End-State Complete	Land Re-Use
[redacted]	Active Laundry Building	End-State Verification Activities / Land Re-Use (occupied by [redacted])	SWS/ C&M /Land Re-Use (occupied by [redacted])
[redacted]	Chemical Plant Exhaust Stack	Operations	Operations
[redacted]	NRX Rod Handling Bays	Decommissioning/ Building Removal	Decommissioning/ Building Removal
[redacted]	Delay Tanks For Radioactive Liquid	Operations	Decommissioning/ Building Removal
[redacted]	Guard Tank Overflow 68,000 LTR	Operations	Decommissioning/ Building Removal
[redacted]	Filter/Fan House [redacted]	Operations	Operations
[redacted]	Loop Decontam Liquid Waste Storage	Operations	Interim End State -SWS
[redacted]	Former Heavy Water Upgrading Plant (slab remains)	End-State Complete / Land Re-use (occupied by [redacted] and [redacted])	Land Re-use
[redacted]	Underground HW Storage Tanks	End-State Complete	Land Re-use
[redacted]	Former Heavy Water Storage Tanks; TSU Material Storage Area	Operations	Operations
[redacted]	Tritium Facility/ Combined Electrolysis Catalytic and Exchange Upgrade and Detritiation Test Facility	Operations	Operations
[redacted]	Vehicle Search Tent	Operations	Operations
[redacted]	Security Command Post Trailer	Operations	Operations
[redacted]	Active Holding Tank Entry	Operations	Interim End State -SWS
[redacted]	Former Recovery Lab	Decommissioning/ Building Removal	Decommissioning / Building Removal
[redacted]	Annex to Building [redacted]	Decommissioning/ Building Removal	Decommissioning / Building Removal
[redacted]	Decomm. Materials Storage	End-State Complete	Land Re-Use
[redacted]	Concentrated IX Regenerant Liquid	Operations	Operations
[redacted]	FMR Liquid Waste Loading/Unloading	Operations	Operations
[redacted]	FMR IX Regenerant Liquid Waste Evap	Operations	Operations
[redacted]	Former Chemical Tower (no annexes)	Interim End-State - SWS	SWS/C&M
[redacted]	C60 & Loop Decontam Liquid Waste St	Operations	Operations

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Building #	Name / Description	Current D&D Status (December 2022)	Plan Forward (expected status in 5 years) [3]
[redacted]	Moly Production Facility/Reac Chem	Operations	Operations
[redacted]	Delay storage pit for [redacted]	Operations	Operations
[redacted]	Efflu Monitor./Filter Test Lab/HVAC	Operations	Interim End State - SWS
[redacted]	NMMT/NFO Offices, Shower/Change Are	Decommissioning/ Building Removal	Land Re-Use
[redacted]	Former Waste Recovery From NRX - structure removed, slab and fenced land only	End-State Verification Activities	Interim End State - SWS
[redacted]	Solution Storage Tank (FISST) for [redacted]	Operations	Decommissioning/ Building Removal
[redacted]	Truck Bay and Pump Annex	Operations	Operations
[redacted]	Storage Building	End-State Complete	Land Re-Use
[redacted]	Universal Hot Cells	Operations	Operations
[redacted]	Pump House	Decommissioning/ Building Removal	SWS/C&M
[redacted]	Reactor Drain Tank; Chemical Active Drain Tank	Decommissioning/ Building Removal	SWS/C&M
[redacted]	Decontam Centre (DC) Active Collection	Operations	Decommissioning / Building Removal
[redacted]	Chem Active Drains (CAD) Collection	Operations	Decommissioning / Building Removal
[redacted]	Chemical Engineering Lab/Offices	Decommissioning/ Building Removal	SWS/C&M / Land Re-Use
[redacted]	Hydrogen Gas Cylinder Storage	Decommissioning/ Building Removal	Removed from site (tank)/ SWS/C&M (pad)
[redacted]	New Processing Facility (NPF)	Operations - Extended Safe Shutdown	Decommissioning / Building Removal
[redacted]	Office Trailer	Operations	Removed from site/ Land Re-Use
[redacted]	Fuel Eng Technical Offices/Labs; Corrosion Tech Offices/Lab; Fuel And Fuel Channel Safety	Decommissioning/ Building Removal	SWS/C&M / Land Re-Use
[redacted]	Garbage Can Storage	Design	Operations
[redacted]	Analytical & Reactor Chemistry Laboratories/Offices	Operations	Operations
[redacted]	Gas Cylinders Storage and Garbage Storage	Operations	Operations
[redacted]	Garbage Can Storage	Land Re-Use (Available for re-use/vacant)	Land Re-Use (Available for re-use/vacant)

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Building #	Name / Description	Current D&D Status (December 2022)	Plan Forward (expected status in 5 years) [3]
[redacted]	Services for laboratories in Building [redacted]	Operations	Operations
[redacted]	Analytical and Reactor Chemistry laboratories/offices	Operations	Operations
[redacted]	Garbage Storage	Land Re-Use (Available for re-use/vacant)	Land Re-Use (Available for re-use/vacant)
[redacted]	Metallurgy Offices/Labs RFFL FAC.	Operations	Operations
[redacted]	Materials Labs And Offices	Operations	Operations
[redacted]	Nuclear Fuel Fabrication Facility (NFFF)	Operations	Operations
[redacted]	Power House	Operations	Operations
[redacted]	Oil Tank Valve House	Operations	SWS/C&M
[redacted]	Chlorinator Building	Operations	Operations
[redacted]	Chlorine Cylinder Shed	End State Verification Activities	End-State – Complete
[redacted]	Main Electrical Substation	Operations	Operations
[redacted]	Sewage pump building service	Operations	Operations
[redacted]	Gravity Tank For Service Water	Decommissioning/ Building Removal	End-State – Complete
[redacted]	Fabrication Facility (NFFF); Testing And Assembly Area; Casting Area	Decommissioning/ Building Removal	SWS/C&M
[redacted]	Charcoal Filter Testing Labs	End-State Complete	Land Re-Use
[redacted]	Pipe Fab/Motor Wind Shop/NRU QA Storage	Operations	SWS/C&M
[redacted]	Pipe Fab/Motor Wind Shop/QA Storage	Operations	SWS/C&M
[redacted]	Emergency Process Water Cooling NRU	End-State Verification Activities	SWS/C&M / Land Re-Use
[redacted]	Valve House A For NRU	End-State Verification Activities	SWS/C&M
[redacted]	Valve House B For NRU	End-State Verification Activities	SWS/C&M
[redacted]	Valve House C For NRU	Decommissioning/ Building Removal	Decommissioning / Building Removal
[redacted]	Valve House D For NRU	Decommissioning/ Building Removal	Decommissioning / Building Removal
[redacted]	Former Tank Used For CANDU® 9 Rupture Disk	End-State Verification Activities	Land Re-use
[redacted]	Former Filtered Water Storage Reserve	End-State Verification Activities	Decommissioning / Building Removal

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Building #	Name / Description	Current D&D Status (December 2022)	Plan Forward (expected status in 5 years) [3]
[redacted]	Radio Communications (New In 1999)	End-State Verification Activities	Land Re-use
[redacted]	Process & Service Water Tower	End-State Verification Activities	Decommissioning / Building Removal
[redacted]	Heavy Water Storage Facility	Decommissioning/ Building Removal	SWS/C&M
[redacted]	Carpenter Shop/Non-Dest. Test Tool	End-State Verification Activities	End-State – Complete
[redacted]	Machine Shop and Thermal Hydraulics Laboratories/Offices	Operations	Operations
[redacted]	Restricted Area Shop	Operations	Operations
[redacted]	Waste Technologies Development/Laboratories And Offices	Operations	End-State – Complete
[redacted]	Waste Proc Tech Dev Labs/Offices	Operations	End-State – Complete
[redacted]	Vehicle/Bulk Decontamination Building	Operations	Operations
[redacted]	Fuel Engineering /Reactor Safety Laboratories And Offices	Operations	Operations
[redacted]	Former Aquatic Storage	End-State Verification Activities	Land Re-use
[redacted]	Decontamination	Operations	Operations
[redacted]	Emergency Equipment Storage	Operations	Land Re-use
[redacted]	Former Liquid Dispersal Area Valve House	End-State Verification Activities	End-State - Complete
[redacted]	High Pressure Mass Transfer Rig	End-State Verification Activities	End-State - Complete
[redacted]	High Pressure Mass Transfer Rig (Tower) (Slab remains)	End-State Verification Activities	End-State - Complete
[redacted]	Burst Test Facility Labs/Offices	Operations	SWS/C&M
[redacted]	Process Sewer Sampling Station	Operations	Operations
[redacted]	Former Oil & Paint Storage	End-State Complete	Land Re-use
[redacted]	Nuclear Materials Storage facility	Operations	Operations
[redacted]	NRU/NRC Storage Equip/Surplus Mat	Operations	Operations
[redacted]	Liquid Nitrogen Tower	Operations	SWS/C&M
[redacted]	NRU/NRC Storage	Operations – Extended Safe Shutdown	SWS/C&M
[redacted]	Decontam Storage Building	End-State Verification Activities	End-State Complete
[redacted]	Flasks/Radioactive-Contam Equipment	Operations	End-State Complete

REDACTED

Building #	Name / Description	Current D&D Status (December 2022)	Plan Forward (expected status in 5 years) [3]
[redacted]	FTIR Lab	End-State Verification Activities	End-State Verification Activities
[redacted]	High Pressure LPCE Test Facility	End-State Verification Activities	SWS/C&M
[redacted]	Hydrogen H_2O Gas Cylinders	End-State Verification Activities	SWS/C&M
[redacted]	Hydrogen/H_2O/Nitrogen Storage	End-State Verification Activities	SWS/C&M
[redacted]	Sandblasting Building	Land Re-Use (Available for re-use/vacant)	N/A
[redacted]	Waste Treatment Centre	Operations	Operations
[redacted]	Shed	Land Re-Use (Available for re-use/vacant)	N/A
[redacted]	Non-radiological emulsified bitumen storage	Operations	Operations
[redacted]	Chemical Storage	Operations	Operations
[redacted]	Hazardous Active and Chemical Storage	Operations	Operations
[redacted]	Temporary Office trailer	Removed from site, End State Complete	Land Re-use (occupied by [redacted])
[redacted]	Active Drain System Holding Tank	Operations	Operations
[redacted]	Nuclear Material Storage facility	Operations	Operations
[redacted]	Mixed Waste Storage Shed	End-State Complete	Land Re-use
[redacted]	WTC STORAGE UNIT	Operations	Operations
[redacted]	High Bay Mock-Up And Assembly Labs	Operations	Operations
[redacted]	Machinery And Equipment Storage	Operations	Operations
[redacted]	Controlled Area Main Pedestrian Entrance/Exit, Radiation Protection Offices, Instrument Shop, Security Office And Locker Area	Operations	Operations
[redacted]	Decommissioning Change Facility	Operations	Operations
[redacted]	Waste Treatment Centre Team Trailer	Operations	Removed from site / Land Re-Use
[redacted]	FD Office Trailer ([redacted]) - being installed	Operations	Operations
[redacted]	FD Office Trailer ([redacted]) - being installed	Operations	Operations
[redacted]	FD Office Trailer ([redacted] greenspace) - being installed	Operations	Operations

REDACTED

Building #	**Name / Description**	**Current D&D Status (December 2022)**	**Plan Forward (expected status in 5 years) [3]**
xSheds	Miscellaneous Sheds, Quantity 3 ([redacted] area)	End-State Verification Activities	Land Re-use

Table Notes: [1]These building/structures are also listed as Areas of Potential Environmental Concern in Table A-4: *Areas of Potential Environmental Concern within MU 1*, and are assessed considering Environmental Remediation requirements.
[2]These buildings have entered Decommissioning / Building Removal stage, but will be returning to SWS/ C&M due to delays to the proposed NSDF.
[3]A re-planning exercise is currently underway which may alter the forward plan status.
SWS is Storage with Surveillance.
C&M is Care and Maintenance.

REDACTED

Table A-4: Areas of Potential Environmental Concern within MU 1

Area of Potential Environmental Concern	Description/Highlights	Current ER Status (December 2022)	Plan Forward (expected status in 5 years)
Inner Controlled Area	Most of CRL's radioactive activities take place in MU 1, home to 5 reactors, one of which is still operating (ZED-2) and to a number of laboratories and support facilities.	APEC Identified and Monitored	APEC Identified and Monitored
Power House Shoreline Landfill	Was used as a construction waste dump in the 1940s and 1950s. Waste consists mainly of buried materials from old demolished buildings. Solid wastes are periodically observed due to local erosion. These wastes have been retrieved and disposed on two occasions.	Environmental Site Assessment	Environmental Site Assessment
NRX Rod Bay Plume toward the Ottawa River	A leak occurred in 1959 as a result of modifications to the NRX Fuel Storage Bays releasing significant quantities of radionuclides to subsurface resulting in a plume of tritium and of ^{90}Sr which continued until 2006 when the rod bay water was removed, leading to a significant reduction in tritium levels. The highest ^{90}Sr concentrations are found in a narrow band 10-to 20-m wide along much of the flow path. The concentrations of ^{90}Sr in the plume have been reasonably constant for the past 15 years, and are expected to gradually decrease in the future. This plume is monitored under the CRL GWMP and updates are provided in the *Annual Compliance Monitoring Report: Environmental Monitoring in 2020 at CRL* (e.g., [106]).	APEC Identified and Monitored	APEC Identified and Monitored
North Embayment (Ottawa River)	Sediment in a small area of the Ottawa River known as the North Embayment has elevated levels of gross beta activity (^{90}Sr and ^{90}Y) as a result of the NRX groundwater plume discharging in this area and a small area of elevated ^{137}Cs concentration in surface sediment.	Risk Assessment	Risk Assessment

REDACTED

Area of Potential Environmental Concern	Description/Highlights	Current ER Status (December 2022)	Plan Forward (expected status in 5 years)
NRU Plume toward the Ottawa River	An ongoing leak in the NRU spent fuel storage bays is the source of a long-term release of tritium contaminated groundwater that began the early 1980s. With the shutdown of the NRU reactor and the removal of a portion of the bay water in 2018, the tritium concentration in the bay is expected to decrease by approximately 15 to 30% per annum due to radiological decay and water losses due to evaporation and bay leakage. Tritium concentrations in the groundwater downgradient of NRU are remaining stable. This plume is monitored under the CRL GWMP and updates are provided in the *Annual Compliance Monitoring Report: Environmental Monitoring in 2020 at CRL* (e.g., [106]).	APEC Identified and Monitored	APEC Identified and Monitored
Building [redacted] Land	Building [redacted] is located on the side of a hill in the Controlled Area and includes a pump house building, a 300 m^3 cylindrical holding tank ([redacted]) and a smaller 30 m^3 cylindrical tank ([redacted]) both used for radioactive contaminated waste water from buildings [redacted] and [redacted]. Evidence of groundwater contamination resulting from leaks in tank [redacted] was first detected in 1972 and again in 1983. The leak from Tank [redacted] during operations resulted in localized, low-level soil contamination. The extent of contamination has not been fully delineated.	Environmental Site Assessment	Environmental Site Assessment
Building [redacted] Land	Building [redacted] was a facility used to process and treat radioactive waste product from the NRX reactor and reactor fuel reprocessing carried out in buildings [redacted] and [redacted]. The liquid wastes contained concentrations of fission products in nitric acid and ammonium nitrate. A	APEC Identified and Monitored	APEC Identified and Monitored

REDACTED

Area of Potential Environmental Concern	Description/Highlights	Current ER Status (December 2022)	Plan Forward (expected status in 5 years)
	process piping failure in 1955 led to a leak of 10 to 50 liters of radioactive liquid on the ground outside the building through a crack in the floor. Considerable contamination is believed to remain in the soil but has not been delineated due to its location under the building.		
LDA Pipeline (inner Controlled Area portion)	Remedial actions have taken place to remove the pipeline and associated contaminated soil in MU 7. Several leaks were reported from the LDA pipeline, however, some of which were in MU 1. The contaminant plume has migrated toward the Controlled Area, near building [redacted], in particular. The remaining section of the pipeline within the controlled area, near the [redacted], remains due to access restrictions related to security and awaiting decommissioning activities related to building [redacted].	Environmental Site Assessment	Environmental Site Assessment
Building [redacted] Land	Located in the Metallurgy Building [redacted], the Fuels and Materials Cells facility has been used for experiments with highly radioactive fuels and reactor components. In 1995 contaminated soil was observed under the facility due to leaks from the active drain. The contamination has not been removed and is still present beneath the centre of the building.	APEC Identified and Monitored	APEC Identified and Monitored
Active Drain System	The Active Drain System collects radioactive wastewater from nuclear facilities and radioactive laboratories within MU 1 and low toxicity water-soluble chemicals. Several leaks have occurred and resulted in localized soil and groundwater contamination. Any legacy piping associated with the Active Drain System has been removed during decommissioning activities as required.	Operations	Operations

REDACTED

Area of Potential Environmental Concern	Description/Highlights	Current ER Status (December 2022)	Plan Forward (expected status in 5 years)
Building [redacted] Infiltration Pit	In 1945, an infiltration pit was installed to allow for disposal of active liquid waste from the north end of building [redacted]. Test wells drilled in 2003 revealed the presence of small amounts of ^{137}Cs at depths corresponding to the location of the infiltration pit. The drain pipe, the infiltration pit and contaminated soils were left in place following decommissioning of building [redacted] due to the infrastructure congestion in the area.	APEC Identified and Monitored	APEC Identified and Monitored
Building [redacted] Land	Low-level radioactive water was observed until the late 1950s in a former small pond located next to building [redacted]. The contaminated materials have not yet been excavated from this area.	APEC Identified and Monitored	APEC Identified and Monitored
Building [redacted] Land	Building [redacted] is a complex used to store radioactive liquid wastes in four separate storage tanks housed in separate concrete vaults. Several leaks and incidents have been reported in and around building [redacted]. ^{137}Cs contamination is believed to remain in the soil at buildings [redacted] and [redacted] and will require further characterization and delineation.	APEC Identified and Monitored	APEC Identified and Monitored
Building [redacted] Land	The building [redacted] reactor exhaust sump has collected up to 20,000 L of water annually. The water is contaminated with tritium and non-tritium alpha and beta activity and represents a potential source of contamination.	APEC Identified and Monitored	APEC Identified and Monitored
Building [redacted] Land	Shallow soil contamination has been observed on the west and north sides of building [redacted] as part of a characterization completed in 2021 ahead of decommissioning execution.	APEC Identified and Monitored	APEC Identified and Monitored
Other contaminant sources in MU 1	Several locations in the CA have been exposed to small spills and leaks affecting the soil in the immediate vicinity of the upset. These spills and leaks have not yet been assessed directly to determine if they may have impacted the	APEC Identified and Monitored	APEC Identified and Monitored

REDACTED

Area of Potential Environmental Concern	Description/Highlights	Current ER Status (December 2022)	Plan Forward (expected status in 5 years)
	groundwater, surface water, or biota in MU 1. Downgradient locations are, however, monitored under the CRL GWMP and updates are provided in the *Annual Compliance Monitoring Report: Environmental Monitoring in 2020 at CRL* (e.g., [106]).		

REDACTED

A.2 Management Unit 2

Table A-5: Status of Buildings/Structures within MU 2

Building #	Name / Description	Current D&D Status (December 2022)	Plan Forward (expected status in 5 years)
[redacted]	WMA D: Low-level waste storage building	Operations	Operations
[redacted]	WMA G: Service Building (backup power supply and testing equipment storage)	Land Re-Use (occupied by [redacted])	N/A
[redacted]	WMA D: Interim Storage of drums of contaminated mixed-waste liquids	Operations	Operations
[redacted]	WMA D: Interim Storage of drums of contaminated mixed-waste liquids	Operations	Operations
[redacted]	WMA D: sampling and transferring drums of contaminated mix-waste liquids	Operations	Operations
[redacted]	WMA D: Low-Level Radioactive Waste Management Office building	Land Re-Use (occupied by [redacted])	N/A
[redacted]	WMA D: Equipment storage and dedicated low background characterization area	Operations	Operations
[redacted]	WMA H: Electric Service Building For WMA H, D And G	Operations	Operations
[redacted]	WMA H: MAGS I	Land Re-Use (occupied by [redacted])	N/A
[redacted] **(former)**	WMA H: MAGS II	Land Re-Use (occupied by [redacted])	N/A
[redacted]	WMA H: Sort and Segregation Pilot Facility	Operations	Operations
[redacted]	WMA H: SMAGS I	Operations	Operations
[redacted]	WMA H: SMAGS II	Operations	Operations
[redacted]	WMA H: SMAGS III	Operations	Operations
[redacted]	WMA H: Waste Sort and Segregation Facility	Construction/ Commissioning	Operations
[redacted]	WMA G: Service Building	Operations	Operations
[redacted]	WMA G: Entrance Building	Operations	Operations

REDACTED

Table A-6: Areas of Potential Environmental Concern within MU 2

Area of Potential Environmental Concern	Description/Highlights	Current ER Status (December 2022)	Plan Forward (expected status in 5 years)
WMA D	Operating WMA established in 1976 to store contaminated obsolete or surplus equipment above ground. It currently contains a building used for the secure storage of slightly contaminated material, one building for heated mechanical equipment storage and a low background space in support of waste characterization work, and a facility comprised of three buildings for sampling and bulking liquid mixed wastes. WMA D also contains a Recoverable Surface Storage Area for the above ground storage of low-level waste in sealand containers. There has been downgradient contamination (namely tritium) detected and associated with historical WMA D operations. Ongoing monitoring of operations and downgradient groundwater quality will continue and updates are provided in the *Annual Compliance Monitoring Report: Environmental Monitoring in 2020 at CRL* (e.g., [106]).	Operations	Operations
WMA G	Established in 1988 to securely store the [redacted] from the NPD prototype CANDU® power reactor in aboveground concrete canisters. The facility design includes multiple engineered barriers to ensure that fuel fission products and actinides remain contained and several routine procedures are carried out to monitor the canisters. Additional canisters have recently been constructed in preparation for receiving the [redacted] from WR-1 and G-1.	Operations	Operations

REDACTED

Area of Potential Environmental Concern	Description/Highlights	Current ER Status (December 2022)	Plan Forward (expected status in 5 years)
	There are no downgradient contamination concerns associated with WMA G operations, historical or current. Ongoing monitoring of operations and downgradient groundwater quality will continue and updates are provided in the *Annual Compliance Monitoring Report: Environmental Monitoring in 2020 at CRL* (e.g., [106]).		
WMA H	Operating WMA established in 2002 that provides waste storage space for low-level solid wastes in a Recoverable Surface Storage Area and low and intermediate level waste in the Shielded Modular Above-Ground Storage (SMAGS) buildings. Recently the original MAGS-I building was demolished and replaced with the new Waste Sort and Segregation Facility. The MAGS-II building has had its waste inventory removed and has been converted to the Sort and Segregation Pilot Facility. There are no downgradient contamination concerns associated with WMA H operations, historical or current. Ongoing monitoring of operations and downgradient groundwater quality will continue and updates are provided in the *Annual Compliance Monitoring Report: Environmental Monitoring in 2020 at CRL* (e.g., [106]).	Operations	Operations

REDACTED

A.3 Management Unit 3

Table A-6: Status of Buildings/Structures within MU 3

Building #	Name / Description	Current D&D Status (December 2022)	Plan Forward (expected status in 5 years)
[redacted]	Equipment Storage Facility	Operations	Operations
[redacted]	Storage Building at WMA B	Operations	Operations
[redacted]	Storage area and change facility for WMA	Operations	Operations
[redacted]	Security monitoring electrical equipment and security systems equipment	Operations	Operations
[redacted]	Tile Array Enclosure for WMA B	Operations	Operations
[redacted]	Trailer for Office and Storage	Removed from Site, Land Re-Use	Land Re-use
[redacted]	Fuel Packaging and Storage (FPS) Facility	Operations	Operations
[redacted]	Annex Building Housing the Rotating Unit for the FPS Transfer Flask	Operations	Operations
[redacted]	Waste Reception Centre in WMA B	Operations	Operations
[redacted]	Waste Handling Building - Super compactor for low-level waste	Operations	Operations
[redacted]	Original Spring B Groundwater Treatment Facility	SWS/ C&M	Land Re-use
[redacted]	Equipment/Chemicals Storage	SWS/ C&M	Land Re-use
[redacted]	WMA B Entrance Building	Operations	Operations
[redacted]	Waste Services Office Trailer Complex	Operations	Operations
[redacted]	WMA Portable Shower/Change Room	Operations	Operations
[redacted]	New Spring B Groundwater Treatment Facility	Operations	Operations

REDACTED

Table A-7: Areas of Potential Environmental Concern within MU 3

Area of Potential Environmental Concern	Description/Highlights	Current ER Status (December 2022)	Plan Forward (expected status in 5 years)
WMA B	WMA B was established in 1953 to succeed WMA A and is currently in operational use as a location for solid LLW, ILW and HLW waste management. Historical Waste Storage: Until 1963 wastes were placed in capped, unlined trenches and until 1959 in asphalt-lined sand trenches. Rectangular concrete bunkers were then used but in 1977 the design was updated to cylindrical reinforced concrete bunkers, which remain in use today. Several special burials (NRU and NRX calandrias) were also made in concrete containers or directly in the trenches. HLW such as irradiated fuel, hot cell waste, fuel bundles, unusable radioisotopes, spent columns, and filters and fission product wastes from ^{99}Mo production are stored in shielded engineered in-ground storage units known as tile holes. Fuel has been removed from the first-generation tile holes to FPS, however tile hole remediation is still required. Some of the underground waste containers have degraded over the years. Operational Waste Storage: Cylindrical Bunkers containing ILW have been formed with concrete walls and pads and include leak detection. Approximately 6000 modern Tile Holes continue to store high-level waste in WMA B, including: •Irradiated Rod Part (IRP) tile holes •Irradiated Fuel Element (IFE) tile holes •Irradiated Material Disposal (IMD) tile holes •Cell Waste (CW) tile holes •Cell Filter (CF) tile holes	Operations	Operations

REDACTED

Area of Potential Environmental Concern	Description/Highlights	Current ER Status (December 2022)	Plan Forward (expected status in 5 years)
	•Reverse Osmosis Disposal (ROD) tile holes WMA B is of high concern due to significant contaminant transport via groundwater and due to numerous HLW, ILW burials and historic LLW storage units.		
Fuel Packaging and Storage Facility	The Fuel Packaging and Storage (FPS) Facility, located within WMA B, was designed and built to retrieve, transfer, dry and store research reactor fuel from the tile holes that house used fuel transferred from the NRX and NRU rod bays between 1963 and 1983. The FPS currently operates to store the fuel retrieved and transferred from 96 first generation tile holes between 2015 December and 2018 August.	Operations	Operations
WMA B Eastern Plume toward Main Stream	A contaminated groundwater plume is transporting chlorinated solvents originating from the unlined sand trenches at the north end of WMA B and tritium from the northeast unlined trenches and the cylindrical bunkers in the southern region of WMA A toward Main Stream. This plume is monitored under the CRL GWMP and updates are provided in the *Annual Compliance Monitoring Report: Environmental Monitoring in 2020 at CRL* (e.g., [106]).	APEC Identified and Monitored	APEC Identified and Monitored
WMA B Southern Plume toward Perch Lake	The tritium contaminated solid waste stored in the cylindrical bunkers has also impacted the groundwater leaving WMA B to the South toward Perch Lake. This plume is monitored under the CRL GWMP and updates are provided in the *Annual Compliance Monitoring Report: Environmental Monitoring in 2020 at CRL* (e.g., [106]).	APEC Identified and Monitored	APEC Identified and Monitored
WMA B Western Plume toward Spring B	The groundwater along the west perimeter of WMA B continues to be substantially affected by the waste stored in the western	APEC Identified and Monitored	APEC Identified and Monitored

REDACTED

Area of Potential Environmental Concern	Description/Highlights	Current ER Status (December 2022)	Plan Forward (expected status in 5 years)
Forest and West Swamp	block of unlined sand trenches, resulting in a contaminant plume comprised primarily of elevated gross beta activity, as well as low concentrations of several organic compounds and elevated concentrations of tritium in the southern third of the perimeter. This plume flows through Spring B forest and toward West Swamp where the groundwater flow path discharges. This plume is monitored under the CRL GWMP, mitigated by the **Spring B Groundwater Treatment Facility (Pump and Treat)** updates are provided in the *Annual Compliance Monitoring Report: Environmental Monitoring in 2020 at CRL* (e.g., [106]).		
Spring B Groundwater Treatment Facility (Pump and Treat) ([redacted])	The WMA B Western groundwater plume has been subject to treatment since 1992 when an experimental treatment system was put into operation. The original Spring B Treatment System has, since then, been treating a significant fraction of migrating radiostrontium, mitigating impacts on the West Swamp where the groundwater flow path discharges. The New Spring B Groundwater Treatment Facility was commissioned in 2020. The original system [redacted] has now ceased operations and planning for decommissioning was initiated in 2022/23. Performance updates are provided in the *Annual Compliance Monitoring Report: Environmental Monitoring in 2020 at CRL* (e.g., [106]).	Operations	Operations

REDACTED

A.4 Management Unit 4

Table A-8: Status of Buildings/Structures within MU 4

Building #	Name / Description	Current D&D Status (December 2022)	Plan Forward (expected status in 5 years)
[redacted]	Emergency Storage Basin	Operations	SWS/C&M
[redacted]	Emergency Equipment Storage	Land Re-Use (proximal to [redacted])	N/A
[redacted]	Document Shack	End-State Complete	Land Re-Use
[redacted]	Fuse Shack	End-State Complete	Land Re-Use
[redacted]	In Vivo Monitoring, Whole-Body/Lung Counters, Environmental Sample Analyses	Operations	Operations
[redacted]	Low Background Office Trailer	Operations	Removed from site-Land Re-Use
[redacted]	Radiation Portal Monitor	Operations	Operations
[redacted]	Site Evacuation/Monitoring Building	Land Re-Use (proximal to [redacted])	N/A
[redacted]	Vehicle Monitor #1	Land Re-Use (proximal to [redacted])	N/A
[redacted]	Vehicle Monitor #2	Land Re-Use (proximal to [redacted])	N/A
[redacted]	Outer Gate House For Site	Land Re-Use (occupied by Plant Rd)	N/A
[redacted]	Emergency Generator	Land Re-Use (occupied by Plant Rd)	N/A
[redacted]	Guard House	Land Re-Use (occupied by Plant Rd)	N/A
[redacted]	Security Tent	Land Re-Use (occupied by [redacted])	N/A
[redacted]	Contractor Management Trailer (at Twin Lakes Soil Management area)	Operations	Operations
[redacted]	Waste Analysis Facility	Operations	Operations
[redacted]	Waste Characterization Facility	Operations	Operations
[redacted]	Waste Characterization Facility Office Trailer 1	Operations	Operations
[redacted]	Waste Analysis Facility Concrete Segregation Facility	Operations	Operations
[redacted]	Waste Characterization Facility Office Trailer 2	Operations	Operations
[redacted]	Sprung Shelter	Operations	Operations
[redacted]	Security Equipment Storage	Land Re-Use (Available for re-use/vacant)	Land Re-Use
[redacted]	Live Firefighter Training Structure	Operations	Operations

REDACTED

Building #	Name / Description	Current D&D Status (December 2022)	Plan Forward (expected status in 5 years)
[redacted]	Fire Equipment Storage	Operations	Operations
[redacted]	Rehabilitation Area for Firefighting Training Evolutions	Operations	Operations
[redacted]	Underground Waste Water Tank	Operations	Operations
[redacted]	Confined Space Training Container	Operations	Operations
[redacted]	Live Fire Equipment Storage Container	Operations	Operations
[redacted]	Class A Fuel Storage Container	Operations	Operations
[redacted]	Personal Protective Equipment Storage Container	Operations	Operations
[redacted]	Live Fire Training Site Gazebo	Operations	Operations
[redacted]	Waste Characterization Services Lab & Fire Training Trailer	Operations	Operations/Removed from site – Land Re-Use
[redacted]	Firefighting Training Trailer	Land Re-Use (occupied by [redacted])	N/A
[redacted]	Salt Storage Building	Operations	Land Re-Use (for new salt storage building being built in-situ in 2023)
[redacted]	Former Bulk Storage Compound Sprung Tent Structure	Operations	Operations
[redacted]	Minwamon Building: Logistics warehouse facility and site entrance building	Operations	Operations
[redacted]	Vehicle Inspection Station	Operations	Operations
[redacted]	Vehicle Inspection Personnel Booth	Operations	Operations
[redacted]	Roadway Booths	Operations	Operations
[redacted]	CRL Site Entrance Canopy	Operations	Operations
[redacted]	Contractor Management Complex	Operations	Operations
[redacted]	Waste Management and Heavy Equipment Break Room Trailer	End State Verification Activities	N/A

REDACTED

Table A-9: Areas of Potential Environmental Concern within MU 4

Area of Potential Environmental Concern	Description/Highlights	Current ER Status (December 2022)	Plan Forward (expected status in 5 years)
Bald Rock	Bald Rock is a site where research was initiated in the 1970's and ended in 1985 to investigate the crystalline rock formations at CRL and their potential for deep cavern storage of radioactive waste. No sign of radioactive or non-radioactive contamination or waste was uncovered during decommissioning and removal of the equipment and instruments completed between 2007 and 2010. Decommissioning and environmental remediation of the 6 boreholes (test wells) at Bald Rock is occurring in 2022 (see **Deep Boreholes**, below). Confirmatory characterization will be undertaken prior to closure.	Execute Remedial Action	Environmental Remediation Project Closeout/ Land Re-use
Deep Boreholes	Thirty-seven of the approximately 50 exploratory deep boreholes existing on the CRL site are slated to be decommissioned and remediated by 2022. Several of these are located in the **Bald Rock** area (see above). No radiological or non-radiological contamination issues exist with respect to these boreholes.	Execute Remedial Action	Environmental Remediation Project Closeout / Land Re-use
Blimkie's Meadow	Blimkie's Meadow is a former farm site (pre-dating operations) located next to WMA A which was used by CNL for the storage of discarded equipment. Its history suggests the presence of contamination at Blimkie's Meadow is unlikely. Confirmatory characterization may be required prior to closure.	Environmental Remediation Project Closeout	Land Re-use
Emergency Storage Basin ([redacted])	The Emergency Storage Basin was built in 1960 as a temporary holding facility for any contaminated water that would have been generated in a major reactor	Operations	SWS/C&M

REDACTED

Area of Potential Environmental Concern	Description/Highlights	Current ER Status (December 2022)	Plan Forward (expected status in 5 years)
	accident. The storage basin has never been used and is considered clean and operational.		
Interim Firing Range	The interim firing range was located near the Twin Lakes sand and gravel aggregate pit. It operated between 2004 and 2019. It is no longer in operation and has been incorporated into the Twin Lakes Soil Management area. The site will require further characterization and possibly cleanup before it is considered as closed.	Land Re-use (as Twin Lakes Soil Management area)	N/A
Old Firing Range	A former sand pit used for shooting practice from 1943 to 2004. The 2,000 m^2 shooting range was located near the Entry Precinct. Approximately 200 m^3 of contaminated soils and 5 m^3 of bullets and shell casings were recovered and sent for off-site disposal in 2010. While most of the impacted soils have been excavated, confirmatory samples and field measurements collected following remediation suggest the presence of lead levels slightly above Ontario guidelines at ground surface remain in a few small areas. Confirmatory characterization will be undertaken prior to closure.	Remediation Project Closeout	Land Re-use
Perch Lake Canopy Tower	The Perch Lake Canopy Tower Site, located on Garrison Petawawa property, was an instrumented experimental site used between the early 1960s and the late 1980s to collect environmental data. All research equipment was removed and no evidence of contamination was identified during cleanup work in 2003.	Land Re-use (area is no longer on the CRL site)	N/A
Snow Dump #2	The gravel-based Snow Dump #2 has been in operation since the early 2000's. Ideally snow disposal sites should have a low permeability base such as pavement to protect groundwater according to the CRL	Operations	Operations

REDACTED

Area of Potential Environmental Concern	Description/Highlights	Current ER Status (December 2022)	Plan Forward (expected status in 5 years)
	Snow Management Plan. Characterization has not occurred to verify the status, therefore such surficial and groundwater contamination is possible.		
Twin Lakes Tracer Test Site	The Twin Lakes Tracer Site was established in 1982 as a location where studies of the dispersion of contaminants in a groundwater flow system occurred under natural gradient conditions. Radiological contamination was not detected an end-state report was completed suggesting the land was suitable for unrestricted land use.	Land Re-use (as Twin Lakes Soil Management area)	N/A
Twin Lakes Soil Management Area	This area is used as a storage and processing area for materials generated by projects and routine operations on the CRL site. Within the pit material is processed and stockpiled in segregated piles allowing for reuse of the material around the CRL site which reduces the need for sourcing new materials when needed.	Operations	Operations
Bulk Storage Compound	The Bulk Storage Compound (BSC) was used for over 60 years to store redundant equipment, recyclable wastes and eventually contaminated materials. During confirmatory sampling in August 2021, a hot particle and soil elevated in radionuclide levels were removed as waste. This eastern half of the area is slated for reuse and will be re-evaluated at a later date. The western half is being reused as the **New Firing Range**. Any residual contamination on the west portion will be removed as part of the eventual closure of the firing range.	Land Re-use (as New Firing Range)	N/A
New Firing Range	Permanent turtle fencing has been installed surrounding the western arm of the former Bulk Storage Compound and it has been commissioned for use as the New Firing Range as of 2022 May.	Operations	Operations

REDACTED

Area of Potential Environmental Concern	Description/Highlights	Current ER Status (December 2022)	Plan Forward (expected status in 5 years)
Waste Analysis Facility ([redacted] series)	The Waste Analysis Facility (WAF) accepts clean solid waste generated or processed at CRL, verifies it is clean, and then sorts and segregates the waste prior to routing it through appropriate waste disposal paths. This waste includes trash/ bagged waste, metal for recycling, organics and concrete for re-use on site.	Operations	Operations
Miller's Road Landfill	The Millers Road Waste Disposal Site is presently leased by the Town of Deep River from Atomic Energy of Canada Limited (AECL) and has been the waste disposal site for the Municipality since approximately 1965. The landfilling of domestic waste ceased in July 2002. Since July 2002 areas within the 4.5 hectares landfilling area have received only clean (non-radioactive) construction and demolition waste. The attenuation zone for the landfill is on AECL land. A characterization will be required prior to future landfill closure. Beside the Miller's Road Landfill, an additional Area of Potential Environmental Concern includes an area known as "old dump" from the 1950s and other areas where unregulated dumping of trash may have occurred.	Operations	Operations
Labine Farm Landfill	Labine Farm Landfill was established prior to the Government of Canada expropriating land for CRL in 1944. Four separate investigations, a surface radiological survey, a non-intrusive geophysical study, an archeological study, and an intrusive characterising investigation all determined that, although there were bits of trash at surface, that the area was not used as a landfill.	Environmental Remediation Project Closeout	Land Re-use

REDACTED

Area of Potential Environmental Concern	Description/Highlights	Current ER Status (December 2022)	Plan Forward (expected status in 5 years)
	Confirmatory characterization may be required prior to closure.		
Salt Storage Facility ([redacted])	The Salt Storage Facility is a 30 m by 50 m enclosed storage building and houses snow removal equipment, sanding vehicles and stockpiles of road salt and gravel. This currently operating facility was commissioned in 2007 and is used to contain road salt prior to use on site roads to prevent the unwanted release of salt to the environment. The area surrounding the 0.8 hectares facility is used to store heavy equipment and serves as a laydown area for soil and gravel; it is surrounded by jersey barriers to prevent turtles from entering. The current facility will be demolished in 2023 and a new facility built on the same footprint.	Operations	Operations
Live Fire Training Facility ([redacted] series)	The live fire training facility was established in 2016 and remains operational. The facility consists of a total area of approximately 1.7 hectares which is graded and compacted with gravel. The graveled area is designed for firefighter training, staging areas for large scale exercises (integrated response) and for future development of training simulators. The installation of a new trailer complex in this area housing waste characterization labs is currently in progress with occupancy expected in 2023.	Operations	Operations

REDACTED

A.5 Management Unit 5

There are no buildings or structures in MU 5

Table A-10: Areas of Potential Environmental Concern within MU 5

Area of Potential Environmental Concern	Description/Highlights	Current ER Status (December 2022)	Plan Forward (expected status in 5 years)
Ottawa River Sediment	Above-background levels of radiological and non-radiological (primarily mercury) substances have been detected in Ottawa River bottom sediment as a result of historical discharges from the CRL Process Sewer system. The area is approximately 400 m long and 200 m wide in water 8 to 30 m deep, and is contained within the top 15 cm of riverbed sediment. The active particles identified can be linked to the period of operation of the NRX reactor (1947-1992). Risk assessment confirms a low risk to the public and negligible and declining risk to Ottawa River biota from this historical sediment contamination. The management goal is to maintain low and acceptable risk to human health and the environment under a Monitored Natural Attenuation approach. The results of an ongoing sediment verification monitoring program [103], have shown that the critical assumptions remain valid and river sediment deposition is further burying the contaminated sediments under clean more recent sediments while allowing radiological contaminants to decay [104], [105]. This monitoring initiative will continue to be conducted every five years or more frequently should any activities take place that could significantly alter the physical stability of the riverbed or in the case of releases to the river [103].	Execute Remedial Action (Monitored Natural Attenuation)	Execute Remedial Action (Monitored Natural Attenuation)

REDACTED

A.6 Management Unit 6

Table A-11: Status of Buildings/Structures within MU 6

Building #	Name / Description	Current D&D Status (December 2022)	Plan Forward (expected status in five years)
[redacted]	Former Disposal Area Valve House	Decommissioning/ Building Removal	Decommissioning/ Building Removal
[redacted]	Groundwater Chemical Pit Pump house	Operations	Operations
[redacted]	Groundwater Collection/ Treatment Area	Operations	Operations
[redacted]	Storage Of Equipment and Chemicals	Operations	Operations

Table A-12: Areas of Potential Environmental Concern within MU 6

Area of Potential Environmental Concern	Description/Highlights	Current ER Status (December 2022)	Plan Forward (expected status in 5 years)
WMA A	WMA A, is an in-ground radioactive waste storage facility located directly south of Plant Road. The first emplacement of radioactive waste at CRL took place in 1946 into what is now referred to as WMA A. These emplacements took the form of direct disposal of solids and liquids to excavated trenches into the sand overburden. The scale of operations was modest until 1952 when the cleanup from the NRX accident generated large quantities of radioactive waste that had to be quickly and safely managed. At this time, approximately 4,500 m^3 of aqueous waste containing mixed fission products was poured into excavated trenches. This was followed by smaller dispersals in 1954 and 1955 respectively. Approximately 20,000 m^3 of buried waste, primarily radioactive, known to include contaminated soil, contaminated equipment and parts, fuel rod ends, special burials and general refuse were disposed of at WMA A in trenches excavated in sand or in discrete burials located in the east and north portions of the site. Additional characterization is planned for 2023-24.	Environmental Site Assessment	Environmental Site Assessment

REDACTED

Area of Potential Environmental Concern	Description/Highlights	Current ER Status (December 2022)	Plan Forward (expected status in 5 years)
WMA A Plume toward South Swamp	Groundwater contamination was detected downgradient from WMA A in South Swamp in 1955. The plume is currently characterized by the presence of ^{90}Sr, ^{90}Y (gross beta) and few incidences of ^{241}Am and ^{137}Cs. The levels observed are significantly above drinking water quality guidelines. This plume is monitored under the CRL GWMP (updates are provided in the *Annual Compliance Monitoring Report: Environmental Monitoring in 2020 at CRL;* e.g., [106]), and is mitigated by the **South Swamp Permeable Reactive Barrier**.	APEC Identified and Monitored	APEC Identified and Monitored
South Swamp Permeable Reactive Barrier	A permeable reactive barrier was installed in 2013 downgradient from WMA A to intercept the ^{90}Sr plume and treat the groundwater to remove contamination as it travels toward South Swamp. Performance updates are provided in the *Annual Compliance Monitoring Report: Environmental Monitoring in 2020 at CRL* (e.g., [106]).	Operations	Operations
Laundry Pit (part of the Liquid Dispersal Area)	The Laundry Pit received liquid wastes with various amounts of radioactivity from the Laundry and Decontamination Centre from 1955 to 1958. Additional characterization was completed in 2021 and using risk-based soil screening criteria, it is estimated that approximately 100-150 m^3 of contaminated soils will require remediation.	Environmental Site Assessment	Environmental Site Assessment
Chemical Pit (part of the Liquid Dispersal Area)	The Chemical Pit was established in 1956 to receive radioactive aqueous wastes from active laboratories (other than the reactors). The excavations in sand were backfilled with cobbles to prevent surface ponding. The liquid wastes (acids, alkalis, etc.) were delivered to the pit through the LDA pipeline receiving on average 18,000 m^3 annually. Much of the remaining inventory of contaminants of	Environmental Site Assessment	Environmental Site Assessment

REDACTED

Area of Potential Environmental Concern	Description/Highlights	Current ER Status (December 2022)	Plan Forward (expected status in 5 years)
	concern (with the exception of Tritium) remains in or immediately below the Chemical Pit. Additional characterization is planned for 2023-24.		
Chemical Pit Plume toward East Swamp	The Chemical pit is located in sand, and by the design of the time, the wastewaters infiltrated and impacted the underlying aquifer with ^{90}Sr. This plume is monitored under the CRL GWMP (updates are provided in the *Annual Compliance Monitoring Report: Environmental Monitoring in 2020 at CRL* (e.g., [106])), and is mitigated by the **Chemical Pit Pump and Treat System**.	APEC Identified and Monitored	APEC Identified and Monitored
Chemical Pit Pump and Treat System	This pilot-scale groundwater treatment system has been operating since 1993 to intercept and treat the ^{90}Sr plume originating from the Chemical Pit before it reaches East Swamp. Performance updates are provided in the *Annual Compliance Monitoring Report: Environmental Monitoring in 2020 at CRL* (e.g., [106]).	Operations	Operations
Reactor Pit 1 (part of the Liquid Dispersal Area)	Reactor Pit 1 (RP1) was a natural depression used between 1953 and 1958 to receive radioactive wastewater (demineralized and contained only radionuclides) from the NRX rod bays. A 1.8 m thick clean sand layer was placed over RP1's contaminated soils in 1958 but liquid dispersals and solid waste burials continued afterwards. In the mid-1970s RP1 was used for the disposal of contaminated metallic wastes, rock, till and sand from the Controlled Area forming a 2 m high mound above grade. Additional characterization is planned for 2022-23.	Environmental Site Assessment	Environmental Site Assessment
Reactor Pit 1 Plume toward Reactor Pit 2, Frog Pond and	A ^{90}Sr plume is moving downgradient from RP1, south toward RP2 as well as south-west toward Frog Pond and then on to WMA A. The Frog Pond is the only surface water body that	APEC Identified and Monitored	APEC Identified and Monitored

REDACTED

Area of Potential Environmental Concern	Description/Highlights	Current ER Status (December 2022)	Plan Forward (expected status in 5 years)
WMA A	is exclusively affected by contaminants released from RP1. This plume is monitored under the CRL GWMP and updates are provided in the *Annual Compliance Monitoring Report: Environmental Monitoring in 2020 at CRL* (e.g., [106]).		
Reactor Pit 2 (part of the Liquid Dispersal Area)	Reactor Pit 2 (RP2), located directly south of RP1, was used to receive active liquid wastes from building [redacted]. It operated from 1956 to 1972. Asbestos cement baffles were installed at right angles in the pit to increase the length of time required for the liquids to flow through the cobble fill (and therefore allow for more radioactive decay to occur). Additional characterization is planned for 2023-24.	Environmental Site Assessment	Environmental Site Assessment
Reactor Pit 2 Plume toward Perch Lake Swamp, East Swamp, and South Swamp	A ^{90}Sr and tritium plume is moving downgradient from RP2, south toward Perch Lake Swamp as well as south-east and west toward East Swamp and South Swamp, respectively. This plume is monitored under the CRL GWMP and updates are provided in the *Annual Compliance Monitoring Report: Environmental Monitoring in 2020 at CRL* (e.g., [106]).	APEC Identified and Monitored	APEC Identified and Monitored
Perch Lake and Upper Perch Creek	The Perch Lake Basin, which drains 18% of CRL site, contains many of the CRL's operating WMAs and those with early vintage waste storage practices, including **WMA A** and the **Liquid Dispersal Area**. Surface water passing through Perch Lake and upper Perch Creek is, therefore, affected by radiological and non-radiological contamination due to the groundwater plumes in MU 6. Surface water from Perch Lake and upper Perch Creek is monitored under the CRL Environmental Monitoring Program and updates are provided in the *Annual*	APEC Identified and Monitored	APEC Identified and Monitored

REDACTED

Area of Potential Environmental Concern	Description/Highlights	Current ER Status (December 2022)	Plan Forward (expected status in 5 years)
	Compliance Monitoring Report: Environmental Monitoring in 2020 at CRL (e.g., [106]).		
Glass Blocks Experimental Sites	Experiments were conducted at two locations near Perch Lake beginning in 1958 to examine leaching rates of two sets of 25 vitrified glass blocks, 12 cm by 10 cm, containing mixed fission products placed below the water table. Groundwater samples were collected to determine how much activity was released from the glass, which species were retained by the soil and how the activity in groundwater changed with time. The blocks were removed in 2006 along with soil within 1 m of the blocks. Residual contamination was observed near the location of the sieve that was used as part of the block removal. Confirmatory characterization will be undertaken prior to closure.	Execute Remedial Action	Environmental Remediation Project Closeout / Land Re-Use
Frog Pond	Frog Pond is a receiving surface water body, 40 m downgradient from Reactor Pit 1.	APEC Identified and Monitored	APEC Identified and Monitored
O'Nest Tracer Site	The O'Nest Tracer Site is located approximately 400-m north of Perch Lake and was used in the 1970s for research on contaminant transport in groundwater using short-lived radionuclides (less than 65 days). The site was abandoned when the ^{90}Sr plume from WMA A reached the site and later decommissioned and remediated. Confirmatory characterization will be undertaken prior to closure.	Environmental Remediation Project Closeout	Land Re-use
Former [redacted] Evaporator Tower	The [redacted] Evaporator Tower was removed from the Controlled Area in 1960. The evaporator was used to concentrate wastes from uranium recovery equipment. The tower was removed in two sections and buried in a trench after it was flattened and covered with sand. Characterization will be completed in	Environmental Site Assessment	Environmental Site Assessment

REDACTED

Area of Potential Environmental Concern	Description/Highlights	Current ER Status (December 2022)	Plan Forward (expected status in 5 years)
	2022 to determine the precise location of the [redacted] tower as it is not currently known.		

REDACTED

A.7 Management Unit 7

Table A-13: Status of Buildings/Structures within MU 7

Building #	Name / Description	Current D&D Status (December 2022)	Plan Forward (expected status in 5 years)
[redacted]	National Research Universal (NRU) Stack monitoring	Operations	SWS/C&M
[redacted]	Technical and Administrative Offices, Glassblowing Laboratory	Operations	Operations
[redacted]	Legacy Neutron & Solid State Physics	Land Re-Use (Available for re-use/vacant)	Land Re-Use
[redacted]	Multi-Use Facility : Industrial Hygiene Laboratory, Molten Fuel Moderator Test Facility, Large Scale Containment Facility, Emergency Response Central, Hydrogen Isotopes Technology Laboratory	Operations	Operations
[redacted]	Gas Cylinders Storage (near Building [redacted])	Operations	Operations
[redacted]	Pipeline Only	Decommissioning/ Building Removal	Interim End State - SWS
[redacted]	Main Exhaust Stack NRU & NRX	Operations	Interim End State - SWS
[redacted]	NRU 48" Underground Duct	Operations	SWS / C&M
[redacted]	Bay Water Tank Array OR “Tritiated Light Water Storage Facility”	Operations	Operations
[redacted]	Harriet Brooks Building : Laboratories and Offices	Operations	Operations
[redacted]	Advanced Nuclear Material Research Centre (ANMRC)	Design	Construction/Commissioning
[redacted]	Security Monitor/Reception & HR	Land Re-Use (occupied by [redacted])	N/A
[redacted]	Transportation Building	Land Re-Use (Available for re-use/vacant)	Land Re-Use (Available for re-use/vacant)
[redacted]	Commercial Operation	Land Re-Use (Available for re-use/vacant)	Land Re-Use (Available for re-use/vacant)
[redacted]	Animal Building	Land Re-Use (Available for re-use/vacant)	Land Re-Use (Available for re-use/vacant)
[redacted]	Radiation Laboratory	Land Re-Use (Available for re-use/vacant)	Land Re-Use (Available for re-use/vacant)

REDACTED

Building #	Name / Description	Current D&D Status (December 2022)	Plan Forward (expected status in 5 years)
[redacted]	Green House	Land Re-Use (Available for re-use/vacant)	Land Re-Use (Available for re-use/vacant)
[redacted]	Environmental Sampling Equipment	End-State Verification Activities	Land Re-Use (Available for re-use/vacant)
[redacted]	Solvent Storage	Land Re-Use (Available for re-use/vacant)	Land Re-Use (Available for re-use/vacant)
[redacted]	Vehicle Maintenance Shop	Land Re-Use (occupied by [redacted])	N/A
[redacted]	Fire Department Services Building	Land Re-Use (occupied by [redacted])	N/A
[redacted]	Fire Truck/Equip Storage	Land Re-Use (Proximal to [redacted])	N/A
[redacted]	Lead Burning Shop	Land Re-Use (Proximal to [redacted])	N/A
[redacted]	Elec/Inst/Pipe Fitting/ AC Shop	Land Re-Use (to be occupied by [redacted])	N/A
[redacted]	Glass Blowing Shop	Land Re-Use (to be occupied by [redacted])	N/A
[redacted]	Operations	Land Re-Use (to be occupied by [redacted])	N/A
[redacted]	Former Miscellaneous Storage	Land Re-Use (Available for re-use/vacant)	Land Re-Use (Available for re-use/vacant)
[redacted]	Mach/Weld/Sheet Metal Shop/Admin	Decommissioning/ Building Removal	Land Re-use (Available for re-use/vacant)
[redacted]	Carpentry And Paint Shop; Sawdust Collection Hopper; Lumber And Wood Waste Storage	End State Verification Activities	Land Re-use (Available for re-use/vacant)
[redacted]	Carpenter Shop Storage	Land Re-Use (Available for re-use/vacant)	Land Re-use (Available for re-use/vacant)
[redacted]	Carpenter Shop Storage	Land Re-Use (Available for re-use/vacant)	Land Re-use (Available for re-use/vacant)
[redacted]	Chemical Storage	Land Re-Use (Available for re-use/vacant)	Land Re-use (Available for re-use/vacant)

REDACTED

Building #	Name / Description	Current D&D Status (December 2022)	Plan Forward (expected status in 5 years)
[redacted]	Surplus Metal/Underground Pipe Storage (Aggregate Storage)	Land Re-Use (occupied by [redacted] – currently under D&D)	Land Re-use (Available for re-use/vacant)
[redacted]	Lubricant/Scaffolding Storage	Land Re-Use (Available for re-use/vacant)	Land Re-use (Available for re-use/vacant)
[redacted]	Pipefitting/Chemical Storage	Land Re-Use (Available for re-use/vacant)	Land Re-use (Available for re-use/vacant)
[redacted]	Sewage Pump House	SWS / C&M	End-State Verification Activities
[redacted]	Library/Central Records/Auditorium	End-State Complete	Land Re-use (Available for re-use/vacant)
[redacted]	Tank For Sewage Treatment Plant	End-State Verification Activities	Land Re-use (Available for re-use/vacant)
[redacted]	Imhoff Tank/Sanitary Waste Water	End-State - Verification Activities	End-State - Verification Activities
[redacted]	Chlorination Building	End-State - Verification Activities	Land Re-use (Available for re-use/vacant)
[redacted]	Manhole 4d-4 For Sewage	End-State - Verification Activities	N/A
[redacted]	Manhole 4d-4/Sanitary Sewage	Operations	Operations
[redacted]	Sewer Sampler Enclosure	End-State - Verification Activities	Land Re-use (Available for re-use/vacant)
[redacted]	Caustic Building/Sewage Treatment	End-State - Verification Activities	Land Re-use (Available for re-use/vacant)
[redacted]	Guard House	Operations	Operations
[redacted]	Vehicle Entrance/Exit	Land Re-Use (occupied by [redacted])	N/A
[redacted]	Vehicle Search Tent	Operations	Operations
[redacted]	Quality Assurance (Org. Development & Training)-South	Land Re-Use (occupied by [redacted])	N/A
[redacted]	Engineering Technical Labs, Machine Shops, Offices	Operations	Operations
[redacted]	Records/ Resource Al. - Central	Land Re-Use (occupied by [redacted])	N/A

REDACTED

Building #	Name / Description	Current D&D Status (December 2022)	Plan Forward (expected status in 5 years)
[redacted]	Procurement Offices/Photography (2nd Floor); Central Store Warehouse/Offices (1st Floor)	Decommissioning/ Building Removal	End-State Complete / - Land Re-Use
[redacted]	National Research Council Tech Lab	Land Re-Use (to be occupied by [redacted])	N/A
[redacted]	Vehicle Entrance/Exit	Operations	Operations
[redacted]	Vehicle Search Tent	Operations	Operations
[redacted]	Former Bioassay Labs And Offices	Land Re-Use (occupied by [redacted])	Land Re-Use (Available for re-use/vacant)
[redacted]	Office Trailer	Removed from site, Land Re-Use	Land Re-Use (Available for re-use/vacant)
[redacted]	Former Salt Storage	Land Re-Use (Available for re-use/vacant)	Land Re-Use (Available for re-use/vacant)
[redacted]	Heavy Equipment Maintenance / Storage	Land Re-Use (occupied by [redacted])	N/A
[redacted]	Storage ZEEP Components / QA / Misc. (Reactor Tooling Storage)	Land Re-Use (occupied by [redacted])	N/A
[redacted]	PCB Storage	Land Re-Use (Available for re-use/vacant)	Land Re-Use (Available for re-use/vacant)
[redacted]	E-Waste Storage Container	Land Re-Use (Available for re-use/vacant)	Land Re-Use (Available for re-use/vacant)
[redacted]	MMIR Quonset Storage (Construction Storage)	Land Re-Use (Available for re-use/vacant)	Land Re-Use (Available for re-use/vacant)
[redacted]	6' Concrete Culvert	Operations	Operations
[redacted]	Site Cafeteria, Occupational Health and Safety, First Aid	Operations	Operations
[redacted]	Metal Finishing Shop	Land Re-Use (Available for re-use/vacant)	Land Re-Use (Available for re-use/vacant)
[redacted]	Comp Labs/Servers/Offices/Printserv	Operations	End-State Complete / Land Re-Use
[redacted]	Fire Protection Head Tank	Operations	Operations
[redacted]	Radiological/Environmental/Dosimetry Laboratories and Offices	Operations	Operations
[redacted]	Irradiation Facility	Operations	Operations

REDACTED

Building #	Name / Description	Current D&D Status (December 2022)	Plan Forward (expected status in 5 years)
[redacted]	Hydrogeological Laboratory	Land Re-Use (Available for re-use/vacant)	Land Re-Use (Available for re-use/vacant)
[redacted]	Hydrogeological Offices	Land Re-Use (Available for re-use/vacant)	Land Re-Use (Available for re-use/vacant)
[redacted]	Environmental Research Office & Library	Land Re-Use (Available for re-use/vacant)	Land Re-Use (Available for re-use/vacant)
[redacted]	Env. Protection Authority (Trailer)	End-State – Complete	Land Re-Use (Available for re-use/vacant)
[redacted]	Biosphere Modelling	Land Re-Use (Available for re-use/vacant)	Land Re-Use (Available for re-use/vacant)
[redacted]	Storage Ultrasonic/Eddy Current Test	Land Re-Use (Available for re-use/vacant)	Land Re-Use (Available for re-use/vacant)
[redacted]	Storage Ultrasonic/Eddy Current Test	Land Re-Use (Available for re-use/vacant)	Land Re-Use (Available for re-use/vacant)
[redacted]	Storage Auxiliary Auto Parts	Land Re-Use (Available for re-use/vacant)	Land Re-Use (Available for re-use/vacant)
[redacted]	Storage – Misc. Bulk	Land Re-Use (occupied by [redacted])	N/A
[redacted]	Biology Research Facility, Animal and Animal Tissue-Based Research Facility	Operations	Operations
[redacted]	Storage Shed For Reinforcing Steel (Fabrication Building)	Land Re-Use (Available for re-use/vacant)	Land Re-Use (Available for re-use/vacant)
[redacted]	Electrical Line Crew Truck/Equip & Welding Shop	Land Re-Use (Site selected for ANMRC facility [redacted])	N/A
[redacted]	Storage Building	Land Re-Use (Site selected for ANMRC facility [redacted])	N/A
[redacted]	Storm Sewer Sampling Station	Operations	Operations
[redacted]	Storage Misc. Bulk Supplies / Gas Cylinders	Land Re-Use (occupied by [redacted])	N/A

REDACTED

Building #	Name / Description	Current D&D Status (December 2022)	Plan Forward (expected status in 5 years)
[redacted]	Environmental Bldg's	End-State Verification Activities	Land Re-Use (Available for re-use/vacant)
[redacted]	Environmental Bldg's	End-State Complete	Land Re-Use (Available for re-use/vacant)
[redacted]	Environmental Bldg's	End-State Complete	Land Re-Use (Available for re-use/vacant)
[redacted]	Practical Training Facility (Former Visitor Information Centre)	Operations	Operations
[redacted]	Liquid Nitrogen Flash Dry Ice Storage	Land Re-Use (Available for re-use/vacant)	N/A
[redacted]	Carport	Land Re-Use (Available for re-use/vacant)	Land Re-Use (Available for re-use/vacant)
[redacted]	Electrical Equipment Storage	Land Re-Use (Available for re-use/vacant)	Land Re-Use (Available for re-use/vacant)
[redacted]	Crane Storage Building	Land Re-Use (Available for re-use/vacant)	Land Re-Use (Available for re-use/vacant)
[redacted]	Drop/Impact Testing Facility	Land Re-Use (occupied by [redacted])	N/A
[redacted]	Fire Test Facility	Land Re-Use (Available for re-use/vacant)	Land Re-Use (Available for re-use/vacant)
[redacted]	Auxiliary Impact / Fire Test Facility	Land Re-Use (Available for re-use/vacant)	Land Re-Use (Available for re-use/vacant)
[redacted]	DROP/IMPACT TESTING FACILITY Trailer	Land Re-Use (Available for re-use/vacant)	Land Re-Use (Available for re-use/vacant)
[redacted]	Sanitary Waste Water Treatment	End-State Verification Activities	End-State –Complete or Land Re-Use (Available for re-use/vacant)
[redacted]	Change Room Asbestos Shop	Land Re-Use (Site selected for ANMRC facility [redacted])	N/A

REDACTED

Building #	Name / Description	Current D&D Status (December 2022)	Plan Forward (expected status in 5 years)
[redacted]	Flammable Gas Cylinder Storage	Land Re-Use (occupied by [redacted])	N/A
[redacted]	Mixed Waste Process/Handling Area	Land Re-Use (occupied by [redacted])	N/A
[redacted]	Hazardous Waste Storage	Land Re-Use (occupied by [redacted])	N/A
[redacted]	Waste Processing Storage	Land Re-Use (occupied by [redacted])	N/A
[redacted]	Waste Processing Storage	Land Re-Use (occupied by [redacted])	N/A
[redacted]	Offices and Non-Nuclear Laboratories	Operations	Operations
[redacted]	Entrance Building, Offices, Security And Fire	Operations	Operations
[redacted]	Science Collaboration Centre	Construction/ Commissioning	Operations
[redacted]	North Office Trailer	Land Re-Use (site selected for ANMRC facility [redacted])	N/A
[redacted]	South Office Trailer	Land Re-Use (site selected for ANMRC facility [redacted])	N/A
[redacted]	Office Trailer For Facility Decommissioning Field Staff	Operations	Removed from site / Land Re-Use
[redacted]	Office Trailer For Facility Decommissioning Field Staff	Operations	Removed from site / Land Re-Use
[redacted]	Office Trailer For Facility Decommissioning Field Staff	Operations	Removed from site / Land Re-Use
[redacted]	Office Trailer For Facility Decommissioning Field Staff	Operations	Removed from site / Land Re-Use
[redacted]	Facilities Decommissioning Office Trailer	Operations	Removed from site / Land Re-Use
[redacted]	Facilities Decommissioning Office Trailer	Operations	Operations
[redacted]	Operations Office Trailer Complex	Operations	Operations
[redacted]	Facility Decommissioning Office Trailer	Operations	Operations
[redacted]	FD Office Trailer (two storey)	Operations	Removed from site / Land Re-Use
[redacted]	Support Facility	Operations	Operations
[redacted]	Fox Hut (Carpenter Storage)	Land Re-Use (Available for re-use/vacant)	N/A
[redacted]	Above Ground Fueling Station	Operations	Operations
[redacted]	Sanitary Sewage Treatment Facility (SSTF)	Operations	Operations

REDACTED

Building #	Name / Description	Current D&D Status (December 2022)	Plan Forward (expected status in 5 years)
[redacted]	Raw Sewage Pump Station Wet Well (New Sanitary Sewage Treatment Facility	Operations	Operations
[redacted]	Raw Sewage Pump Station Valve Chamber (New Sanitary Sewage Treatment Facility)	Operations	Operations
[redacted]	Hauled Liquid Waste Receiving Tank (New Sanitary Sewage Treatment Facility)	Operations	Operations
[redacted]	Power Generator Station (New Sanitary Sewage Treatment Facility)	Operations	Operations
[redacted]	Fuel Storage Tank (New Sanitary Sewage Treatment Facility)	Operations	Operations

Table A-14: Areas of Potential Environmental Concern within MU 7

Area of Potential Environmental Concern	Description/Highlights	Current ER Status (December 2022)	Plan Forward (expected status in 5 years)
Inner Supervised Area	The inner SA is occupied by non-nuclear facilities, office buildings, radioisotope laboratories, and industrial facilities. The Site Utility Revitalization Plan has upgraded some site utilities with plans to upgrade those outstanding. Several buildings have been demolished in the SA over the past several years and lands, including utility corridors, were subject to environmental characterization in preparation for reuse. No characterization has taken place so far in MU 7 to evaluate for potential impacts from accelerants of fire-fighting foams (e.g., per- and polyfluoroalkyl substances (PFAS)) that may have historically been used for fire training.	Environmental Site Assessment	Environmental Site Assessment
Dawson City	Dawson City is the original worker camp used during the construction of the CRL site. Built in the early 1940s and operated until 1957. Today, only a few of the old concrete foundations, some underground infrastructure piping, and a small amount of trash remain below grade.	Environmental Site Assessment	Environmental Site Assessment

REDACTED

Area of Potential Environmental Concern	Description/Highlights	Current ER Status (December 2022)	Plan Forward (expected status in 5 years)
	Environmental characterization activities have identified only minor exceedances of applicable industrial land use screening criteria and did not identify elevated radionuclide activity. Portions of the APEC may be affected by the Operational Sanitary Landfill Groundwater Plume.		
Foundation Road Landfill	Was used as an industrial waste dump that operated from 1946 until 1960. Metallic waste, asbestos containing material, coal ash, demolition debris, and blast rock are present. Characterization efforts have determined that all material in the metal-waste knoll area are potentially radiologically contaminated including sand blasting material used on the thermal shield prior to its burial. Concentrations of PCBs and Dioxin and Furans exceed hazardous waste limits in some samples. Further characterization has taken place in the southern portion of the landfill in 2022 to determine if this area would be suitable for a parking lot extension. The entire Foundation Road Landfill may be broken down into sub-areas to allow for site redevelopment projects.	Environmental Site Assessment	Land Re-use (partial)
Inactive Landfill Sandpit	The Inactive Landfill Sandpit is a flat area previously used as a sand borrow pit that lies below the high-tension power line adjacent to the Foundation Road Landfill and across from Snow Dump #1. The disposal of demolition and construction wastes suggests that asbestos containing materials may be present along with other potential contaminants. Further characterization is currently occurring as part of potential site revitalization projects.	Environmental Site Assessment	Environmental Site Assessment

REDACTED

Area of Potential Environmental Concern	Description/Highlights	Current ER Status (December 2022)	Plan Forward (expected status in 5 years)
Legacy Concrete Area	Legacy concrete, with an unconfirmed source of origin, is located across from the Upper Inactive Landfill and immediately west of the Sanitary Landfill. About 40% of the exposed concrete pieces at this site showed evidence of fixed beta/gamma contamination; gamma spectrometry on several pieces linked this to ^{137}Cs.	APEC Identified and Monitored	APEC Identified and Monitored
Electrical Yard Landfill	Historically used as a non-radioactive landfill which operated from 1960 to 1972. Characterization has indicated that some of the waste within this landfill is hazardous waste.	Environmental Site Assessment / Risk Assessment	Environmental Site Assessment / Risk Assessment
Upper Inactive Landfill	The materials buried in the Upper Inactive Landfill consists of waste from the Power House Building. It is characterized by very loose black ash, cinders, and clinker, indicating that the bulk of the material is waste from the CRL Power House. Radiological analysis indicated that concentration were not elevated above background.	APEC Identified and Monitored	APEC Identified and Monitored
Snow Dump #1	Snow dump #1 was used for several years until concern was raised about road salt entering the adjacent stream with snow melted runoff. When snow dumping was discontinued, it evolved into an overflow parking area and in 2013 it was formally converted, as well as paved, and is now Parking Lot A. Environmental Characterization for non-radiological contamination has not been conducted at the site. This is included in the area proposed for the siting of a Small Modular Reactor at CRL. Coal ash has been observed in portions of the Parking Lot A extension.	Environmental Site Assessment	Land Re-use

REDACTED

Area of Potential Environmental Concern	Description/Highlights	Current ER Status (December 2022)	Plan Forward (expected status in 5 years)
LDA Pipeline Route	The LDA Pipeline route is 1.5 km long and was comprised of two buried, separate 4-inch pipes: the Reactor Drain and the Chemical Active Drain. The majority of the LDA pipeline itself has been removed and the majority of the route is now in the post-remedial verification stage. Soil remediation on the hillside near [redacted] and on the south side of Plant Road where the pipeline crossed the road is still required. The **O-3 wetland** was contaminated due to a pipeline leak and will need to be assessed for potential cleanup.	Environmental Site Assessment	Environmental Site Assessment
NRX Emergency Pipeline Route	The 1.8 km above ground pipeline route was constructed in 1952 to disperse a large quantity of contaminated waste water after the NRX accident. The Pipeline was removed in 1961 and obviously contaminated soil was removed. Complete environmental characterization has not been performed across the entire route.	Environmental Site Assessment	Environmental Site Assessment
Ventilation Stack Duct Route	Constructed in 1957 for the ventilation stack for NRX, operations were shut down in 1992 and the stack was removed in 2013. The sub surface structures (footings) remain and will require investigation.	Environmental Site Assessment	Environmental Site Assessment
Sanitary Landfill	The Sanitary Landfill is operational and has been used since 1963 for the disposal of non-radioactive garbage from the cafeteria and offices, nonhazardous solid wastes construction waste, building rubble and uncontaminated soil and rock Based upon current practices, the expected remaining operating life of the sanitary landfill is approximately 7 to 10 years. The only radioactive substance detected above normal background levels near the Sanitary	Operations	Operations

REDACTED

Area of Potential Environmental Concern	Description/Highlights	Current ER Status (December 2022)	Plan Forward (expected status in 5 years)
	Landfill is tritium, and is below the drinking water screening limit of 7,000 Bq/L. Sampling of groundwater for non-radiological compounds has not been completed. It has not been determined whether elevated electric conductivity readings in groundwater are associated with a plume originating from the Sanitary Landfill or from the use of road salt in the area.		
Tritiated Light Water Storage Facility ([redacted])	This tank farm for the storage of tritiated light water removed from the NRU rod bays was constructed in 2012 the northwest corner of the Dawson City site. The facility consists of seven, horizontal double walled above ground storage tanks each supported on a concrete platform. The concrete pad is bermed and protected with an epoxy liner. The pad is designed to collect any spill or runoff in a catch basin located in the centre of the pad. Six of the tanks are filled with a total volume of 1.07 million litres of water, the remaining tank serves as a spare. Monitoring data indicates that there have been no leaks from these tanks to date.	Operations	Operations

REDACTED

A.8 Management Unit 8

Table A-14: Status of Buildings/Structures within MU 8

Building #	Name / Description	Current D&D Status (December 2022)	Plan Forward (expected status in 5 years)
[redacted]	Bulk Material Landfill Sprung Structure	Operations	Operations
[redacted]	Environmental Storage Building [redacted]	Operations	Operations
[redacted]	Environmental Storage Building [redacted]	Operations	Operations

Table A-15: Areas of Potential Environmental Concern within MU 8

Area of Potential Environmental Concern	Description/Highlights	Current ER Status (December 2022)	Plan Forward (expected status in 5 years)
WMA C	WMA C is currently a long-term waste storage facility which operated between 1963 and 2006. Unlined trenches and pits were excavated for the disposal of low-level radioactive solid and liquid wastes from CRL and from off-site sources such as labs, universities, and hospitals. An extension to WMA C was added toward the southeast in 1993. No characterization of the wastes has been completed due to the highly heterogeneous nature of the materials. Mixed waste containing both radiological and chemical/biological hazardous materials have been disposed of at WMA C. More than 1,550 m^3 of hazardous wastes were also disposed of in the trenches and in special pits, in particular chlorinated solvents, hazardous metals and waste reactor coolant. An impermeable geomembrane cover was installed over WMA C in 2013 and has been an effective improvement, indicated by decreasing tritium trends in contaminant migration since 2015.	Operations	Operations
WMA C Plume toward Duke Swamp and Bulk Storage Swamp	A tritium plume originating at WMA C divides and extends to the west to Duke Swamp and another to the south to Bulk Storage Swamp. Downgradient tritium levels have decreased significantly following the installation of an impermeable geomembrane cover over the entire WMA C area in 2013. This plume is monitored under the CRL GWMP (updates are provided in the *Annual Compliance Monitoring Report: Environmental Monitoring in 2020 at CRL* (e.g., [106])), and is mitigated by an impermeable geomembrane cover [116].	APEC Identified and Monitored	APEC Identified and Monitored

REDACTED

Area of Potential Environmental Concern	Description/Highlights	Current ER Status (December 2022)	Plan Forward (expected status in 5 years)
WMA J (Bulk Material Landfill)	WMA J was established south of WMA C in 2010. The Bulk Material Landfill is an operational facility for the long-term management of dewatered sewage sludge from the CRL Sanitary Treatment Plant for the next 100 years. A Sprung structure ([redacted]) is installed over WMA J to reduce the infiltration of precipitation. Leachate collected from the landfill is transported to and treated at the CRL Sanitary Sewage Treatment Facility ([redacted]).	Operations	Operations

REDACTED

A.9 Management Unit 9

Table A-16: Status of Buildings/Structures within MU 9

Building #	Name / Description	Current D&D Status (December 2022)	Plan Forward (expected status in five years)
[redacted]	Monitoring equipment for 7 tanks in Waste Tank Farm	Operations	Operations
[redacted]	Site Office	Operations	Operations
[redacted]	[redacted] Whole Body Monitoring Building	Construction/ Commissioning	Operations
[redacted]	Tank Farm Weather Enclosure	Construction/ Commissioning	Operations
[redacted]	Legacy Waste Processing Intermodal	Construction/ Commissioning	Operations

Table A-17: Areas of Potential Environmental Concern within MU 9

Area of Potential Environmental Concern	Description/Highlights	Current ER Status (December 2022)	Plan Forward (expected status in 5 years)
WMA E	WMA E received waste from 1976 up to approximately 1984. The buried material includes concrete, asphalt, soil and rock and other construction waste some of which are visible along the side slopes of the waste management area and will need to be removed and properly buried. Several environmental characterizations have been completed at WMA E. There are isolated pockets of radiologically contaminated asphalt, other solid wastes and soil still present at the site. Two soil samples exceeded applicable screening criteria for metals.	Operations/ Environmental Site Assessment	Operations
Waste [redacted] Farm	This WMA accepted liquid wastes from 1961 to 1987 and contains seven underground stainless steel storage tanks for radioactive waste solutions and sludge. As part of the Stored Liquid Waste Project waste recovery operations are on-going at the Tank Farm to mitigate the risk of contaminant leakage. All legacy radioactive liquid waste has been removed from the direct-buried single-walled	Operations	Operations

REDACTED

Area of Potential Environmental Concern	Description/Highlights	Current ER Status (December 2022)	Plan Forward (expected status in 5 years)
	storage tanks at Building [redacted] and has been processed through the Waste Treatment Centre.		
Lysimeter Research Facility	An underground installation used to study the release of radioactivity from waste packages and the movement of radionuclides through different buffer/backfill materials from 1989 to 1995. The area was remediated in 2003. Confirmatory characterization will be undertaken prior to closure.	Execute Remedial Action	Environmental Remediation Project Closeout / Land Re-use

REDACTED

A.10 Management Unit 10

There are no buildings or structures in MU 10

Table A-18: Areas of Potential Environmental Concern within MU 10

Area of Potential Environmental Concern	Description/Highlights	Current ER Status (December 2022)	Plan Forward (expected status in 5 years)
WMA F	Between 1976 and 1979, WMA F received contaminated soils, rubble and slag from four off-site Ontario facilities. The Port Hope wastes represent up to 80% of the materials at WMA F and consist of excavated soils from residential and commercial properties and low concentration wastes from the Eldorado refinery. Wastes containing niobium from two Ottawa facilities (Albion and Rideau Roads) (approximately 20% of volume) and soils contaminated with radium from Mono Mills (< 1% of volume) have also been buried at WMA F. Significant contaminants known to be in WMA F waste include radionuclides (including long-lived radionuclides); ^{226}Ra, ^{230}Th, ^{232}Th, ^{234}U, ^{235}U, and ^{238}U; arsenic and copper. No groundwater contamination has been detected at WMA F [78].	Remedial Planning	Remedial Planning
Wash Pad Area	This is the area where the trucks were washed after unloading wastes into WMA F. Surface soil (46 m^3), concrete pads and buried pipe were excavated in 2018 but residual contamination is still present.	Remedial Planning	Remedial Planning

A.11 Management Unit 11

Table A-19: Status of Buildings/Structures within MU 11

Building #	Name / Description	Current D&D Status (December 2022)	Plan Forward (expected status in 5 years)
[redacted]	Pump House (from Nitrate Plant operation)	Decommissioning / Building Removal	Decommissioning/ Building Removal

REDACTED

Table A-20: Areas of Potential Environmental Concern within MU 11

Area of Potential Environmental Concern	Description/Highlights	Current ER Status (December 2022)	Plan Forward (expected status in 5 years)
Nitrate Plant	Operated between 1953 and 1954 to process waste ammonium nitrate solutions. Four buildings were buried in situ when operations ceased. Process condensate and other radioactive liquids were discharged to an infiltration pit excavated next to the buildings. Additional characterization is planned to begin in 2022/23. Rusty and leaky drums containing radium paint wastes were found in a portion of the Nitrate Plant and locally impacted surface soils.	Environmental Site Assessment	Environmental Site Assessment
Nitrate Plant Plume toward Duke Swamp	The disposal of waste liquids in the infiltration pit resulted in the development of a groundwater plume with elevated ^{90}Sr concentrations which has been monitored since 1955. This plume has been migrating through the surficial aquifer toward Duke Swamp southwest of the area. This plume is monitored under the CRL GWMP (updates are provided in the *Annual Compliance Monitoring Report: Environmental Monitoring in 2020 at CRL* (e.g., [106])), and is mitigated by the **Wall and Curtain Permeable Reactive Barrier**.	APEC Identified and Monitored	APEC Identified and Monitored
Wall and Curtain Permeable Reactive Barrier	CNL continues to manage and operate the Wall and Curtain Permeable Reactive Barrier (PRB). The system retains ^{90}Sr that would otherwise discharge into Duke Swamp from the Nitrate Plant groundwater plume. Updates are provided in the *Annual Compliance Monitoring Report: Environmental Monitoring in 2020 at CRL* (e.g., [106]).	Operations	Operations
Thorium Pit	A small dispersal pit used to dispose neutralized waste solutions from thorium fuel cycle experiments between 1955 and the 1960s. The pit was filled with lime and covered with soil. Additional characterization is planned to begin in 2022/23.	Environmental Site Assessment	Environmental Site Assessment

REDACTED

Area of Potential Environmental Concern	Description/Highlights	Current ER Status (December 2022)	Plan Forward (expected status in 5 years)
Thorium Pit Plume toward Duke Swamp	A ^{90}Sr groundwater plume extends to Duke Swamp, while other, less mobile radionuclides have not migrated outside of the immediate area around the pit. ^{90}Sr and ^{241}Am in groundwater exceed the Health Canada Drinking Water Quality Guidelines. Vegetation in Duke Swamp has taken up the ^{90}Sr contamination from Thorium Pit. This plume is monitored under the CRL GWMP and updates are provided in the *Annual Compliance Monitoring Report: Environmental Monitoring in 2020 at CRL* (e.g., [106]).	APEC Identified and Monitored	APEC Identified and Monitored
Acid-Chemical-Solvent (ACS) Pits	Three pits where acids, chemicals and solvents were disposed of from 1982 to 1987, some in packages. A fourth pit for pyrophoric wastes is also believed to be present but no information exists about its operation. Additional characterization is planned to begin in 2023.	Environmental Site Assessment	Environmental Site Assessment

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Appendix B Cross-Check with REGDOC-2.11.2 and CSA N294-19 Requirements

Table B-1: Cross-Check of ODCP with REGDOC-2.11.2 and CSA N294-19 Requirements

Sections of Clause 6.1.1 in REGDOC-2.11.2 and Annex A of CSA N294-19 (both nearly the same)	ODCP Section
a) a description of the location of the facility, including	3 Site Location and Physical Setting
a) i) a map of the facility and its specifications;	Figure 1, Figure 3 and Figure 4
a) ii) geographic information;	3 Site Location and Physical Setting
a) iii) details regarding the surrounding environment;	3.3 Topography and Hydrology
a) iv) land uses; and	3.2 Land Use
a) v) illustrations and maps of the facility in relation to the municipality;	Figure 1
b) purpose and description of the facility, including	4.1 Chalk River Laboratories' Strategic Priorities & 4.3 Site Layout
b) i) primary components and systems;	4.3.1 Controlled, Supervised and Outer Areas
b) ii) building type and construction, including location of any hazardous building materials (e.g., asbestos, PCBs);	4.3.2 Buildings, Facilities, and Support Functions (Active/Operational), 4.5 Principal Hazardous Conditions
b) iii) building services (e.g., power, heating, ventilation, sewer, water, fire protection);	10.13 Existing Site Infrastructure
b) iv) laboratories and other hazardous handling areas;	4.4 Nature and Extent of Contamination, 9 The Cleanup Strategy & Appendix A
b) v) type, quantity, and form of radioactive and hazardous materials stored, produced, or used during operation; and	4.5.1 Radiological Hazards and 4.5.4 Chemical Hazards
b) vi) design features used to reduce the spread of contamination and facilitate decontamination and dismantling;	4.7 Design Features to Reduce Contamination and Facilitate Cleanup
c) post-operational conditions, including c) i) a summary of the shutdown process, including planned removal of stored inventories of hazardous or radioactive materials;	8.2 Preliminary Site Cleanup Goals, 9.1.2 Potential Next land Uses 9.2.1 Shutdown Process
c) ii) the predicted nature and extent of contamination remaining in the primary systems and components (in list or table format with reference to applicable illustrations);	These are developed as part of facility specific DDPs and are too detailed to appear in an overview such as the ODCP. For cleanup high-level information is

REDACTED

Sections of Clause 6.1.1 in REGDOC-2.11.2 and Annex A of CSA N294-19 (both nearly the same)	**ODCP Section**
	provided for each Area of Potential Environmental Concern in Appendix A.
c) iii) the predicted nature and extent of contamination on floors, walls, work surfaces, ventilation systems, etc.;	These are developed as part of facility specific DDPs and are too detailed to appear in an overview such as the ODCP.
c) iv) the identification of any separate planning envelopes; and	14.1 Cost Estimate
c) v) an overview of the principal hazardous conditions anticipated to exist;	4.5 Principal Hazardous Conditions
c) d) the decommissioning strategy, including	9.2 Decommissioning Strategy, 9.3 Environmental Remediation Strategy
d) i) the final end-state objective;	9.1.3 & 9.3.1 Interim End-States and Final End-State Agreement, Risk-based Soil Screening and Cleanup Criteria
d) ii) rationale for d) ii) 1) the decommissioning strategy selected;	9.2 Decommissioning Strategy
d) ii)2) interim end-states;	9.1.3 Interim End-States and Final End-State Agreement
d) ii) 3) periods of SWS; and	9.2.3 Deferred Decommissioning and Storage with Surveillance
d) ii) 4) in situ decommissioning concepts;	9.2.4 In situ Decommissioning
d) iii) the requirements for long-term institutional controls; and	12 Long-term Stewardship
d) iv) the assessment of alternative strategies (or a rationale for why alternatives do not exist or do not warrant consideration);	9.3.4 Alternative Cleanup Approaches
e) a plan of the decommissioning work, including	9.1 Cleanup Function, 9.2 Decommissioning Strategy/PDP/DDP
e) i) a work breakdown structure;	9.1 Cleanup Function Strategy, 9.2 Decommissioning Strategy /PDP/DDP
e) ii) a summary of the main steps for decontamination/disassembly/removal of each of the systems (preferably grouped into work packages);	9.1 Cleanup Function and 9.2 Decommissioning Strategy/PDP/DDP

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Sections of Clause 6.1.1 in REGDOC-2.11.2 and Annex A of CSA N294-19 (both nearly the same)	**ODCP Section**
e) iii) for each work package, identification of those types of activities that could pose a significant hazard to workers, the public, or the environment;	9.2 Decommissioning Strategy/PDP/DDP
e) iv) the role of existing operational standard procedures for radiation protection, hazardous	9.2 Decommissioning Strategy/PDP/DDP
materials handling, industrial safety, and environmental protection in managing hazards;	9.2 Decommissioning Strategy/PDP/DDP
e) v) specific activities for which additional protection/mitigation procedures will be required at the detailed planning stage;	PDP/DDP
e) vi) a summary of the final dismantlement of the structures; and	10 Current Assessment Status by Management Unit; Appendix A Detailed Informed for each Management Unit on the Status of Buildings Structures, and Areas of Potential Environmental Concern, as applicable
e) vii) a conceptual schedule showing the approximate year of facility shutdown and the approximate sequencing and duration of the decommissioning work packages and, where relevant, storage periods;	13 Conceptual Schedule
f) radiological monitoring and survey commitments, including	8.3.1 Radiation Protection, 7.5 Integrated Environmental Monitoring
f) i) a program for conducting periodic contamination surveys and the recording of contamination events during facility operation;	7.5 Integrated Environmental Monitoring, 7.6 Incident Tracking
f) ii) a commitment to conduct detailed post-operation surveys in support of DDP development; and	9.3.3 Monitored Natural Attenuation
f) iii) a commitment to develop plans and protocols acceptable to the AHJ at the detailed planning stage for monitoring	7.5 Integrated Environmental Monitoring
f) 1) work hazards during decommissioning;	4.5 Principal Hazardous Conditions
f) 2) personnel dosimetry;	4.6 Work Hazard Monitoring and Worker Protection Precautions
f) 3) environmental emissions and effluents; and	7.5.1 Monitoring for Potential Off-site Impacts

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Sections of Clause 6.1.1 in REGDOC-2.11.2 and Annex A of CSA N294-19 (both nearly the same)	**ODCP Section**
f) 4) materials, sites, and structures to be cleared from regulatory control;	10 Current Assessment Status by Management Unit; Appendix A Detailed Informed for each Management Unit on the Status of Buildings Structures, and Areas of Potential Environmental Concern, as applicable
g) a waste management strategy specifying	9.7 Waste Management Strategy
g) i) the approximate quantities and characteristics of radioactive and chemically hazardous wastes expected to arise from the decommissioning (tied to specific work packages, if possible);	9.7.1 Waste Inventory and Waste Forecast, Appendix A, for decommissioning refer to specific PDPs/DDPs (not included in ODCP)
g) ii) the anticipated final disposition of radioactive and chemically hazardous materials; and	9.7.2 Waste Strategies by Classification, Table 6: CRL Waste Classifications and Baseline Waste Strategies
g) iii) a commitment to segregate as much material as possible for reuse and recycling;	9.7 Waste Management Strategy
h) a commitment to prepare a DDP for regulatory approval prior to dismantling and demolition;	9.1 Cleanup Function, 9.2 Decommissioning Strategy & Figure 7
h) i) a commitment to periodically review and update the PDP until a DDP is prepared, in accordance with Clause 6.2.2;	9.1 Cleanup Function, 9.2 Decommissioning Strategy & Figure 7
j) the physical state of the facility at j) i) the end of operations; and	10 Current Assessment Status by Management Unit and Appendix A
j) ii) the start of decommissioning;	10 Current Assessment Status by Management Unit and Appendix A
k) the records required for decommissioning, including a description of the facility operational	15 Record Retention
records that will be maintained to periodically update the PDP and prepare the DDP(s);	15 Record Retention
l) a public engagement plan, including a public information program and avenues for public participation;	6 Consultation and Engagement with First Nations, Metis and the Public

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Sections of Clause 6.1.1 in REGDOC-2.11.2 and Annex A of CSA N294-19 (both nearly the same)	**ODCP Section**
m) an engagement plan with First Nations as per the requirements and guidance of CNSC REGDOC-3.2.2; and	6.1 Engagement with First Nations and Metis Communities
n) the cost and a financial guarantee, specifying*	14.1 Cost Estimate
n) i) an estimate of the total present-value cost of the decommissioning;	14.1 Cost Estimate
n) ii) a reasonable basis for how cost estimates were derived; and	14.1.2 Change Management & 14.1.4 Remedial Action Cost Engineering Requirements Model
n) iii) a description of how the required funds will be provided;	14.2 Funding Source
Notes: *As per REGDOC-2.11.2, the conservative cost estimate of decommissioning and a financial guarantee, as described in REGDOC-3.3.1 [109].	

Table B-2: Cross-Check between the ODCP and 2018 CPDP with CSA N294-19

Section	**ODCP - Section Title**	**CPDP 2018**	**N294 -19**
	Executive Summary	Executive Summary	
1	Overview Decommissioning and Cleanup Plan		√
1.1	Introduction	1	√
1.2	Purpose		√
1.3	Scope	1	√
1.4	Acronyms and Terminology		
2	Changes Since Last Revision of the Comprehensive Preliminary Decommissioning Plan	2	√
3	Site Location and Physical Setting	4.1.1	√
3.1	Surrounding Communities	4.1.2	√
3.2	Land Use	4.1.3	√
3.3	Topography and Hydrology	4.1.4	√
3.4	Wildlife and Habitats	4.1.5	√
3.5	Geology	4.1.6	√
3.6	Climate	4.1.7	√
4	Site Missions and Background for Cleanup Planning		√
4.1	Chalk River Laboratories' Strategic Priorities	2.1	√
4.2	Operating History	4.2	√

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Section	ODCP - Section Title	CPDP 2018	N294 -19
4.3	Site Layout	4.5	√
4.3.1	Controlled, Supervised, and Outer Areas	4.5.1, 4.5.2,4.5.3	√
4.3.2	Buildings, Facilities, and Support Functions (active/operational)	Appendix A / 4.5.3	√
4.3.3	Waste Management Areas and Affected Lands	4.5.4	√
4.3.4	Management Units	7.1.2 Table B-1	√
4.3.5	Site Master Plan and Future Developments		√
4.3.5.1	Infrastructure and Utility Network	4.4.2, Table A-5	√
4.4	Nature and Extent of Contamination	Table B-1	√
4.5	Principal Hazardous Conditions	5	√
4.5.1	Radiological Hazards	5.2	√
4.5.2	Nuclear Criticality Control	5.3	√
4.5.3	Industrial Hazards	5.4	√
4.5.4	Chemical Hazards	5.5	√
4.6	Work Hazard Monitoring and Worker Protection Precautions	5.6	√
4.7	Design Features to Reduce Contamination And Facilitate Cleanup		√
5	Applicable Programs and Standards		
5.1	Regulatory Framework		√
5.2	CNL/AECL Policies and Commitments		√
5.3	Management Systems		√
5.3.1	Support Programs	5.7	√
5.3.2	Compliance		√
6	Consultation and Engagement with First Nations, Metis and the Public		√
6.1	Public Information Program		√
6.2	Engagement Objectives		√
6.3	Engagement with First Nations and Metis Communities		√
6.4	Dissemination of Information to the Public		√
6.5	CRL Community Advisory Panel		√
6.6	Environmental Stewardship Council at CRL		√
6.7	Key Public Engagement on CRL Cleanup Planning to Date		√
6.8	Planned Future Public Engagement		√
7	Environmental Protection Program	6.1	√
7.1	Environmental Reviews	6.1	√
7.2	The Natural Environment	6.1	√

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Section	ODCP - Section Title	CPDP 2018	N294 -19
7.2.1	Species at Risk		DDP
7.2.2	Sustainable Forest Management Plan		
7.2.3	Vegetation Control		
7.3	Sustainability Plans and Outcomes		
7.4	CRL Site-Wide Environmental Risk Assessment (ERA)		√
7.5	Integrated Environmental Monitoring Program		√
7.5.1	Monitoring for Potential Off-Site Impacts		√
7.6	Incident Tracking		√
8	Cleanup Vision, Mission, Goals ,Objectives and Principles		√
8.1	Cleanup Vision and Mission		
8.2	Preliminary Site Cleanup Goals		√
8.3	Recommended Dose/Concentration Cleanup Objectives		√
8.3.1	Radiation Protection		
8.4	Cleanup Planning Principles		√
9	The Cleanup Strategy		
9.1	Cleanup Function		
9.1.1	Facilities and Capabilities Required to Enable Cleanup	7.1.1 partial	√
9.1.2	Potential Next Land Uses at CRL		√
9.1.3	Interim End-States and Final End-State Agreement		√
9.2	Decommissioning Strategy	7.1.1	√
9.2.1	Shutdown Process		√
9.2.2	Requirements for Prompt Decommissioning	7.1.1 partial	√
9.2.3	Deferred Decommissioning and Storage with Surveillance	7.1.1	√
9.2.4	In Situ Decommissioning		√
9.3	Environmental Remediation Strategy	7.1.2	√
9.3.1	Risk-based Soil Screening and Cleanup Criteria		√
9.3.2	In Situ Decommissioning		
9.3.3	Monitored Natural Attenuation		√
9.3.4	Alternative Cleanup Approach		√
9.4	End-State Requirements	3	√
9.5	Cleanup Planning Assumptions		
9.6	Prioritization Tool		
9.7	Waste Management Strategy	7.1.3	√

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Section	ODCP - Section Title	CPDP 2018	N294 -19
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9.7.2	Waste Strategies by Classification	7.1.4	√
9.7.3	Key Enabling Waste Facilities / Capabilities		√
9.8	Constraints and Limitations		√
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10.3	Management Unit 3		*
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Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

Radiation Levels and Limits

900-508740-STD-019

Revision 0.2

Information Use

Approved by:	Marc Jones	2025/01/29
	Manager, Corporate Radiation P	Date

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1. Scope and Applicability

This document applies to all work conducted under a licence issued by the Canadian Nuclear Safety Commission (CNSC) to Canadian Nuclear Laboratories (CNL) [1]. Radiation exposures that are not caused by activities licenced by the CNSC (e.g. air travel) are explicitly excluded. However, doses of radiation received from x-rays or other man-made sources of radiation [2], when present at a CNL site, are included in these limits.

This document defines the radiological limits and levels to which the Radiation Protection (RP) Program operates at CNL. Primarily this includes the:

- Legal limits dose received by and committed to humans;
- The establishment of action levels as defined by the regulations; and
- The permissible levels of contamination present in the work place or when released.

The following limits and levels are not included in this document:

- Establishment and use of dose control points [3].
- The limits for radiation or contamination found in radiological areas and zones [4].
- Environmental protection action levels [5]..

2. Purpose

The purpose of this document is to standardize the levels of radionuclide contamination and levels of radiation exposure permitted under CNL's Radiation Protection Program.

3. Pre-Requisites

Historical data is normally required in determining if action levels are appropriate and accurate.

Measurements are required to determine if levels or limits have been reached.

4. Definitions and Acronyms

This document relies primarily on word meaning as found in common dictionaries. The current *Glossary of Controlled Terms and Acronyms* [6] contains specific meanings for those words that require further clarification.

4.1 Definitions

ALARA	An optimization process aimed to reduce consequences as low as reasonably achievable, taking economic and social factors into account.
Annual Limit on Intake	The activity, in becquerel, of a radionuclide that will deliver an effective dose of 20 mSv during the 50-year period after the radionuclide is taken into the body of a person 18 years old or older

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	or during the period beginning at intake and ending at age 70 after it is taken into the body of a person less than 18 years old.
Balance of the Pregnancy	The period from the moment CNL is informed, in writing, of the pregnancy to the end of the pregnancy.
Contamination	Nuclear substances on surfaces, or within solids, liquids, or gases (including the human body), where their presence is unintended or undesirable.
Critical Level	A measurement with a 95% confidence to be indistinguishable from background.
Decontamination	Action taken to remove radionuclides from clothing and the external surfaces of the body, from rooms, building surfaces, equipment, and other items.
Derived Air Concentration	The concentration of a radionuclide in air that, when inhaled at a breathing rate of 1.1 m^3 per hour for 2,000 hours per year, results in the intake of 1 Annual Limit on Intake.
Detectable	A level of radiation at or above the critical level with a given system of detection.
Five-year Dosimetry Period	The period of five calendar years beginning on 2001 January 1, and every period of five calendar years after that period.
Fixed Contamination	Contamination other than non-fixed contamination.
Low Toxicity Alpha Emitters	Natural uranium, depleted uranium, natural thorium, uranium-235, uranium-238, thorium-232, thorium-228, and thorium-230 when contained in ores, or in physical and chemical concentrates; or alpha emitters with a half-life of less than ten (10) days.
Non-Fixed Contamination	Contamination that can be removed from a surface during routine conditions.
One-year Dosimetry Period	The period of one calendar year beginning each January 1 but may be extended or reduced up to two weeks so that the end of the dosimetry period coincides with the end of a dosimeter-wearing period or a bioassay-sampling period.
Personal Clothing	Clothing that is not owned, leased, or otherwise possessed by CNL.

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Radon Progeny	The following radioactive decay products of radon-222: polonium-218; lead-214; bismuth-214; polonium-214; lead-210; bismuth-210; and polonium-210, and the following radioactive decay products of radon-220: polonium-216; lead-212; bismuth-212; and polonium-212.
Release	To remove from a licensed activity without another licensee taking possession.
Skin Contamination	Any radioactive contamination on the skin, hair, or other surface of the human body.
Sum of Quotients Rule	The rule that determines a limit if more than one nuclide is present by dividing the total activity by the corresponding sum of quotients obtained by dividing the activity (or activity concentration) of each radioactive nuclear substance by its corresponding applicable limit. If L is the overall limit, A is the total activity (or activity concentration), and i denotes the components of those factors: $$L = A \div \sum_i \frac{A_i}{L_i}$$
Uniformly Distributed	The distribution of radioactive nuclear substances is considered uniform within a material if the maximum concentration does not exceed ten (10) times the average concentration [8].

4.2 Acronyms

ALI	Annual Limit on Intake
CNL	Canadian Nuclear Laboratories
CNSC	Canadian Nuclear Safety Commission
DAC	Derived Air Concentration
DROL	Designated Representative of the Licensee
LSA	Low Specific Activity
MDA	Minimum Detectable Activity
NEW	Nuclear Energy Worker
NORM	Naturally Occurring Radioactive Material
RP	Radiation Protection

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SCO Surface Contaminated Object

5. Roles and Responsibilities

5.1 Designated Representative of the Licensee

The Designated Representative of the Licensee (DROL) may be either the Facility DROL, the Functional Support Manager of the RP Program, or some other DROL. The DROL is responsible for communicating with the CNSC as specified in the regulations or the licence.

5.2 Radiation Protection Functional Support Manager

In this procedure the Radiation Protection Functional Support Manager is responsible for:

- Acting as the DROL in this procedure when no other DROL applies.
- Acting as the DROL for the change of action levels.
- Ensuring requirements in subsection 6(2) of the *Radiation Protection Regulations* are followed when an action level is reached.
- Confirming this procedure is uniformly and accurately applied across CNL.
- Notify worker and the Commission of any dose limit exceedance and the corresponding dose received within the required period in accordance with *Radiation Protection Regulations* [2].
- Authorize the return to work (after being removed for exceeding a dose limit) under specific conditions to protect the health and safety of the worker [2].

5.3 Line Manager

The line manager is the manager responsible for either the person or material for which a limit or level applies, as the case may be. The line manager is responsible for:

- Ensuring that no worker exceeds the dose limits set out in this standard.
- Removing exposed workers from radiation work until the Radiation Protection Program Manager can confirm radiation dose is accurately determined.
- Complete all required actions for any action level exceedance.
- Implementing corrective actions to prevent reoccurrence of an action level exceedance.

5.4 Dosimetry Services

Almost every exceedance where dose is the parameter will be first discovered by the dosimetry service. They are responsible for:

- Notifying the RP program manager and RP functional support manager.

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- Calculating any dose consequences.

5.5 Group 1 Employees

5.5.1 Radiation Protection Program Manager

Group 1 Radiation Protection Program Managers, in respect of their assigned area, are responsible for:

- Communicating any action level exceedance to line management and the area health physicist;
- Reviewing and approving work where an action level may be exceeded if it can be demonstrated that the dose expected to be received by, or committed to, workers is as low as reasonably achievable, taking into account social and economic factors;
- Advising the Radiation Protection Functional Support Manager with regard to the actions taken to restore the radiation protection program after an exceedance;
- Performing reviews of the action levels and documenting this review;
- Approving action levels; and
- Obtaining concurrence from the Radiation Protection Functional Support Manager that effectiveness of the radiation protection program is restored when an action level is reached.

5.5.2 Health Physicists

Group 1 Health Physicists are responsible for:

- Releasing radioactive or contaminated items as per §6.3.1; and
- Approving work without respiratory protection where the air concentration exceeds 1 derived air concentration (DAC) after an as low as reasonably achievable (ALARA) assessment.

5.5.3 Radiation Surveyor

Group 1 Radiation Surveyors are responsible for:

- Releasing items contaminated with radon progeny unless the radon progeny is formed as part of a licensed activity.

5.6 Workers

Workers are responsible for submitting required in vitro bioassay or arriving for scheduled in vivo bioassay appointments.

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6. Standards

6.1 Regulatory Dose Limits

CNL is required to comply with the Radiation Protection Regulations that specify limits on radiation dose. Certain limits apply to different groups, at different times, and to different parts of the body. When skin is unevenly irradiated, the equivalent dose received by the skin is the average equivalent dose over the 1 cm2 area that received the highest equivalent dose [2].

6.1.1 Members of the Public

Members of the public are those that are not nuclear energy workers (NEW) as defined in the *Nuclear Safety and Control Act*.

6.1.1.1 Effective Dose Limits

The effective dose limit for any person who is not a nuclear energy worker is 1 mSv in a calendar year [2].

6.1.1.2 Equivalent Dose Limits

The equivalent dose limits for any person who is not a nuclear energy worker are:

- 15 mSv to the lens of an eye in a calendar year;
- 50 mSv to the skin in a calendar year; and
- 50 mSv to the hands and feet in a calendar year [2].

6.1.2 Nuclear Energy Workers

A NEW is defined in the Nuclear Safety and Control Act as someone who is required, in the course of their business or occupation in connection with a nuclear substance or nuclear facility, to perform duties in such circumstances that there is a reasonable probability that they may receive a dose of radiation that is greater than 1 mSv per calendar year [2].

6.1.2.1 Effective Dose Limits

Nuclear energy workers that have not informed CNL, in writing, that they are pregnant have the following effective dose limits:

- 50 mSv in a one-year dosimetry period; and
- 100 mSv in a five-year dosimetry period [2].

A NEW that has informed CNL, in writing, they are pregnant has an effective dose limit of 4 mSv for the balance of the pregnancy [2].

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6.1.2.2 Equivalent Dose Limits

The equivalent dose limits for any person that is a nuclear energy worker are:

- 50 mSv to the lens of an eye in a one-year dosimetry period;
- 500 mSv to the skin in a one-year dosimetry period; and
- 500 mSv to the hands and feet in a one-year dosimetry period [2].

6.1.3 Emergency Dose Limits

The dose limits in sections 6.1.1 and 6.1.2 do not apply to a person participating in the control of a nuclear emergency [2]. CNL must not request that a pregnant woman participate in the control of a nuclear emergency [2]. The dose limits here may be exceeded by a person who acts voluntarily to save or protect human life [2].

6.1.3.1 Effective Dose Limits

If CNL requests a person to participate in the control of a nuclear emergency the effective dose limit is:

- 50 mSv if none of the following actions are taken;
- 100 mSv if actions are taken to minimize dose consequences, for members of the public, associated with the release of radioactive material;
- 500 mSv if actions are taken to prevent health effects of radiation that are fatal or life-threatening, or that result in permanent injury; or
- 500 mSv if actions are taken to prevent the development of conditions that could significantly affect people and the environment [2].

6.1.3.2 Equivalent Dose Limits

If CNL requests a person to participate in the control of a nuclear emergency the equivalent dose limit to skin is:

- 500 mSv if none of the following actions are taken;
- 1000 mSv if actions are taken to minimize dose consequences, for members of the public, associated with the release of radioactive material;
- 5000 mSv if actions are taken to prevent health effects of radiation that are fatal or life-threatening, or that result in permanent injury; or
- 5000 mSv if actions are taken to prevent the development of conditions that could significantly affect people and the environment [2].

6.2 Radiation Protection Action Levels

For greater clarity, dose from the following do not contribute to action levels:

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- Nuclear substances used as medication, including excreta.
- Actions taken for the control of a nuclear emergency.
- Activities or actions carried out at any site not controlled by CNL.
- Activities on a CNL site by a sub-contractor operating exclusively under their own CNSC licence.

"Action levels are designed to alert licensees before regulatory dose limits are reached" [9]. Because an "action level must provide a meaningful indicator over a defined period of time of the state of a radiation protection program" [9], the CNSC expects licensees to select and review action levels to ensure they still accurately represent what "may indicate a loss of control of part of a licensee's radiation protection program" [2].

Radiation protection action levels are documented in a controlled list [10] separate from this document.

6.2.1 Legacy Action Levels

CNL sites that have action levels that are already approved on the date this procedure comes into effect may keep them notwithstanding the methods described in this document. These action levels may stay in place as long as the CNSC accepts they are appropriate.

6.2.2 Action Level Creation

Every application for a licence from the CNSC must contain any proposed action levels [11]. As a licensee, CNL is expected to:

- 'Identify the measurable parameters that will indicate, directly or indirectly, whether the radiation protection program is adequately controlled' [9].
- 'On the basis of realistic assumptions, select appropriate action levels, expressed in terms of appropriate parameters, for all key processes and activities' [9].
- 'As operating experience accumulates, revise action levels accordingly as needed to ensure that they remain a meaningful indicator of a potential loss of control of the radiation protection program' [9].

A DROL may propose any action level that will be ultimately acceptable to the CNSC. The method described here should be appropriate in most circumstances.

Action levels are based on a parameters for key activities. Once a parameter is selected, the action level, *L*, will be generated using the data for that parameter, or measurand, in the following way:

$$L = (\mu + z\sigma) \times h$$

Where μ is the measurand mean, z is the standard score corresponding to the confidence interval chosen, σ is the population standard deviation, and h is a factor of which the action level is higher than the upper bound of normal operation [12].

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For normal or Gaussian data, $\mu = m$, the population mean and $\sigma = s$, the population standard deviation.

If the value of the parameter is estimated, x, the estimate is used as the mean, $\mu = x$, and the standard deviation would be the square root of the single-value estimate, $\sigma = \sqrt{x}$.

If the dataset is log-normal skewed, the following equation may be used instead [12]:

$$L = e^{(\mu + z\sigma)} \times h$$

Where: $\mu = \ln\left(m / \sqrt{1 + {s^2}/{m^2}}\right)$ and $\sigma = \sqrt{\ln\left(1 + {s^2}/{m^2}\right)}$

If an exact dataset cannot be obtained, e.g. prior to a licenced activity being performed, a similar or estimated dataset may be used.

Note that while both z and h are selected by the analyst the values across parameters should be consistent*, i.e.* almost always the same within a single licence. That said, action levels must demonstrate the radiation protection program is controlled.

6.2.3 Action Level Review and Revision

The review of action levels must occur at a frequency not less than every five years.

To revise any action level CNL must 'obtain an appropriate licensing action from the CNSC' [9]. Such an action can only be performed by the appropriate DROL.

6.2.4 Action Level Reached

As required by the regulations, when an action level is reached CNL must:

- conduct an investigation to establish the cause for reaching the action level;
- identify and take action to restore the effectiveness of the radiation protection program, if required; and
- notify the CNSC within the period specified in the licence [2].

For greater clarity, planned action level exceedances will be reported to the CNSC. An investigation will take place and corrective actions will be implemented (as necessary) as required by the regulations [2].

6.3 Contamination Levels

This standard does not include naturally occurring contamination at or below the levels found in the surrounding air, soil, and water. All contamination levels may be interpreted to be net of naturally occurring radioactive material once confirmed by a Group 1 Health Physicist.

Naturally occurring radon progeny is expected, and is not a contaminant. Unless the radon is formed as part of a licensed activity (e.g. fuel processing or research), items and personnel with

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detectable radon progeny may be released once the radioactivity is confirmed to be radon progeny by a Group 1 Radiation Surveyor.

For the purpose of direct monitoring of surfaces for total surface activity, the surface area of the detector must be used (unless it exceeds 100 cm^2) as the averaging surface area for comparison against total surface activity. For skin contamination, the total surface activity is assessed for the maximum level of radioactivity within any 1 cm^2 of skin for dose assessment purposes [2]. If a detector surface area (e.g. 170 cm^2) exceeds 100 cm^2 any averaging must be limited to 100 cm^2, not the actual surface area of the detector (e.g. 170 cm^2).

Contamination must not be averaged over an area greater than 300 cm^2 unless the total averaging area is 10,000 cm^2 or less and the maximum average activity in any 100 cm^2 section is less than three (3) times the values in Table 1.

In most situations, measurement of removable surface contamination is not necessary or appropriate to demonstrate compliance with this standard [13]. Therefore it is not necessary to use wiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual surface contamination levels are within the limits for removable contamination.

If removable contamination is sampled, the collection factor for any wipe or smear used for must be 10% unless determined experimentally [14].

The minimum detectable activity (MDA) of devices used to detect contamination must be no greater than clearance criterion using the nuclide with the lowest detection efficiency that may be present. “For any given system designed to count and quantify radioactivity, the MDA should be calculated for the most restrictive scenario (*i.e.* for the nuclide with the lowest detection efficiency and the most restrictive regulatory criterion)” [14].

La Prade contamination levels are per the licence for that site, see Appendix D. This section does not apply to the La Prade Licence.

196 Toronto Road site contamination levels are per the licence for that site [15], see licence basis document Environmental Laboratory Operating Procedure - Low-level Radioactive Waste Management Office [16]. This section does not apply to the Toronto Road Licence.

6.3.1 Release Contamination Levels

Transporting a package, low specific activity (LSA), or surface contaminated object (SCO) as defined in the regulations [17] to another licensee is not a release; the process *Off-Site Transportation of Dangerous Goods* [18] is followed instead.

The criterion for release of radioactive substances in a mass of one tonne or less from a CNL site is an effective dose of 10 µSv or equivalent skin dose of 50 mSv per year for any member of the public per release. This is consistent with the exemption quantities provided by the CNSC [19] developed by the European Commission [20].

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The criterion for clearance of radioactive substances in a mass of greater than one tonne from a CNL site is an effective dose of 10 µSv. In addition to applying realistic parameter values, low probability events have a criterion of effective dose of 1 mSv or equivalent skin dose of 50 mSv per year for any member of the public per release. This is consistent with the unconditional clearance levels provided by the CNSC [19] developed by the International Atomic Energy Agency [21].

A dose of 10 µSv per year corresponds to a trivial level of risk [21].

The Historic Waste Program in Port Hope maintains release levels per *Port Hope Area Initiative Radiation Protection Plan* [22]. These release levels for Port Hope Area Initiative do not contradict this section.

Whiteshell Laboratories maintains release levels per *Contamination Clearance Levels Used for WL Decommissioning* [23]. These release levels for Whiteshell Laboratories do not contradict this section.

6.3.1.1 Surface Contamination Levels

An SCO may be released by a Group 1 Health Physicist if the radiological contamination does not exceed the values in Table 1. The derivation of this table is explained in Appendix B.

Table 1: Surface Contamination Release Levels

Nuclide Type	**Total Contamination[1]**
Alpha emitters that are not low toxicity alpha emitters	0.4 Bq/cm^2
All other radionuclides	4 Bq/cm^2

Notwithstanding the values in Table 1, the non-fixed contamination on the external surfaces of any object must be kept as low as achievable.

There is no requirement to do a sum of quotients if both types of radionuclide are present.

These values are identical to the non-fixed contamination permitted on the external surfaces of any package or SCO-I as defined in the regulations [9].

6.3.1.2 Volumetric Contamination Levels

Deliberate dilution of material (as opposed to the dilution that takes place in normal operations when radioactivity is not a consideration) of contaminated material is strictly forbidden for clearance purposes. Dilution or other processing may be permitted if the final waste is decreased in volume.

[1] The surface contamination must not be averaged over an area greater than 300 cm^2

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6.3.1.2.1 Uniformly Contaminated Material in Excess of One Tonne

Uniformly distributed contamination in a mass in excess of one tonne[2] may be released by a Group 1 Health Physicist if the radiological contamination does not exceed the values in Appendix A. These values are the same as the unconditional clearance levels found in Schedule 2 of the *Nuclear Substances and Radiation Devices Regulations*.

If the nuclide is not found in Appendix A the limit for the nuclide is:

- 0.1 Bq/g if the nuclear substance has an atomic number greater than 81 and it or its progeny emits alpha radiation; or
- 1 Bq/g otherwise.

If more than one nuclide is present the sum of quotients rule applies.

6.3.1.2.2 Uniformly Contaminated Material of One Tonne or Less

Uniformly distributed contamination in a mass of one tonne[2] or less may be released by a Group 1 Health Physicist if the radiological contamination does not exceed the values in Appendix A. These values are the same as the exemption quantity for uniformly distributed material found in Schedule 1 of the *Nuclear Substances and Radiation Devices Regulations*.

Should uniformly contaminated material of one tonne[1] or less exceed the specific activity limits listed in Appendix A (listed in Bq/g) as uniformly contaminated material it still may be released if it does not exceed the non-uniformly contaminated material limits in Appendix A (listed in Bq).

If the nuclide is not found in Appendix A, the limit for the nuclide is:

- 1 Bq/g if the nuclear substance has an atomic number greater than 81 and it or its progeny emits alpha radiation; or
- 10 Bq/g otherwise.

If more than one nuclide is present the sum of quotients rule applies.

6.3.1.2.3 Non-Uniformly Contaminated Material

Contamination that is not uniformly distributed and is not an SCO (in bulk quantity or not) may be released by a Group 1 Health Physicist if the radiological contamination does not exceed the values in Appendix A. These values are the same as the exemption quantity for non-uniformly distributed material found in Schedule 1 of the *Nuclear Substances and Radiation Devices Regulations*.

If the nuclide is not found in Appendix A the limit for the nuclide is:

[2] The quantity of one tonne is valid for all circumstances other than for abandonment or disposal in which case it is one tonne per year per nuclear facility.

LIEN - SEE ATOM

- 1,000 Bq if the nuclear substance has an atomic number greater than 81 and it or its progeny emits alpha radiation; or
- 10,000 Bq otherwise.

If more than one nuclide is present the sum of quotients rule applies.

6.3.1.3 Personnel Contamination

No contaminated person shall be released from the site unless they are being sent for medical treatment if the levels of contamination (internal or surface) exceed the maximum levels allowed for non-uniform contaminated material, *cf.* §6.3.1.2.3 [17]. Personnel decontamination may be subject to a personal decision to cease decontamination and leave site. CNL cannot stop this, although the quantity of the substance [2] and dose [2] to the worker must both be ascertained and risk communicated.

Nuclear energy workers that are contaminated and further decontamination is contraindicated may be released by a Group 1 Health Physicist if the most exposed 1 cm^2 will not absorb greater than 50 mSv before the worker next returns to work.

Other workers (*i.e.* those that are not nuclear energy workers) must always be free of skin contamination when released. If a person that is not a NEW must be released (or leaves site) with skin contamination the Functional Support Manager must ensure that the dose and quantity of nuclear substance is estimated or ascertained prior to release [2].

6.3.1.4 Special Release

The group 1 radiation protection program manager may release radioactive substances and materials from a CNL site that is shown to cause less than an effective dose of 10 µSv per year. In addition to applying realistic parameter values, low probability events have a criterion of effective dose of 1 mSv or equivalent skin dose of 50 mSv per year for any member of the public per release.

6.3.2 Workplace Contamination Levels

This section does not apply to radiological zone limits outlined in *Radiological Areas and Zones* [4].

6.3.2.1 Personal Protective Equipment and Clothing

Non-fixed contamination must not be present on laundered personnel protective equipment and clothing. However, laundered personnel protective equipment and clothing may have fixed contamination up to the values in Table 1.

LIEN - SEE ATOM

6.3.2.2 Personnel and Personal Clothing

Skin and personal clothing and effects must be kept free of detectable (i.e. it exceeds the critical level) radiological contamination.

6.3.3 Airborne Contamination

Airborne contamination means radioactive solids or liquids suspended in, or radioactive gasses dissolved or mixed in, ambient atmosphere.

6.3.3.1 Respiratory Protective Equipment

Respiratory protective equipment must be worn if radioactive airborne contamination exceeds the derived air concentration (DAC). Exceptions must be justified based only on an ALARA assessment and be approved by a Group 1 Health Physicist.

Where the use of respiratory protective equipment may cause an increase in the total dose due to an extension of working time, the requirements for respiratory protective equipment may need to be modified to achieve ALARA [24]. In these situations an ALARA assessment must be conducted, and likewise approved by a Group 1 Health Physicist.

In environments contaminated with mixed fission products, respiratory protective equipment must be worn when the airborne contamination concentration exceeds the conservative default values in Table 2. The derivation of this table is found in Appendix C.

Table 2: **Default DAC for unknown airborne contamination**

Radioactive Contaminant	**Bq/m^3**
Mixture of fission product noble gases without alpha emitters or radioiodines present	1600
Mixture of long-lived radionuclides without alpha emitters or radioiodines present	500
Mixture of fission product noble gases and radioiodines are known to be present	100
Mixture of long-lived radionuclides with alpha emitters	0.65

6.3.3.2 Radon

No employee, other than a nuclear energy worker, can be exposed in the course of any year to a concentration of radon that on average, over the year, is higher than 800 Bq/m^3 [25].

LIEN SEE ATOM

6.3.4 Soil Contamination

Soil may be re-used according to the Table 3 for Chalk River Laboratories and Whiteshell Laboratories sites. For the purposes of soil re-use, the following apply to the radiological component of soil only, other contamination limits may apply determined by the Environmental Protection Program. Concrete, and asphalt may be categorized with the same table at the RP Program Manager's discretion.

Samples, or other monitoring, must be taken to confirm the radioactive nuclear substance is uniformly distributed. Averaging of contamination that is non-uniformly distributed must not exceed a mass of one (1) metric tonne.

Soil may be considered clean if the quantity of radioactive material is below a level found in Appendix A. If multiple nuclides are found, the sum of quotients rule applies.

NORM present in the soil does not contribute to the clearance criteria (unless associated with the production of nuclear energy). This may be determined by assessment of the uncontaminated surrounding soil.

Excavated soil may be placed back into the ground if the future exposure to the public will not exceed 0.3 mSv/a. This may be assumed to be 30 times the values found in Appendix A for uniform contamination of more than 1 tonne regardless of the material in question' mass.

The re-use of contaminated soil is prohibited within 2.5 meters of piping that contains, or may contain, a fluid (*i.e.* gas or liquid) that may be ingested or inhaled (*e.g.* water, breathing air). This is consistent with Ministry of Environment, Conservation, and Parks (Ontario) procedure F-6-1 [26].

This section does not apply to a soil use plan approved by CNSC staff.

Table 3: Soil Use Criteria

Group	Category	Criteria	Use
Inactive	Clean	Soil that is below a level found in Appendix A.	Unrestricted, on site. Offsite use still requires Health Physics approval.
	Potential	Soil with no detectable contamination on surface measurement.	Restricted to within a controlled area or contaminated lands.
Contaminated	Re-use	Detectable levels of contamination that are less than 30 times the level found in Appendix A.	Immediate re-use is permitted, the hole may be refilled with this soil.
	Waste	Detectable levels of contamination that are greater than 30 times the level found in Appendix A.	None, must be stored as waste.

LIEN SEE ATOM

7. Documented Information

Creation, Capture and Use of Information Assets [27] provides current information on the storage, preservation, turnover and retention requirements for records.

8. References

[1] *Nuclear Safety and Control Act*, S.C. 1997, c. 9, His Majesty in Right of Canada

[2] *Radiation Protection Regulations*, SOR/2000-203, His Majesty in Right of Canada

[3] *Dose Control Points,* 900-508740-MCP-007, 12614085

[4] *Radiological Areas and Zones,* 900-508740-MCP-027, 50931395

[5] *Administrative Levels and Action Levels for CRL Air and Liquid Radioactive Effluents,* 900-509200-STD-008, 51059932

[6] *Glossary of Controlled Terms and Acronyms*, https://cnllnc.sharepoint.com/sites/TermsandDefinitions

[7] *Regulations for the Safe Transport of Radioactive Material*, 2018 Edition, SSR-6 (Rev. 1), International Atomic Energy Agency

[8] *Guideline for the exemption or clearance from regulatory control of materials that contain, or potentially contain, nuclear substances*, N292.5-11 (R2021), CSA Group

[9] *Radiation Protection,* REGDOC-2.7.1, Canadian Nuclear Safety Commission

[10] *Radiation Protection Action Levels,* 900-508740-LST-002, 52638715

[11] *General Nuclear Safety and Control Regulations*, SOR/2000-202, His Majesty in Right of Canada

[12] *Establishing and implementing action levels for releases to the environment from nuclear facilities*, N288.8-17, CSA Group

[13] *Surface and Volume Radioactivity Standards for Clearance*, ANSI/HPS N13.12-2013, The Health Physics Society

[14] *Licence Application Guide: Nuclear Substances and Radiation Devices,* REGDOC-1.6.1, Canadian Nuclear Safety Commission

[15] *Nuclear Substance and Radiation Device Licence 15193-5-23.0,* Canadian Nuclear Safety Commission.

[16] *Environmental Laboratory Operating Procedure - Low-level Radioactive Waste Management Office,* LLRWMO-508760-OP-05002, 40903416

[17] *Packaging and Transport of Nuclear Substances Regulations, 2015*, SOR/2015-145, His Majesty in Right of Canada

[18] *Off-Site Transportation of Dangerous Goods,* 900-508520-STD-001, 47354663

[19] *Nuclear Substances and Radiation Devices Regulations*, SOR/2000-207, His Majesty in Right of Canada

LIEN - SEE ATOM

[20] *Principles and Methods for Establishing Concentrations and Quantities (Exemption Values) Below which Reporting is not Required in the European Directive,* Radiation Protection 65, Commission of the European Communities, 1993

[21] *Derivation of Activity Concentration Values for Exclusion, Exemption and Clearance*, Safety Reports Series 44, International Atomic Energy Agency, 2005

[22] *Port Hope Area Initiative Radiation Protection Plan,* 4500-508740-PLA-001,

[23] *Contamination Clearance Levels Used for WL Decommissioning*, WLD-508740-REPT-001, 17080622

[24] *ALARA,* 900-508740-STD-013, 42071926

[25] *Canada Occupational Health and Safety Regulations*, SOR/86-304, His Majesty in Right of Canada

[26] *Procedures to Govern Separation of Sewers and Watermains*, F-6-1, His Majesty in Right of Ontario

[27] *Creation, Capture and Use of Information Assets,* 900-511300-STD-003, 50746207.

[28] *Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material,* 2012 Edition, SSG-26, International Atomic Energy Agency

[29] *Monitoring of Radioactive Contamination on Surfaces*, Technical Report Series 120, International Atomic Energy Agency

[30] *Reassessment of the Technical Bases for Estimating Source Terms,* NUREG-0956, U.S. Nuclear Regulatory Commission

[31] *Nuclear Substance and Radiation Device Licence 15193-4-26.1,* Canadian Nuclear safety Commission

LIEN - SEE ATOM

Appendix A Contamination Limits for Release

The following table states the maximum quantity released for items that are not an SCO.

Nuclide		Uniformly Contaminated Material of More than One Tonne[3, 4] Bq/g	Uniformly Contaminated Material of One Tonne[2] or Less[5] Bq/g	Non-Uniformly Contaminated Material Irrespective of Mass[4, 6] Bq
Actinium 227		1	0.1	1000
Actinium 228		1	10	1000000
Americium 241		0.1	1	10000
Americium 242		1000	1000	1000000
Americium 242m	d	0.1	1	10000
Americium 243	d	0.1	1	1000
Antimony 122		10	100	10000
Antimony 124		1	10	1000000
Antimony 125		0.1	100	1000000
Argon 37		1	1000000	100000000
Argon 41		1	100	1000000000
Arsenic 73		1000	1000	10000000
Arsenic 74		10	10	1000000
Arsenic 76		10	100	100000
Arsenic 77		1000	1000	1000000
Astatine 211		1000	1000	10000000
Barium 131		10	100	1000000
Barium 133		1	100	1000000
Barium 140	d	1	10	100000
Berkelium 249		100	1000	1000000
Beryllium 7		10	1000	10000000
Bismuth 206		1	10	100000
Bismuth 207		0.1	10	1000000
Bismuth 210		0.1	1000	1000000
Bismuth 212		0.1	10	100000
Bromine 82		1	10	1000000
Cadmium 107		1	1000	10000000

[3] To be read as "*one tonne per nuclear facility per year*" with respect to disposal or abandonment.

[4] *Nuclear Substances and Radiation Devices* Schedule 2, Unconditional Clearance Levels.

[5] *Nuclear Substances and Radiation Devices* Schedule 1, Exemption Quantities.

[6] Uniformly contaminated substances of less than one tonne may also use the criterion in this column.

LIEN - SEATOM

Nuclide		Uniformly Contaminated Material of More than One Tonne[3, 4] Bq/g	Uniformly Contaminated Material of One Tonne[2] or Less[5] Bq/g	Non-Uniformly Contaminated Material Irrespective of Mass[4, 6] Bq
Cadmium 109		1	10000	1000000
Cadmium 113m		1	1000	1000000
Cadmium 115		10	100	1000000
Cadmium 115m		100	1000	1000000
Calcium 45		100	10000	10000000
Calcium 47		10	10	1000000
Californium 246		1000	1000	1000000
Californium 248		1	10	10000
Californium 249		0.1	1	1000
Californium 250		1	10	10000
Californium 251		0.1	1	1000
Californium 252		1	10	10000
Californium 253		100	100	100000
Californium 254		1	1	1000
Carbon 11		1	10	1000000
Carbon 14		1	10000	10000000
Cerium 139		1	100	1000000
Cerium 141		100	100	10000000
Cerium 143		10	100	1000000
Cerium 144	d	10	100	100000
Cesium 129		10	100	100000
Cesium 131		1000	1000	1000000
Cesium 132		10	10	100000
Cesium 134		0.1	10	10000
Cesium 134m		1000	1000	100000
Cesium 135		100	10000	10000000
Cesium 136		1	10	100000
Cesium 137	d	0.1	10	10000
Cesium 138		10	10	10000
Chlorine 36		1	10000	1000000
Chlorine 38		10	10	100000
Chromium 49	d	100	10	1000000
Chromium 51		1	1000	10000000
Cobalt 55		10	10	1000000
Cobalt 56		0.1	10	100000
Cobalt 57		1	100	1000000

LIEN - SEE ATOM

Nuclide		Uniformly Contaminated Material of More than One Tonne[3, 4] Bq/g	Uniformly Contaminated Material of One Tonne[2] or Less[5] Bq/g	Non-Uniformly Contaminated Material Irrespective of Mass[4, 6] Bq
Cobalt 58		1	10	1000000
Cobalt 58m		10000	10000	10000000
Cobalt 60		0.1	10	100000
Cobalt 60m		1000	1000	1000000
Cobalt 61		100	100	1000000
Cobalt 62m		10	10	100000
Copper 60		1	10	100000
Copper 64		100	100	1000000
Copper 67		1	100	1000000
Curium 242		10	100	100000
Curium 243		1	1	10000
Curium 244		1	10	10000
Curium 245		0.1	1	1000
Curium 246		0.1	1	1000
Curium 247		0.1	1	10000
Curium 248		0.1	1	1000
Dysprosium 159		1	1000	10000000
Dysprosium 165		1000	1000	1000000
Dysprosium 166		100	1000	1000000
Einsteinium 253		100	100	100000
Einsteinium 254		0.1	10	10000
Einsteinium 254m		10	100	1000000
Erbium 169		1000	10000	10000000
Erbium 171		100	100	1000000
Europium 152		0.1	10	1000000
Europium 152m		100	100	1000000
Europium 154		0.1	10	1000000
Europium 155		1	100	10000000
Fermium 254		10000	10000	10000000
Fermium 255		100	1000	1000000
Fluorine 18		10	10	1000000
Gadolinium 153		10	100	10000000
Gadolinium 159		100	1000	1000000
Gallium 67		1	100	1000000
Gallium 72		10	10	100000
Germanium 68	d	10000	10	100000

LIEN - SEATOM

Nuclide	Uniformly Contaminated Material of More than One Tonne[3, 4] Bq/g	Uniformly Contaminated Material of One Tonne[2] or Less[5] Bq/g	Non-Uniformly Contaminated Material Irrespective of Mass[4, 6] Bq
Germanium 71	1	10000	100000000
Gold 195	1	100	10000000
Gold 198	10	100	1000000
Gold 199	100	100	1000000
Hafnium 181	1	10	1000000
Holmium 166	100	1000	100000
Hydrogen 3	100	1000000	1000000000
Indium 111	10	100	1000000
Indium 113m	100	100	1000000
Indium 114m	10	100	1000000
Indium 115	1	1000	100000
Indium 115m	100	100	1000000
Iodine 123	100	100	10000000
Iodine 125	100	1000	1000000
Iodine 126	10	100	1000000
Iodine 129	0.01	100	100000
Iodine 130	10	10	1000000
Iodine 131	10	100	1000000
Iodine 132	10	10	100000
Iodine 133	10	10	1000000
Iodine 134	10	10	100000
Iodine 135	10	10	1000000
Iridium 190	1	10	1000000
Iridium 192	1	10	10000
Iridium 194	100	100	100000
Iron 52	10	10	1000000
Iron 55	1000	10000	1000000
Iron 59	1	10	1000000
Krypton 74	1	100	1000000000
Krypton 76	1	100	1000000000
Krypton 77	1	100	1000000000
Krypton 79	1	1000	100000
Krypton 81	1	10000	10000000
Krypton 83m	1	100000	1000000000000
Krypton 85	1	100000	10000
Krypton 85m	1	1000	10000000000

LIEN - SEATOM

Nuclide		Uniformly Contaminated Material of More than One Tonne[3, 4] Bq/g	Uniformly Contaminated Material of One Tonne[2] or Less[5] Bq/g	Non-Uniformly Contaminated Material Irrespective of Mass[4, 6] Bq
Krypton 87		1	100	1000000000
Krypton 88		1	100	1000000000
Lanthanum 140		1	10	100000
Lead 203		10	100	1000000
Lead 210	d	1	10	10000
Lead 212	d	0.1	10	100000
Lutetium 177		100	1000	10000000
Manganese 51		10	10	100000
Manganese 52		1	10	100000
Manganese 52m		10	10	100000
Manganese 53		100	10000	1000000000
Manganese 54		0.1	10	1000000
Manganese 56		10	10	100000
Mercury 197		100	100	10000000
Mercury 197m		100	100	1000000
Mercury 203		10	100	100000
Molybdenum 90		10	10	1000000
Molybdenum 93		10	1000	100000000
Molybdenum 99		10	100	1000000
Molybdenum 101		10	10	1000000
Neodymium 147		100	100	1000000
Neodymium 149		100	100	1000000
Neptunium 237	d	1	1	1000
Neptunium 239		100	100	10000000
Neptunium 240		10	10	1000000
Nickel 59		100	10000	100000000
Nickel 63		100	100000	100000000
Nickel 65		10	10	1000000
Niobium 93m		10	10000	10000000
Niobium 94		0.1	10	1000000
Niobium 95		1	10	1000000
Niobium 97		10	10	1000000
Niobium 98		10	10	100000
Nitrogen 13		1	100	1000000000
Osmium 185		1	10	1000000
Osmium 191		100	100	10000000

LIEV - SEATOM

Nuclide	Uniformly Contaminated Material of More than One Tonne[3, 4] Bq/g	Uniformly Contaminated Material of One Tonne[2] or Less[5] Bq/g	Non-Uniformly Contaminated Material Irrespective of Mass[4, 6] Bq
Osmium 191m	1000	1000	10000000
Osmium 193	100	100	1000000
Oxygen 15	1	100	1000000000
Palladium 103	1000	1000	100000000
Palladium 109	100	1000	1000000
Phosphorous 32	1000	1000	100000
Phosphorous 33	1000	100000	100000000
Platinum 191	10	100	1000000
Platinum 193m	1000	1000	10000000
Platinum 197	1000	1000	1000000
Platinum 197m	100	100	1000000
Plutonium 234	100	100	10000000
Plutonium 235	100	100	10000000
Plutonium 236	1	10	10000
Plutonium 237	100	1000	10000000
Plutonium 238	0.1	1	10000
Plutonium 239	0.1	1	10000
Plutonium 240	0.1	1	1000
Plutonium 241	10	100	100000
Plutonium 242	0.1	1	10000
Plutonium 243	1000	1000	10000000
Plutonium 244	0.1	1	10000
Polonium 203	10	10	1000000
Polonium 205	10	10	1000000
Polonium 207	10	10	1000000
Polonium 210	1	10	10000
Potassium 40	10	100	1000000
Potassium 42	100	100	1000000
Potassium 43	10	10	1000000
Praseodymium 142	100	100	100000
Praseodymium 143	1000	10000	1000000
Promethium 147	1000	10000	10000000
Promethium 149	1000	1000	1000000
Protactinium 230	10	10	1000000
Protactinium 231	1	1	1000
Protactinium 233	10	100	10000000

LIEN - SEATOM

Nuclide		Uniformly Contaminated Material of More than One Tonne[3, 4] Bq/g	Uniformly Contaminated Material of One Tonne[2] or Less[5] Bq/g	Non-Uniformly Contaminated Material Irrespective of Mass[4, 6] Bq
Radium 223	d	1	100	100000
Radium 224	d	1	10	100000
Radium 225		10	100	100000
Radium 226	d	1	10	10000
Radium 227		100	100	1000000
Radium 228	d	1	10	100000
Radon 220		0.1	10000	10000000
Radon 222		0.1	10	100000000
Rhenium 186		1000	1000	1000000
Rhenium 187	d	100	1000000	1000000000
Rhenium 188		1	100	100000
Rhodium 103m		10000	10000	100000000
Rhodium 105		100	100	10000000
Rubidium 86		100	100	100000
Ruthenium 97		10	100	10000000
Ruthenium 103		1	100	1000000
Ruthenium 105		10	10	1000000
Ruthenium 106	d	0.1	100	100000
Samarium 151		1000	10000	100000000
Samarium 153		100	100	1000000
Scandium 46		0.1	10	1000000
Scandium 47		100	100	1000000
Scandium 48		1	10	100000
Selenium 75		1	100	1000000
Selenium 79		1	10000	10000000
Silicon 31		1000	1000	1000000
Silver 105		1	100	1000000
Silver 110m		0.1	10	1000000
Silver 111		100	1000	1000000
Sodium 22		0.1	10	1000000
Sodium 24		1	10	100000
Strontium 85		1	100	1000000
Strontium 85m		100	100	10000000
Strontium 87m		100	100	1000000
Strontium 89		1000	1000	1000000
Strontium 90	d	1	100	10000

LIEN - SEATOM

Nuclide		Uniformly Contaminated Material of More than One Tonne[3, 4] Bq/g	Uniformly Contaminated Material of One Tonne[2] or Less[5] Bq/g	Non-Uniformly Contaminated Material Irrespective of Mass[4, 6] Bq
Strontium 91		10	10	100000
Strontium 92		10	10	1000000
Sulphur 35		100	100000	100000000
Tantalum 182		0.1	10	10000
Technetium 96		1	10	1000000
Technetium 96m		1000	1000	10000000
Technetium 97		10	1000	100000000
Technetium 97m		100	1000	10000000
Technetium 99		1	10000	10000000
Technetium 99m		100	100	10000000
Tellurium 123m		1	100	10000000
Tellurium 125m		1000	1000	10000000
Tellurium 127		1000	1000	1000000
Tellurium 127m		10	1000	10000000
Tellurium 129		100	100	1000000
Tellurium 129m		10	1000	1000000
Tellurium 131		100	100	100000
Tellurium 131m		10	10	1000000
Tellurium 132		1	100	10000000
Tellurium 133		10	10	100000
Tellurium 133m		10	10	100000
Tellurium 134		10	10	1000000
Terbium 160		1	10	1000000
Thallium 200		10	10	1000000
Thallium 201		100	100	1000000
Thallium 202		10	100	1000000
Thallium 204		1	10000	10000
Thorium 226	d	1000	1000	10000000
Thorium 227		1	10	10000
Thorium 228	d	1	1	10000
Thorium 229	d	0.1	1	1000
Thorium 230		1	1	10000
Thorium 231		1	1000	10000000
Thorium 232		1	10	10000
Thorium 234	d	1	1000	100000
Thorium natural	d	1	1	1000

LIEN - SEATOM

Nuclide		Uniformly Contaminated Material of More than One Tonne[3, 4] Bq/g	Uniformly Contaminated Material of One Tonne[2] or Less[5] Bq/g	Non-Uniformly Contaminated Material Irrespective of Mass[4, 6] Bq
Thulium 170		100	1000	1000000
Thulium 171		1000	10000	100000000
Tin 113		1	1000	10000000
Tin 125		10	100	100000
Tungsten 181		10	1000	10000000
Tungsten 185		1000	10000	10000000
Tungsten 187		10	100	1000000
Uranium 230	d	10	10	100000
Uranium 231		100	100	10000000
Uranium 232	d	0.1	1	1000
Uranium 233		1	10	10000
Uranium 234		1	10	10000
Uranium 235	d	1	10	10000
Uranium 236		10	10	10000
Uranium 237		100	100	1000000
Uranium 238	d	1	10	10000
Uranium 239		100	100	1000000
Uranium 240		1	1000	10000000
Uranium 240	d	100	10	1000000
Uranium natural	d	1	1	1000
Vanadium 48		1	10	100000
Xenon 123		1	100	1000000000
Xenon 129m		1	1000	10000
Xenon 131m		1	10000	10000
Xenon 133		1	1000	10000
Xenon 135		1	1000	10000000000
Ytterbium 169		1	100	10000000
Ytterbium 175		100	1000	10000000
Yttrium 90		1000	1000	100000
Yttrium 91		100	1000	1000000
Yttrium 91m		100	100	1000000
Yttrium 92		100	100	100000
Yttrium 93		100	100	100000
Zinc 65		0.1	10	1000000
Zinc 69		1000	10000	1000000
Zinc 69m		10	100	1000000

LIEW - SEE ATOM

Nuclide		Uniformly Contaminated Material of More than One Tonne[3, 4] Bq/g	Uniformly Contaminated Material of One Tonne[2] or Less[5] Bq/g	Non-Uniformly Contaminated Material Irrespective of Mass[4, 6] Bq
Zirconium 93	d	10	1000	10000000
Zirconium 95		1	10	1000000
Zirconium 97	d	10	10	100000

Parent nuclides marked with "d" above include their progeny in secular equilibrium listed:

Parent	Progeny
Am-242m	Am-242
Am-243	Np-239
Ba-140	La-140
Bi-212	Tl-208 (0.36), Po-212 (0.64)
Ce-144	Pr-144
Cs-137	Ba-137m
Np-237	Pa-233
Pb-210	Bi-210, Po-210
Pb-212	Bi-212, Tl-208 (0.36), Po-212 (0.64)
Ra-223	Rn-219, Po-215, Pb-211, Bi-211, Tl-207
Ra-224	Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64)
Ra-226	Rn-222, Po-218, Pb-214, Bi-214, Po-214, Pb-210, Bi-210, Po-210
Ra-228	Ac-228
Rn-220	Po-216
Rn-222	Po-218, Pb-214, Bi-214, Po-214
Ru-106	Rh-106
Sr-90	Y-90
Th-226	Ra-222, Rn-218, Po-214
Th-228	Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64)
Th-229	Ra-225, Ac-225, Fr-221, At-217, Bi-213, Po-213, Pb-209
Th-234	Pa-234m
Th-nat	Ra-228, Ac-228, Th-228, Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64)
U-230	Th-226, Ra-222, Rn-218, Po-214
U-232	Th-228, Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64)
U-235	Th-231
U-238	Th-234, Pa-234m
U-240	Np-240m
U-nat	Th-234, Pa-234m, U-234, Th-230, Ra-226, Rn-222, Po-218, Pb-214, Bi-214, Po-214, Pb-210, Bi-210, Po-210
Zr-93	Nb-93m
Zr-97	Nb-97

n.b. The natural uranium activity equals the activity from uranium isotopes (48.9% from U-238, 48.9% from U-234, and 2.2% from U-235)

LIEN SEF ATOM

Appendix B Derivation of SCO Release Criteria

The International Atomic Energy Agency (IAEA) advisory material for the regulations for the safe transport of radioactive material [27] state the following for the use of the values for release:

> *In summary, the pathways of exposure were external beta irradiation of the skin, ingestion, and the inhalation of resuspended material. Consideration of radionuclides was limited to the most hazardous radionuclides in common use, namely, Pu-239 and Ra-226 in the case of alpha emitters and Sr-90 in the case of beta emitters. These derived limits correspond to values that were generally accepted for laboratory and plant working areas and were therefore conservative in the context of transport packages for which exposure time and handling time for workers were expected to be very much less than for workers in laboratories or active plants. Since this derivation, although there have been changes in radiological protection parameters, the transport contamination limits have not been changed.*

The following limiting situation is provided as a low-probability event that demonstrates compliance with the 1 mSv threshold for those events.

The scenario involves inhalation surface contamination of Pu-239. The resuspension rate used by the IAEA is 10^{-5} m^{-1} [29]. The exposure time is given as half a working year, or 1000h [27].

Current values are used for a dose coefficient for the inhalation of a 5 µm activity median aerodynamic diameter particle. The chemical form, S, is consistent with inhaled plutonium oxide.

$$1\ \text{mSv} > \ 748\ \mu\text{Sv} = 0.4\ \frac{\text{Bq}}{\text{cm}^2} \times \frac{10^4 \text{cm}^2}{1\ \text{m}^2} \times \frac{10^{-5}}{\text{m}} \times \frac{1.1 \text{m}^3}{\text{h}} \times \frac{17\ \mu\text{Sv}}{\text{Bq}} \times 1000\text{h}$$

The 10 µSv/a criterion is valid because even if the 10^{-2}/a probability event occurs, it would not exceed the 1 mSv/a limit for the general public. In this case, it would also be equivalent to a 10 hour exposure as an expected pathway.

The threshold criterion for skins dose is 50 mSv/a. The examined scenario by the IAEA was Sr-90/Y-90 at 4 Bq/cm^2 exposing a worker for a work-year. Only the 4 Bq/cm^2 of Sr-90 is assumed limiting and therefore two decays (one of Sr-90 and one of Y-90) are present per Bq. Using recent ICRP values, the dose is expected to be:

$$50\ \text{mSv} > \ 33\ \text{mSv} = 4\ \frac{\text{Bq}}{\text{cm}^2} \times \frac{1.16\ \times 10^{-6}\ \text{mGy} \cdot \text{cm}^2}{\text{s} \cdot \text{Bq}} \times \frac{3600\ \text{s}}{\text{h}} \times 2000\text{h}$$

LIEN - SEE ATOM

Appendix C Derivation of Airborne Concentration Values Requiring Respirators

The levels of airborne contamination due to mixed fission gasses vary as a function of time, and possibly escape location, therefore different levels are proposed when the hazard mix is unknown.

In all situations, the most conservative value is used for the potential mix of radionuclides.

C.1 Mixture Of Fission Product Noble Gases are Present without Alpha Emitters or Radioiodines Present

This value is specifically for noble gases and their daughter products. All fission products that decay to stable daughters are excluded because noble gases are submersion doses and respirators will not affect dose outcomes. It is assumed that 5 minutes of exposure or hold-up of gasses is reasonable, and that after 8 half-lives the original activity would be zero (0). Therefore radionuclides with a half-life of less than 37.5 seconds are excluded as not concerning. This leaves those presented in Table C-1 as the only viable nuclides of concern.

Table C-1: Noble gases present in fission reactor fuel

Noble Gas	Daughter	ALI (Bq)	DAC (Bq/m^3)
Kr-88	Rb-88	5.71E+08	2.60E+05
Kr-89	Rb-89	9.52E+08	4.33E+05
Xe-135	Cs-135	1.67E+07	7.58E+03
Xe-137	Cs-137	3.57E+06	1.62E+03

Cesium-137 has the lowest DAC. Therefore the restrictive DAC for ‘noble gasses only’ is 1,620 Bq/m^3.

C.2 Mixture of Long-Lived Radionuclides Without Alpha Emitters or Radioiodines Present

Long-lived radionuclides are defined as those with a half-life longer than 30 minutes. The fission product that is not a radioiodine (without alpha emission) that has the lowest annual limit on intake (ALI) is Eu-154 with a 5 µm ALI of 1.05E6 Bq. Therefore, the most conservative DAC that can be assigned in the absence of alpha emitters or radioiodines is 475 Bq/m^3. Rounding to the most significant digit gets the same result as Sr-90.

Table C-2: High-dose radionuclides present in fission reactor fuel

Nuclide	ALI (Bq)	DAC (Bq/m^3)
Sr-90	1.11E+06	5.05E+02
Cs-137	3.57E+06	1.62E+03
Eu-154	1.05E+06	4.78E+02
Eu-155	1.05E+07	4.78E+03

LIEN - SEE ATOM

C.3 Mixture of Fission Product Noble Gases are Present and Radioiodines are Known to be Present

The following radioiodines are known to be present as a by-product of fission reactor operation:

Table C-3: Radioiodines present in fission reactor fuel

Radioiodine	ALI (Bq)	DAC (Bq/m^3)
I-129	2.13E+05	9.67E+01
I-130	1.25E+07	5.68E+03
I-131	1.18E+06	5.35E+02
I-132	6.06E+07	2.75E+04
I-132m	7.69E+07	3.50E+04
I-133	6.06E+06	2.75E+03
I-134	1.33E+08	6.06E+04

Iodine-129 has the lowest DAC. Therefore the restrictive DAC for radioiodines is 96.7 Bq/m^3.

C.4 Mixture Of Fission Product Noble Gases are Present and Radioiodines are Known to be Present

NUREG-0956 [30] lists radionuclides at time of a hypothetical accident. The following alpha-emitting radionuclides are listed as present:

Table C-4 Alpha emitters present in fission reactor fuel

Nuclide	ALI (Bq)	DAC (Bq/m^3)
Np-239	6.45E+07	2.93E+04
Pu-238	1.67E+03	7.58E-01
Pu-239	1.43E+03	6.49E-01
Pu-240	1.43E+03	6.49E-01
Pu-241	1.54E+05	6.99E+01
Am-241	2.50E+03	1.14E+00
Cm-242	1.43E+04	6.49E+00
Cm-244	3.51E+03	1.59E+00

Uranium would be present, but with a much higher ALI than any of those above.

Therefore, the DAC for alpha emitters must be less than or equal to 0.65 Bq/m^3

LIEN - SEE ATOM

Appendix D LaPrade Release Criteria

Levels of contamination are listed in absolute values. The removable fraction, i.e. the percent removed on a swipe, must not be considered greater than 10% unless determined experimentally [31].

Levels of contamination must not be averaged over an area of greater than 100 cm^2 [31].

In the absence of information about true radionuclide identity, the nuclide that has the highest radiotoxicity of those that could be present will be selected [31].

D.1.1 Operational Contamination Levels

The non-fixed contamination in any 'area, room, or enclosure where unsealed nuclear substances are used or stored' must not exceed:

Warning: 3 becquerels per square centimetre for all Class A radionuclides;

Warning: 30 becquerels per square centimetre for all Class B radionuclides;

Warning: 300 becquerels per square centimetre for all Class C radionuclides [31].

All other areas must not exceed:

Warning: 0.3 becquerels per square centimetre for all Class A radionuclides;

Warning: 3 becquerels per square centimetre for all Class B radionuclides;

Warning: 30 becquerels per square centimetre for all Class C radionuclides [31].

D.1.2 Disposal

The following limits on disposal apply:

Warning: 37 MBq/kg hydrogen-3 for solid waste of less than three tonnes per building per year. The waste must be in solid form and uniformly distributed in the waste [31].

Warning: 1 TBq per year hydrogen-3 in water soluble form to a municipal sewer system per building per year [31].

Warning: 37 kBq/m^3 hydrogen-3 released to atmosphere in gas form, averaged over a one-week period, applied to releases of less than 3 Mm^3 per year [31].

LIEN - SEE ATOM

UNRESTRICTED

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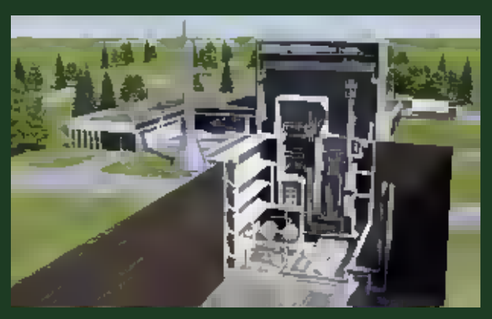
Canadian Nuclear Laboratories

Integrated Waste Strategy









CW-508600-062-000, Revision 2.1 | 2023 September

CNL acknowledges that its operations across Canada occur on the unceded, traditional territories of Indigenous Peoples, and we recognize the unique history, spiritual beliefs, cultural practices and languages of these communities. We are also firmly committed to being an active participant in Canada's journey on the road towards healing and reconciliation.

EXECUTIVE SUMMARY

The Canadian Nuclear Laboratories (CNL) Integrated Waste Strategy presents the guiding framework for the lifecycle strategies for the management of all types of waste at CNL-operated sites across Canada. The scope of the Integrated Waste Strategy includes the strategies for clean, hazardous, and radioactive wastes (solid and liquid) that have been generated and are in storage, and wastes that will be generated in the future. The CNL Integrated Waste Strategy seeks to answer three key questions in regard to waste management approaches:

1. Where are we today?
2. Where do we want to get to?
3. What actions are needed to get there?

The wastes that CNL manages are the result of over 75 years of pioneering work by Atomic Energy of Canada Limited (AECL), and now CNL. From this work, scientific breakthroughs and contributions have resulted in positive impacts for Canadians and people across the world. The by-product of this work at CNL sites to advance clean energy and contribute to health sciences is the clean, hazardous, and radioactive waste that CNL is committed to managing safely. CNL is recognized as a leader in implementing solutions for some of Canada's largest environmental challenges. The CNL priority to restore and protect Canada's environment is realized through the cleanup (decommissioning and environmental remediation), and waste management work that is currently ongoing. These experiences and existing waste management capabilities create the foundation for where we are today and support development of optimal and sustainable strategies going forward.

Looking forward, CNL recognizes that waste management decisions need to be guided by core principles, by science and innovation, and by learning from others through collaboration and engagement. For the CNL Integrated Waste Strategy, there is a clear focus on holistic waste lifecycle solutions, which recognize and reflect the inherent flexibility required in strategic decision-making. The lifecycle focus prioritizes minimizing the burden on future generations, and CNL is positioned as the Canadian leader in transitioning from rolling stewardship (continued storage) approaches for radioactive waste management to final disposal solutions. The CNL Near Surface Disposal Facility is the key example of this, and as a LLW disposal facility, this proposed Facility would enable the remediation and clean-up of legacy wastes and affected lands by providing a safe, monitored disposal solution. The lifecycle focus also results in the need for new capabilities and facilities, which will be used to retrieve, characterize, process, package, and store waste leading up to disposal. These new capabilities and facilities represent a key element of the strategy of where we are going.

CNL is committed to developing strong relationships with Indigenous Peoples. This is cultivated through fostering meaningful opportunities for dialogue and participation. At CNL, there is clear recognition of the important role that Indigenous Peoples perform in Canada and appreciation of the responsibilities that they have as stewards of the environment. The journey involves listening and learning, and CNL encourages Indigenous participation to help identify how CNL can incorporate Indigenous knowledge in waste management projects and activities in the future. This collaboration represents a key element of how CNL will realize elements of this Integrated Waste Strategy and the overall CNL waste strategy.

The CNL Integrated Waste Strategy is a summary-level document that consolidates the detailed plans from various teams across CNL. It serves as a communication tool, a planning tool, and a decision-making tool. The CNL Integrated Waste Strategy *reflects* waste management decisions, activities, and projects, and *informs* future decisions about lifecycle plans. The CNL Integrated Waste Strategy remains a document that will be periodically updated to reflect CNL's progress on key actions and define upcoming strategic priorities and supporting activities.

EXECUTIVE SUMMARY

Class of Waste	Key Elements of the Strategy	Lifecycle Disposition Pathways
Clean Waste	• Implementing radiological and hazardous substances clearance processes for impacted or potentially impacted materials to enable the disposal of non-radiological and non-hazardous wastes • Increase recycling opportunities as available	Reuse, recycling, or disposal through third-party (off-site) facilities
Hazardous Waste (Non-Radiological)	• Characterizing wastes for handling, storage, transportation and/or further processing • Implementing radiological clearance processes for impacted or potentially impacted materials • Ensuring that compliance with regulations provides the foundation for lifecycle management processes	Reuse, recycling, processing and/or disposal through third-party (off-site) facilities
Radioactive Low-Level Waste (Solid)	• Characterizing wastes for radiological and non-radiological contaminants for handling, storage, transportation and future disposal • Processing and packaging to meet storage, transportation and disposal requirements • Implementing waste diversion approaches to minimize waste volumes requiring storage or disposal • Consolidating waste at CRL • Time-phasing waste generation from cleanup work (decommissioning and environmental remediation) • Utilizing existing infrastructure and assets where suitable • Developing and implementing new capabilities (facilities and technologies) for optimized lifecycle management and enabling future clean-up work • Incorporating industry best practices and innovations as part of a fit-for-use approach at CNL • Driving continuous improvement to improve safety, effectiveness and efficiency	• LLW disposal in the proposed Near Surface Disposal Facility • Long-term management in the Port Granby and Port Hope Long-Term Waste Management Facilities • In-situ disposal for the NPD and WR-1 Facilities
Radioactive Intermediate-Level Waste (Solid)		• Disposal in the recommended national Deep Geological Repository for Canadian ILW • In-situ disposal for the NPD and WR-1 Reactors
Radioactive High-Level Waste (Solid)	• Developing and implementing new capabilities (facilities and technologies) for retrieval, processing, storage, and transportation to accelerate the remediation of legacy facilities • Consolidating waste at CRL • Conditioning and stabilization of research reactor fuels to meet disposal Waste Acceptance Criteria	Disposal in the Nuclear Waste Management Organization's Deep Geological Repository for Used Fuel
Radioactive Liquid Waste	• Characterizing wastes for radiological and non-radiological contaminants • Optimizing the amount of wastes that are treated and compliantly discharged • Minimizing secondary wastes and post-processed waste from Radioactive Liquid Waste treatment • Utilizing existing infrastructure and adding new capabilities/facilities for Radioactive Liquid Waste	• Solidified waste to be managed as LLW or ILW • Discharge of treated liquids verified to meet effluent discharge limits

Waste Hierarchy

EXECUTIVE SUMMARY

Focus Action	Summary of Actions	Targeted Waste Class
Lifecycle Plans	Improve and optimize lifecycle plans with a focus on: • Transitioning from storage framework to disposal frameworks for radioactive wastes • Detailed lifecycle mapping of waste for discrete projects/programs • Minimizing the potential for re-work with a focus on creating "disposal ready" waste packages	All
Indigenous Engagement	Use the CNL Integrated Waste Strategy as a mechanism for engagement with Indigenous Peoples on the overall strategy and discrete projects.	All
Stakeholder Engagement	Use the CNL Integrated Waste Strategy as a mechanism for engagement with internal (CNL) and public stakeholders.	All
Sustainability	Track CNL's performance against key sustainability measures for waste management to identify, evaluate and implement continuous improvement actions.	All
Waste Forecasts	Continue to improve and optimize the CNL-wide Waste Forecast data based on improved characterization data and time-phased profiles.	All
Clean Waste Disposal	In collaboration with surrounding communities, establish long-term disposal solutions (e.g., landfill/capacity expansions) to enable the disposal of non-radiological waste.	Clean
CRL Enabling Facilities for Nuclear Liabilities	Progress the planning and implementation of the following enabling facilities/capabilities: • Environmental Remediation (including Groundwater Processing) • High-Level Waste (HLW) Conditioning • HLW & Intermediate-Level Waste (ILW) Storage • ILW and Low-Level Waste (LLW) Processing • Radioactive Liquid Processing System(s) • Retrieval Systems for legacy HLW and ILW • Transportation Package (Cask) Handling • Tritiated Heavy Water Management • Utility and Security Infrastructure Enhancement	LLW, ILW, HLW, Radioactive Liquids
ILW Disposal	Drive CNL's evolution from processing and packaging for *storage* to processing and packaging for *disposal*, while evolving CNL's plan to align with the national Integrated Strategy for Radioactive Waste.	ILW
In-Situ Disposal	Complete the regulatory approval processes for the in-situ disposal of the NPD and WR-1 Reactors, and implement the in-situ decommissioning approach.	LLW and ILW
LLW Disposal	Complete the regulatory approval process for the Near Surface Disposal Facility at the CRL site and begin construction.	LLW
Waste Certification	Improve and optimize the CNL waste assurance processes to include a Waste Certification process for disposal readiness.	LLW and ILW
HLW Disposal	Evaluate and confirm the approach/strategy to convert research reactor fuels and other enriched fuels into a configuration to meet the Waste Acceptance Criteria for the planned national Deep Geological Repository.	HLW

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Chalk River Laboratories Main Campus Aerial View

1. INTRODUCTION

1.1 PURPOSE

The Canadian Nuclear Laboratories (CNL) Integrated Waste Strategy provides the framework for the lifecycle management of all types of waste at all CNL-operated sites across Canada. The overarching goals of the CNL Integrated Waste Strategy are to:

- Ensure integration of the management of waste across CNL-operated sites;
- Define optimal routes for all CNL-managed wastes using a lifecycle approach;
- Identify and enable waste management opportunities and efficiencies; and
- Enable the safe and effective reduction of Atomic Energy of Canada Limited's (AECL) waste liabilities.

The CNL Integrated Waste Strategy aims to answer three important questions:

1. Where are we today?
2. Where do we want to get to?
3. What actions are needed to get there?

The CNL Integrated Waste Strategy is a document that summarizes CNL's waste management lifecycle plans, recognizing the overall CNL waste strategy includes discrete projects and plans. The Integrated Waste Strategy is also used to both *reflect* and *inform* decisions related to managing waste across CNL. The Integrated Waste Strategy is a communication, planning, and decision-making tool.

Figure 1-1: CNL's Waste Strategy



CNL is operated under the Government-Owned, Contractor-Operated (GOCO) model. Waste is considered a liability, which is owned by AECL, as a representative of the Government of Canada. CNL is the operator, which is responsible for developing and implementing safe and effective strategies and approaches for waste management. AECL provides technical and performance oversight for all CNL activities, and the two organizations work closely together to implement the lifecycle approach for waste management at sites across Canada that AECL is responsible for.

AECL owns the waste. CNL manages waste. AECL and CNL are both committed to safety and efficiency for the waste management lifecycle.

1. INTRODUCTION (continued)

1.2 SCOPE

The CNL Integrated Waste Strategy includes the framework for the management of the following types of waste (see Glossary for full definitions):

- Clean Waste (Conventional, Non-Hazardous, Non-Radioactive)
- Hazardous Waste (Non-Radioactive)
- Radioactive Solid Waste
    - Low-Level Radioactive Waste (LLW), including Mixed LLW
    - Intermediate-Level Radioactive Waste (ILW), including Mixed ILW
    - High-Level Radioactive Waste (HLW)
- Radioactive Liquid Waste

Environmental effluents, including liquid and gaseous effluents, are not considered waste and are out-of-scope for this Integrated Waste Strategy.

The CNL Integrated Waste Strategy is a living document that is reviewed and updated as process and significant project changes are implemented, and waste routes are optimized or, as a minimum, every five years.

1.3 WASTE STRATEGY GUIDING PRINCIPLES

In establishing and optimizing strategies for waste management, CNL makes decisions that are guided by science and aligned to values and principles. The following statements, which were developed through various engagements throughout 2022, represent the Waste Strategy Guiding Principles and Objectives to inform strategic and technical decisions:

1. **Demonstrated excellence in safety performance**, in terms of worker safety, safety of the public, and protection of the environment, both now and in the future.
2. **Transparency and meaningful engagement of stakeholders, knowledge holders, and rights holders**, including CNL employees, the Canadian Nuclear Safety Commission (CNSC), Indigenous Peoples in Canada, and public stakeholders.
3. **Minimized burden on future generations** through accelerated nuclear liability reduction initiatives and timelines, and a focus on permanent disposition of wastes.
4. **Optimized efficiency in the management of waste materials**, with a focus on waste minimization, and underpinned by deliverable technical strategies and plans resulting in consolidated ‘fit for purpose’ capabilities and facilities.
5. **Strategic alignment with CNL’s Sustainability planning and targets**, including the pursuit of opportunities for carbon reduction and climate resilience, as well as minimization of environmental impacts.
6. **Technical alignment to the Nuclear Waste Management Organization (NWMO)-led Canadian Integrated Strategy for Radioactive Waste**, as part of Canada’s Radioactive Waste Policy Review.
7. **Technical and strategic alignment with domestic and international best practices**, with adaptations of relevant good practices to align with the Canadian regulatory and social environment, and inclusive of the CNL-specific challenges, constraints and drivers.
8. **Optimized total lifecycle strategies**, based on deliverable technical strategies, baselines, and plans in alignment with CNL’s current and future missions.
9. **Optimized value for money for Canadians**, in terms of both project costs and lifecycle liability impacts, with full recognition of how money spent will benefit CNL, the surrounding communities, and the people of Canada.
10. **Optimized alignment to other CNL Programs and Missions**, including the pursuit of new Science and Technology initiatives, new facilities, and new programs of work.

1. INTRODUCTION

1.4 SITE OVERVIEWS

For more than 75 years, Atomic Energy of Canada Limited (AECL), and now CNL have operated sites to establish Canada as a world leader in nuclear science and technology. During that time, some profound benefits on a national and global scale have been realized including the use of Canada Deuterium Uranium (CANDU) reactors to help Ontario transition away from coal as a source of electricity and the use of medical isotopes from the National Research Universal (NRU) reactor and the National Research Experimental (NRX) reactor at the Chalk River Laboratories (CRL) site that have improved the health of an estimated one billion people over 60 years. From the beginning, AECL - and now CNL – studied and improved the way that nuclear waste is stored with a priority on the safety of workers, the public, and the environment.

As of 2023, only the CRL site has an enduring operational mission of nuclear science and technology. All of the other CNL-operated sites are undergoing cleanup, which includes facilities decommissioning and environmental remediation; all of which generates clean, hazardous and radioactive waste that must be managed. The work at the Port Hope Area Initiative (PHAI), Whiteshell Laboratories (WL) , Nuclear Power Demonstration (NPD), Douglas Point (DP), Gentilly-1 (G-1), Northern Transportation Route (NTR) and La Prade sites represents some of the largest and most complex cleanup projects in Canada. Each of these sites are summarized in the subsequent sections, recognizing the shared commitment to environmental stewardship and responsible waste management.

Chalk River Laboratories

Located in eastern Ontario, the CRL site is Canada's largest science and technology complex. The CRL site is approximately 9,000 acres and has been in operation for over 75 years. The CRL site has been identified as the only CNL-operated site with a long-term enduring mission.

The CRL site has an extensive history of nuclear science and technology activities. These activities formerly included the production of radioisotopes used to treat or diagnose over 20 million people in 80 countries every year. The CRL site has an enduring science and technology mission, with focus on:

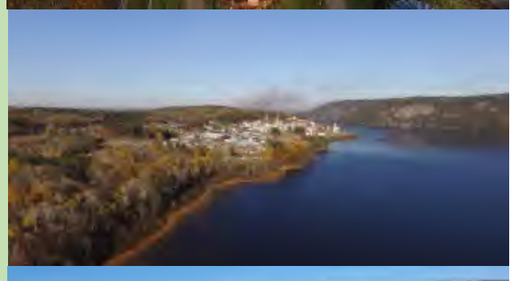
- Advancing Clean Energy (Small Modular Reactors, Hydrogen Technologies, Reactor Sustainability, and Advanced Fuels)
- Advancing and Supporting Nuclear Health Sciences (Nuclear Medicine, Radiopharmaceuticals, and Radiation Research)

The nuclear science and technology activities at the CRL site have led to the production of radioactive and other hazardous wastes. Such wastes have been carefully managed at dedicated areas, such as waste management areas, since the 1950s in alignment with relevant good practices of the time. While the majority of the CRL site remains undisturbed, certain areas, including the waste management areas have been contaminated to varying degrees. As there remains a significant amount of buried waste, soil contamination and groundwater contamination exists. Therefore, remedial actions are required to reduce risks to the environment. This decommissioning and remediation mission, otherwise known as the Clean-up Mission, at the CRL site has included the safe decommissioning and demolition of over 110 structures and facilities since 2015, with a future scope of work planned over the next 60 years.

Responsible decommissioning and radioactive waste management is necessary in order to clean up the CRL site, protect the environment, and make way for new buildings that will support the ongoing nuclear science and technology mission at the CRL.









1. INTRODUCTION

1.4 SITE OVERVIEWS

Port Hope Area Initiative

Located in southern Ontario, the Port Hope Area Initiative (PHAI) represents the Government of Canada's commitment to clean-up and safely manage historic low-level radioactive waste currently located in the municipalities of Port Hope and Clarington. The PHAI is a community-recommended solution to a longstanding environmental issue that is being carried out as two projects – the Port Hope Project and the Port Granby Project:

- The Port Hope Project involves the cleanup of approximately 1,200,000 m^3 of historic low-level radioactive waste from sites located in Port Hope, the construction of the Port Hope Long-Term Waste Management Facility, and the long-term monitoring and maintenance of the new facility. The primary goal of the Port Hope Project is to return remediated sites to their pre-construction state or to a better condition, with a vision of creating areas for recreational uses such as walking trails and a lookout point.
- The Port Granby Project is an initiative for the safe, long-term management of historic low-level radioactive waste located in the Municipality of Clarington. Historic low-level radioactive waste was relocated from an existing waste management facility on the shoreline of Lake Ontario, to the new Port Granby Port Hope Long-Term Waste Management Facility. The historical facility was remediated in 2020, and the purpose-built Port Granby Port Hope Long-Term Waste Management Facility was capped and closed in 2021. This Facility provides safe long-term management of approximately 800,000 m^3 (1.3 million tonnes) of historic waste, with no intent for future retrieval.









1. INTRODUCTION

1.4 SITE OVERVIEWS

Whiteshell Laboratories

Located in eastern Manitoba, Whiteshell Laboratories (WL) is an 11,000 acre former research site that is currently being decommissioned and remediated. The WL site is the second largest of AECL's sites operated by CNL. It was established in 1963, with a focus on the largest organically cooled, heavy water moderated nuclear reactor in the world, the WR-1 Reactor. The WL site includes various non-nuclear buildings and nuclear facilities, including the Shielded Facilities, as well as a radioactive waste management area and storage canisters for used fuel awaiting consolidation to CRL. Several buildings and facilities, such as the Active Liquid Waste Treatment Centre and Decontamination Center have been safety decommissioned. Since 2003, the focus at WL has been on the cleanup mission while continually protecting the environment.









Nuclear Power Demonstration

Located in eastern Ontario, the Nuclear Power Demonstration (NPD) reactor is a shut-down reactor, which was Canada's first nuclear power reactor to supply electricity to the electrical distribution grid. Operations started in 1962, and NPD served as an important training facility for reactor engineers and operators. Following shutdown of the reactor, the fuel and power generating equipment was removed from the site and transferred to the CRL site. The NPD site currently consists of a limited number of structures and several temporary structures which are being added to support the decommissioning project work.









CNL has proposed to decommission the WR-1 and NPD Reactors through an in-situ disposal process where the end state is to encase radioactivity in a stable, proven form to allow for continued decay with long-term care and maintenance activities for an agreed period. In-situ disposal has been used successfully at a number of nuclear sites worldwide.

Through in-situ disposal, the remaining reactor components and systems remain underground inside the thick concrete foundation structure which is then filled with grout and the current above ground structures demolished. The grouted structure would then be capped with concrete and covered with an engineered barrier.

This approach minimizes the risks to the health, safety and security of the public, workers and the environment. The resulting below-grade structure would be monitored until the radioactive levels reach background levels.

1. INTRODUCTION

1.4 SITE OVERVIEWS

Douglas Point

Located in southwestern Ontario, the Douglas Point Facility is comprised of the reactor building, service building, turbine building and administration wing, an area for storing concrete canisters containing used nuclear fuel and several outbuildings. The Douglas Point reactor, which is permanently shut down and partially decommissioning, is 200-megawatt electric prototype CANDU reactor.

The Douglas Point Waste Facility is located on the Bruce Power nuclear site. Lifecycle decommissioning plans for the reactors are currently being developed and would be subject to review and acceptance by the Canadian Nuclear Safety Commission.



Gentilly-1



Located on the southern Quebec, Gentilly-1 is a shutdown prototype nuclear reactor that was operated from 1972 to 1977. The reactor was a prototype 250-megawatt (equivalent) boiling light water power reactor built as a joint project between Hydro-Québec and AECL in order to advance reactor technologies.

The Gentilly-1 reactor is currently in a 'safe shutdown state'. This means that the reactor is not operating, fuel has been transferred from the reactor to storage canisters on-site (awaiting consolidation to CRL), and the facility is being left in place to allow for radioactive decay. Lifecycle decommissioning plans for the reactors are currently being developed and would be subject to review and acceptance by the Canadian Nuclear Safety Commission.

Northern Transportation Route

Located in the Northwest Territories and northern Alberta, the Northern Transportation Route (NTR) is an initiative to clean up small quantities of uranium-impacted soil that resulted from spillage during the past handling of uranium ore at points along the 2,000 kilometre route of waterways and portages between Port Radium and Fort McMurray.

Formal investigations were conducted and NTR sites with higher radiation levels were cleaned up from the 1990s to 2011. Through the NTR initiative, remaining uranium-ore spillage would be collected and transported south to appropriate licensed storage facilities in Alberta.



La Prade

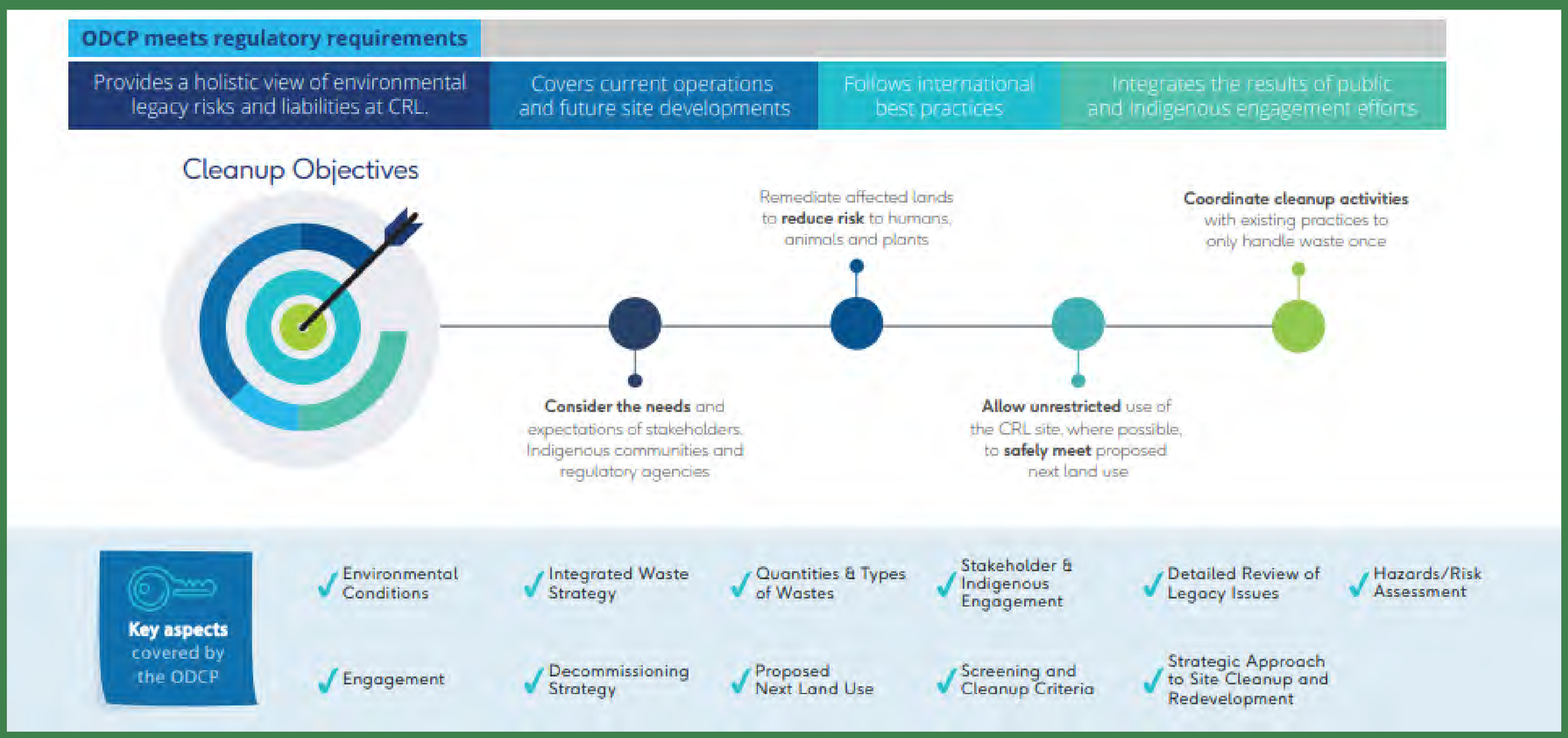
Located near the Gentilly-1 site in south-central Quebec, the La Prade site is used to store an AECL-owned inventory of heavy water. The La Prade site would be closed once the inventory of heavy water is consolidated at the CRL site.

CRL's Overview Decommissioning and Cleanup Plan

The Overview Decommissioning and Cleanup Plan (ODCP) provides the holistic and strategic approach to cleanup in support of revitalization efforts under way at CRL. These revitalization efforts are leading to the creation of an open campus environment dedicated to world-class research and development in nuclear science and technology. The plan provides an overview of the future redevelopment opportunities created by decommissioning and removing obsolete buildings and infrastructure within the built up area of the site. It highlights the framework for several new facilities that would be required as part of CNL's commitment to growing the research conducted at CRL and outlines the environmental remediation efforts underway to reduce and effectively manage Canada's nuclear liabilities.

At CRL, the Overview Decommissioning and Cleanup Plan and Integrated Waste Strategy are complementary plans The Overview Decommissioning and Cleanup Plan highlights several additional essential enabling facilities, capabilities and factors that are required for effective cleanup of the CRL site. Many of these new enabling facilities are related to waste management, with the recognition that CNL needs the facilities and capabilities to enable the lifecycle management of radiological waste liabilities across the CNL site.

The Overview Decommissioning and Cleanup Plan presents an overview of the decommissioning and remediation strategy, and a summary of environmental conditions across the site detailed by each Management Unit. The Management Units consist of groupings of historical waste management areas, support facilities, and experimental research installations.



In support of the Overview Decommissioning and Cleanup Plan, the CRL Community Advisory Panel was established in 2021 to create a forum to bring new voices from the community into the dialogue between CNL and the surrounding communities. Through the Community Advisory Panel , CNL aims to increase understanding, grow our appreciation of our communities' diverse perspectives, and enable members of the community to access first-hand knowledge about CNL activities.

While the focus of the Community Advisory Panel is on decommissioning and remediation of the CRL site, the engagement continuously incorporates considerations for waste management.

1. INTRODUCTION

1.5 WASTE INVENTORY AND FORECAST

The key to the systematic development of the CNL Integrated Waste Strategy depends upon an accurate base of information that describes the quantities and characteristics of the wastes that have been generated (inventory) and the waste that will be generated (forecast) [IAEA, 2016]. More detailed definitions of these distinct elements are outlined below:

Waste Inventory: *Waste data that reflects generated (existing) waste. The data may include parameters such as volume, mass, and chemical, radiological and physical characteristics.*

Waste Forecast: *Projection/estimation of future waste data such as volume, mass, and chemical, radiological and physical characteristics that is based on one or more of actual analyses of the waste, process knowledge (e.g., waste origin), internal and external Operating Experience, knowledge of waste processes to be employed, and calculations.*

The waste inventory and forecast represents a quantification of the scope of the CNL waste management lifecycle. The forecast, like any type of estimate is subject to a range of uncertainty aligned with the extent and accuracy of characterization activities and level of planning and design detail that have been completed to-date. There is specific focus on tracking radioactive waste inventories and forecasts due to the unique challenges and regulatory requirements for radioactive waste management. The subsequent tables present a summary of CNL's existing waste inventories and lifecycle forecast, with solid radioactive waste volumes aligned with the most recent public reporting by AECL. These inventories and forecasts will continue to be updated and publicly shared through Natural Resources Canada, as well as other CNL documentation.

Table 1-4.1: Existing Inventory of Waste Across CNL (as of 2022)

Class of Waste	Type of Waste (m^3)					
	Non-Radioactive		Radioactive			
	Clean	Hazardous	LLW	ILW	HLW	Liquids
Chalk River	200,000*	10,000*	350,476	5,830	143	3,500
Douglas Point	0	0	62	6	89	0
Gentilly-1	0	0	1	2	13	0
La Prade	0	0	0	0	0	500
Northern Transportation Route	0	7,800	0	0	0	0
NPD	0	0	2,289	389	0	0
Port Hope Area	0	0	1,572,781	0	0	0
Whiteshell	60,000	500	20,515	989	29	30
TOTAL	260,000	10,500	1,946,124	7,216	274	4,030

The CRL Clean and Hazardous Waste Inventories reflect planning assumptions from over 75 years of operations and are subject to change based on upcoming site assessments and investigations.*

Table 1-4.2: Lifecycle Waste Forecast including Current Inventories

Class of Waste	Type of Waste (m^3)					
	Non-Radioactive		Radioactive			
	Clean	Hazardous	LLW	ILW	HLW	Liquids
Chalk River	1,100,000	10,000 (5,000 – 50,000)	829,922 (600,000 – 900,000)	6,432 (5,000 – 12,000)	143	12,000/year*
Douglas Point	70,000	0	731 (500 – 1,000)	264 (200 – 400)	89	<10/year
Gentilly-1	67,000	0	908 (600 – 1,000)	319 (300 – 500)	13	<10/year
La Prade	0	0	0	0	0	0
Northern Transportation Route	0	7,800	0	0	0	0
NPD	n/a	0	2,289	389	0	0
Port Hope Area	n/a	0	2,083,000 (Up to 2,300,000)	0	0	150,000/year **
Whiteshell	77,000	2,000	45,217 (28,000 – 80,000)	1,435 (1,000 – 1,800)	29	<100/year
TOTAL	1,314,000	19,800 (14,000 -60,000)	2,962,067 (2,714,000 – 3,284,000)	8,839 (6,500 – 14,400)	274	n/a

At CRL, over 95% of the Radioactive Liquid Waste Forecast is projected to be leachate from the proposed Near Surface Disposal Facility Waste Water Treatment Plant. *
At Port Hope, over 99% of the Radioactive Liquid Waste Forecast will come be leachate treated at the Port Hope and Port Granby Waste Water Treatment Plants. **

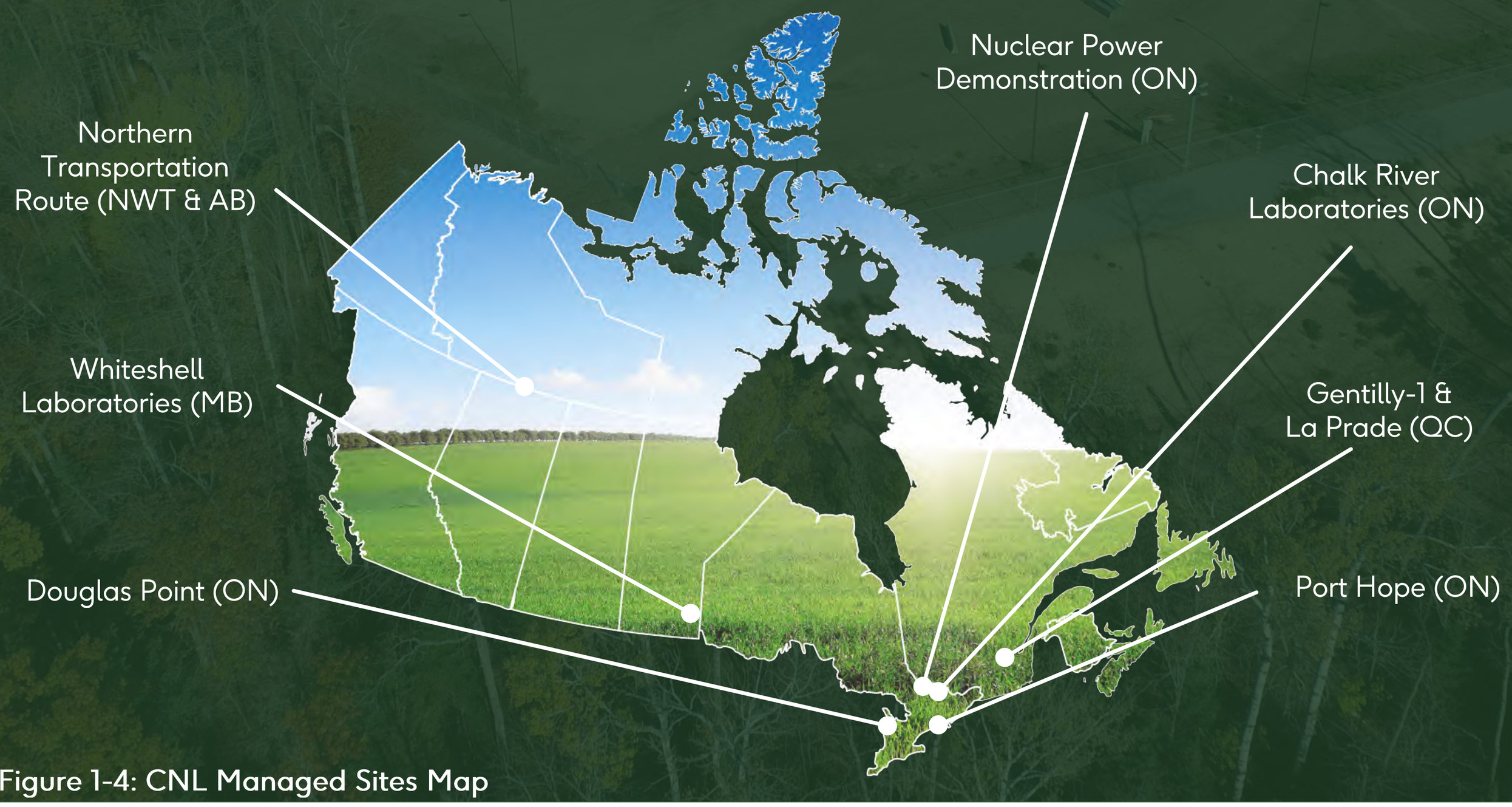


Figure 1-4: CNL Managed Sites Map

1. INTRODUCTION

1.5 PROGRESS ON CNL'S PREVIOUS WASTE STRATEGY ACTION PLAN

Table 1-5: Process Summary of Key Actions for Previous Revision of the CNL Integrated Waste Strategy

Key Action from Previous Revision (2019)	Progress Summary
Continuing to update and refine waste inventory and forecasting.	CNL has refined and updated the CNL-wide waste forecasts based on a) new characterization data, b) reviews of historical data, and c) revised time-phasing based on plans, opportunities, constraints, and risks.
Continuing to develop characterization program and technical improvements.	CNL has expanded it's capabilities for waste characterization, including improved internal governance and standards, new approaches and procedures (such as the Waste Characterization Handbook), new technologies, and the new CRL Waste Characterization Facility.
Continuing to identify and improve transport capabilities across CNL.	CNL has procured, licensed, fabricated, and commissioned over twenty new Type B Transportation Packages to safely transport ILW, as well as the associated on-site transfer and handling equipment. CNL has completed the licensing of the Used Fuel Transportation Package for select fuel types to support the consolidation of the WL fuel inventory at the CRL site. CNL has also continued to demonstrate it's commitment to excellence through safe and compliant execution of LLW and ILW transportation operations, and repatriation programs.
Identifying planning and technical gaps across the ERM program.	CNL has made significant progress in developing strategies for the various types of waste that had planning/technical gaps that were identified in 2019. Areas of significant development from 2019-2022 included work on tritiated heavy water; legacy used fuel and co-stored ILW retrieval and processing approaches; enhanced capabilities and capacities for transportation and storage capabilities for LLW, ILW and HLW; and LLW characterization and processing.
Identifying and implementing processing capabilities for LLW requiring additional processing to enable it to meet the proposed Near Surface Disposal Facility Waste Acceptance Criteria.	CNL designed, licensed, commissioned and is currently operating the new Sort and Segregation Facility at the CRL site (Appendix C). CNL has also initiated a project to establish another processing facility (Waste Processing and Reduction Facility) to complement the Sort and Segregation Facility.
Ensuring sufficient LLW storage capability is maintained at CRL prior to proposed Near Surface Disposal Facility availability.	CNL has established and implemented a Near Surface Disposal Facility monitoring and mitigation strategy. This includes tracking actual rates of LLW generation against forecasts, and the LLW storage capacity available prior to the Operational Phase of the Near Surface Disposal Facility. Increased CRL storage capacities are in development.
Defining and implementing an ILW strategy which focuses on producing waste which is ready for disposal.	CNL has established and initiated the implementation of a multi-faceted ILW retrieval, processing and storage strategy, which utilizes reconfigured existing assets along with plans for new approaches and infrastructure.
Identifying and implementing liquid waste processing capability at CRL to meet future CNL needs.	CNL has initiated the Tritiated Heavy Water Management Program, including the progression of the design of the Heavy Water Detritiation Facility Project. CNL has also progressed the Stored Liquid Waste Project's Hazard Reduction System and updates to the CRL Waste Treatment Centre.
Expanding HLW dry storage capability at CRL in a phased manner.	CNL has completed the Phase 1 expansion of the existing CRL Waste Management Area for used fuel storage in concrete canisters. Phase 2 expansion is currently underway.
Implementing a program of work to ensure HLW meets the NWMO used fuel Deep Geological Repository Waste Acceptance Criteria.	CNL initiated the Shielded Facilities Program and progressed the options analyses processes to identify required capabilities and capacities to convert HLW into a disposal-ready configuration.

2. WASTE MANAGEMENT AT CNL-OPERATED SITES

The CNL Waste Management Function provides oversight of waste management activities at all CNL-operated sites and has responsibility to ensure that all CNL waste-related activities throughout the Waste Management Lifecycle (Figure 2-2) follow a consistent waste management process that protects the workers, the public, and environment, and remains complaint with applicable regulatory and licensing requirements. The Waste Management Function helps waste generators and waste receivers to demonstrate and document the commitment to environmental stewardship by maintaining a high level of quality and excellence in all CNL activities in a work culture that prioritizes safety and fosters continual improvement.

2.1 CLASSIFICATION OF WASTE

In general alignment with international and domestic regulatory guidance, CNL classifies waste as non-radioactive waste consisting of "clean" or conventional waste and hazardous waste, as well as radiological wastes, which is subdivided into three classes: LLW, ILW, and HLW. HLW is also commonly referred to as irradiated fuel or used fuel. Although Canadian standards acknowledge that LLW can be subdivided further to include Very Low-Level Waste (VLLW), CNL incorporates VLLW as part of LLW rather than as a separate waste stream to be managed. A sub-class of each of the three classes of radioactive waste are Mixed Wastes, which include hazardous constituents. Radioactive Liquid Wastes are not a separate class, but have been broken out separately in this Integrated Waste Strategy.

Table 2 -1: Classification of Waste

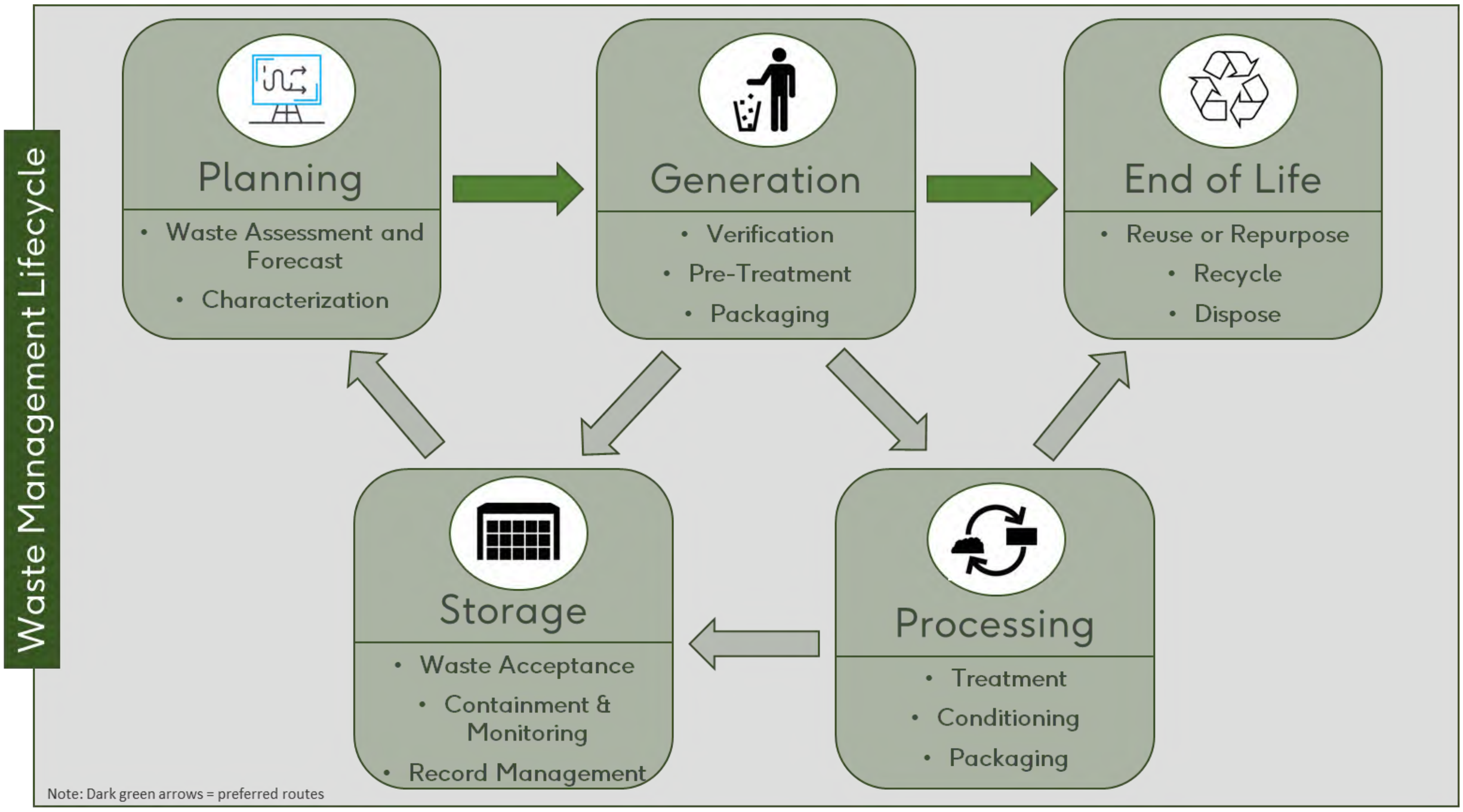
Class*	Definition	Examples
Non-Radioactive Waste	Any waste material that is declared to be non-radioactive by its history, location and use.	
Clean Waste	Non-hazardous material that is declared to be non-radioactive by its history, location and use; or non-hazardous material that has been determined to meet regulatory requirements for unconditional clearance	Building materials and demolition debris Organic materials; Office waste
Hazardous Waste	Solid, liquid or gaseous waste material, other than a radioactive material, that may pose a potential hazard to human health or the environment when improperly treated, stored, transported or disposed of, or otherwise managed, and as specified in applicable regulations.	Asbestos-containing waste; Chemical wastes; Hydrocarbon-contaminated soils; PCB-containing wastes;
Radioactive Waste	A gas, liquid, sludge, or solid that has been declared as a waste and contains a nuclear substance in excess of the clearance or exemption criteria and without foreseeable use	
Low-Level Radioactive Waste	LLW contains material with radionuclide content above established unconditional clearance levels and exemption quantities (set out in the *Nuclear Substances and Radiation Devices Regulations* [Government of Canada, 2015]), but generally has limited amounts of long-lived radionuclides. LLW requires isolation and containment for periods of up to a few hundred years and is suitable for disposal in near surface facilities.	Radiologically contaminated soils; Surface contaminant equipment and building materials (metal, concrete, wood, bagged waste)
Intermediate-Level Radioactive Waste	ILW generally contains long-lived radionuclides in concentrations that require isolation and containment for periods greater than several hundred years. ILW needs no provision, or only limited provision, for heat dissipation during its storage and disposal. Due to its long-lived radionuclides, ILW generally requires a higher level of containment and isolation than can be provided in near surface repositories.	Cemented Target Material; Irradiated reactor components; Wastes with elevated concentrations of long-lived radionuclides (e.g., actinides)
High-Level Radioactive Waste	HLW is used nuclear fuel that has been declared as Radioactive Waste and/or is waste that generates significant heat via radioactive decay. HLW typically has levels of activity concentration in the range of 10^4 to 10^6 TBq/m^3. HLW is associated with penetrating radiation, and thus shielding is required. HLW also contains significant quantities of long-lived radionuclides necessitating long-term isolation.	Used fuel elements, bundles and baskets

2. WASTE MANAGEMENT AT CNL-OPERATED SITES

2.2 WASTE MANAGEMENT LIFECYCLE

The CNL Waste Management Lifecycle represents a series of iterative and often non-linear stages including planning, generation, transport, processing, storage and disposal of waste. The Waste Management Lifecycle reflects a 'cradle-to-grave' or "cradle-to-cradle" approach. It recognizes the importance of holistic lifecycle planning prior to generation and that there are significant differences in details between waste classes and waste streams. It represents all classes of waste, recognizing the significant different in details between different waste classes and streams. Although not explicitly labelled, the arrows represent waste movements including on-site transfers and/or off-site transportation activities.

Figure 2-2: Waste Management Lifecycle



2.3 WASTE HIERARCHY

The CNL Waste Hierarchy is a framework for waste management decision making that applies waste minimization techniques to reduce the quantity of all waste types (Non-radioactive, Hazardous, and Radioactive Waste) requiring disposal, to as low as practicable. Across all CNL-operated sites, these techniques shall be considered in order, at the onset of all planned work, i.e., at source. The techniques are: prevent, reduce, reuse, recycle, and dispose.

The Waste Hierarchy is applied at all stages of the Waste Management Lifecycle. The effective use of diversion, recycle and reuse pathways requires ongoing options analysis and characterization.

2. WASTE MANAGEMENT AT CNL-OPERATED SITES

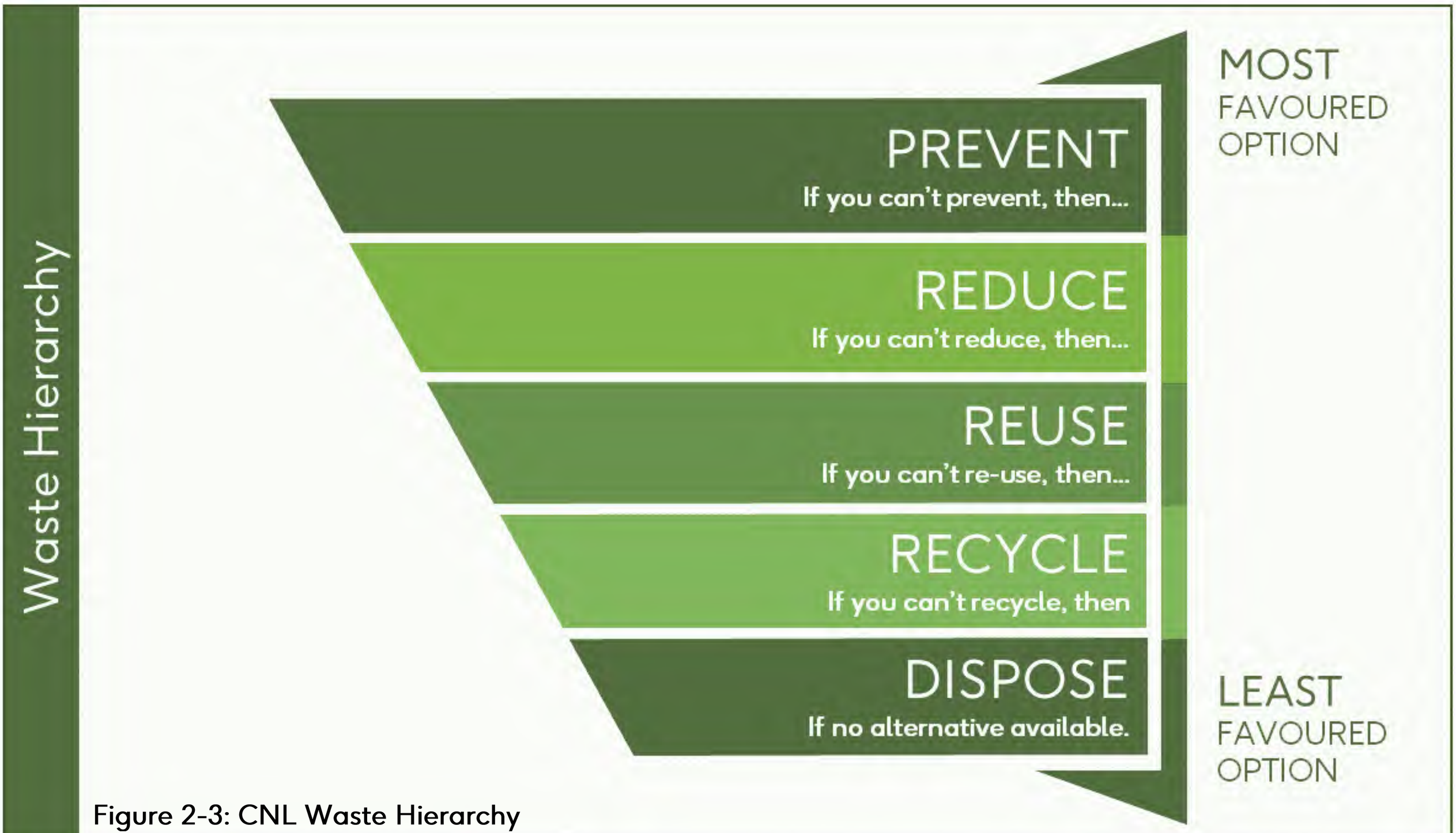


Figure 2-3: CNL Waste Hierarchy

Hierarchy Steps	Waste Strategy Examples
Prevent	Avoid generation of wastes; Planning for decommissioning at the design stage; Minimizing the use of single-use disposables
Reduce	Segregation of waste classes and streams; Prioritizing the durability and reusability of equipment
Reuse	Reusing concrete and ground materials on-sites; reusing surplus equipment; detritiating tritiated heavy water; utilizing mobile systems that can be used at multiple projects/sites
Recycle	Recycling of metals, plastics, paper products, wood products; off-site metal melt processing of LLW metals
Dispose	Landfill disposal of demolition waste; future disposal of LLW in the Near Surface Disposal Facility; future disposal of used fuel of the national Deep Geological Repository

Waste minimization usually requires a trade-off between the benefits accrued and the safety implications or cost of achieving those benefits. In addition, implementation of a waste minimization strategy is always an optimization exercise that takes into consideration factors such as worker doses, the cost of recovering materials, the availability of disposal routes for specific types of waste, the quantities of waste generated in each category, and the duration and cost of interim storage of waste compared with the estimated ultimate disposal cost [IAEA, 2007].

2. WASTE MANAGEMENT AT CNL-OPERATED SITES

The following regulatory documents are a key part of the CNSC's regulatory framework for waste management and decommissioning:

- REGDOC-2.11, *Framework for Radioactive Waste Management and Decommissioning in Canada*
- REGDOC-2.11.1, Waste Management, Volume I: *Management of Radioactive Waste*
- REGDOC-2.11.1, Waste Management, Volume III: *Safety Case for Disposal of Radioactive Waste*
- REGDOC-2.11.2, Decommissioning
- REGDOC-3.3.1, *Financial Guarantees for Decommissioning of Nuclear Facilities and Termination of Licensed Activities*

The following CSA Group standards complement the CNSC's regulatory framework on waste management:

- N292.0, *General Principles for the Management of Radioactive Waste and Irradiated Fuel*
- N292.1, *Wet Storage of Irradiated Fuel and Other Radioactive Materials*
- N292.2, *Interim Dry Storage of Irradiated Fuel*
- N292.3, *Management of Low- and Intermediate-Level Radioactive Waste*
- N292.5, *Guideline for the Exemption or Clearance From Regulatory Control of materials That Contain, or Potentially Contain, Nuclear Substances*
- N292.6, *Long*
- *-Term Management of Radioactive Waste and Irradiated Fuel*
- N292.7, *Deep Geological Disposal of Radioactive Waste and Irradiated Fuel*
- *N292.8, Characterization of Radioactive Waste and Irradiated Fuel*
- N294, *Decommissioning of Facilities Containing Nuclear Substances*

2.4 NATIONAL CONTEXT OF POLICY AND GOVERNANCE

In Canada, matters that relate to nuclear activities and substances are under the jurisdiction of the Government of Canada. Natural Resources Canada (NRCan) is responsible for determining Canada's nuclear energy policies, including those that concern radioactive waste. In 2023, the Government of Canada released Canada's Policy for Radioactive Waste Management and Decommissioning [NRCan, 2023). The policy communicates a vision and a summary of the roles and responsibilities of the Government of Canada, as well as waste producers and owners [CNSC, 2022]. This modernized policy underpins this version of the CNL Integrated Waste Strategy.

The Canadian Nuclear Safety Commission (CNSC) is responsible for the regulatory oversight of the management of radioactive waste, including, as applicable, handling, processing, transport, storage and disposal of that waste. The CNSC's regulatory framework consists of laws passed by Parliament, as well as licences and regulatory documents issued and/or used by the CNSC to regulate the nuclear industry [CNSC, 2022].

The responsibility for ensuring safe transport of nuclear substances, including radioactive waste, is jointly shared between the CNSC and Transport Canada. The basic philosophy that has guided the development of CNSC regulations for transport is that safety is incorporated in the design of the transport package. Package designs are combined with additional regulatory controls including labelling, placarding, and quality assurance and maintenance records, and allow for radioactive material to be carried safely in all modes of transport such as road, rail, air and sea [CNSC, 2022].

2.5 INTERNATIONAL GUIDANCE AND BENCHMARKING

As long-term strategies and solutions for the safe management of radioactive waste evolve, the Government of Canada must continue to demonstrate how it meets its international obligations under the terms of the *Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management* [IAEA, 1997] [CNSC, 2022].

Consistent with its statutory mandate "to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world", the IAEA's activities include: developing and transferring nuclear technologies for peaceful purposes to its Member States; contributing to the strengthening of the global nuclear safety framework and strengthening the security of nuclear material and facilities [IAEA, 2023]. The IAEA suite of documentation, including General Safety Requirements and Technical Documents, inform CNL's approach to waste management.

As a learning organization, CNL is actively involved in international collaboration projects, and pursues academic partnerships and benchmarking opportunities to help identify, evaluate, and implement new approaches for waste management.

CNL Integrated Waste Strategy

Regulatory Framework for Waste Management at CNL-Operated Sites

International

Legal Requirements	Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management
	Agreement Between the Government of Canada and the IAEA for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons
Guidance	IAEA Publications: Safety Standards, Technical Documents (TECDOCS, Conference Proceedings, Nuclear Energy Series)
Standards	International Standards Organization (ISO) Standards

National (Canada)

Policy	*Policy for Radioactive Waste Management and Decommissioning* (NRCan)
Strategy	*Integrated Strategy for Radioactive Waste* (NWMO)
Regulatory Framework	*Nuclear Safety and Control Act* (Government of Canada)
	Impact Assessment Act (Government of Canada)
	CNSC Regulations
	Site Licenses and Certificates for Transportation Packages
	Regulatory Documents, including REGDOC-2.11, *Framework for Radioactive Waste Management and Decommissioning in Canada*
Standards	Canada Standards Association (CSA) Standards: N286, N292-series, and N294

Provincial

Provincial Waste Management Acts and Regulations

Municipal

Municipal Waste By-Laws

CNL

Policy	Environment Policy & Nuclear Safety Policy
Strategy	Integrated Waste Strategy
Requirements	Waste Function Requirements, Standards, and Processes
Site-Specific Requirements, Processes, and Clean-up Plans	
Project-Specific Waste Management Approaches	

National Policy for Radioactive Waste Management

In 2020, the Government of Canada initiated the process to modernize Canada's radioactive waste policy. This process included engagement with the public, the Canadian nuclear industry, and Indigenous communities. The revised and modernized policy was released in 2023. In this national policy, the following three key areas were prioritized in terms of federal government commitments:

1. Health, safety, and security of people and the environment;
2. Inclusive engagement, openness, and transparency;
3. Canada's commitment towards building partnerships and advancing reconciliation with Indigenous peoples; and
4. Global Excellence in radioactive waste management and decommission.

The Government of Canada's vision for radioactive waste management and decommissioning is as follows:

- The generation of radioactive waste is minimized to the extent reasonably achievable, and waste management is optimized, taking into account health, safety, security, environmental and socio-economic considerations;
- The management of radioactive waste, including its storage and disposal, must ensure that both human health and the environment will be protected, now and in the future, to reduce the burden on future generations;
- All radioactive waste and decommissioning activities and all radioactive waste management facilities, locations, and sites are safely managed by waste generators and/or owners and regulated by Canada's nuclear regulator, the CNSC, to protect human health, safety, security and the environment now and over the long term, and to ensure nuclear non-proliferation;
- Radioactive waste generators and/or owners, governments, Indigenous peoples, scientific experts, current and prospective nuclear host communities, and other interested Canadians regularly collaborate on and contribute, in an open and transparent manner, to the planning, development, review and implementation of an Integrated Strategy for Canada's Radioactive Waste;
- The government commits to the implementation of the United Nations Declaration on the Rights of Indigenous Peoples in consultation and collaboration with Indigenous peoples, with regards to radioactive waste management and decommissioning;
- By 2050, key elements of Canada's radioactive waste disposal infrastructure are in place, and planning is well under way for the remaining facilities necessary to accommodate all of Canada's current and future radioactive wastes; and
- Canada's advances in technology and approaches to radioactive waste management and decommissioning, its consistent fulfillment of international commitments and obligations, and its contributions to international discourse and practices in these areas establish Canada as a centre of expertise and leadership.

Integrated Strategy for Radioactive Waste

In the fall of 2020, the Minister of Natural Resources Canada tasked the Nuclear Waste Management Organization (NWMO) with leading an engagement process with Canadians and Indigenous Peoples to inform the development of an integrated long-term management strategy for all of Canada's radioactive waste, in particular low- and intermediate-level waste, as part of the government's radioactive waste management policy review. In 2023, following a public comment period in 2022, the NWMO released the Integrated Strategy for Radioactive, which provided the following recommendations:

1. Intermediate-level waste and non-fuel high-level waste to be disposed of in a deep geological repository with implementation by the NWMO.
2. Low-level waste to be disposed of in multiple near surface disposal facilities with implementation by waste generators and waste owners.

This strategy also document four key implementing principles [NWMO, 2023].

Transportation is an essential element of the CNL Integrated Waste Strategy. CNL, and previously AECL, have been safely transporting radioactive materials (including waste) throughout Canada for over 60 years. Future transportation activities are focused on the consolidation of radioactive wastes (LLW, ILW, and HLW) at the CRL site, recognizing that >90% of the AECL-owned inventory of solid radioactive waste (other than LLW managed at the Port Hope Area Initiative) is already located at the CRL site.

Across Canada, all aspects of the packaging and transportation of radioactive waste is regulated by the CNSC and Transport Canada. Every radioactive waste shipment meets the requirements in the Canadian *Packaging and Transport of Nuclear Substances Regulations* [Government of Canada, 2015], which are based on the IAEA's *Regulations for the Safe Transport of Radioactive Materials* [IAEA, 2018].







3. CNL'S WASTE STRATEGIES

3.1 CLEAN WASTE STRATEGY

Vision of Excellence for Clean Waste Management:

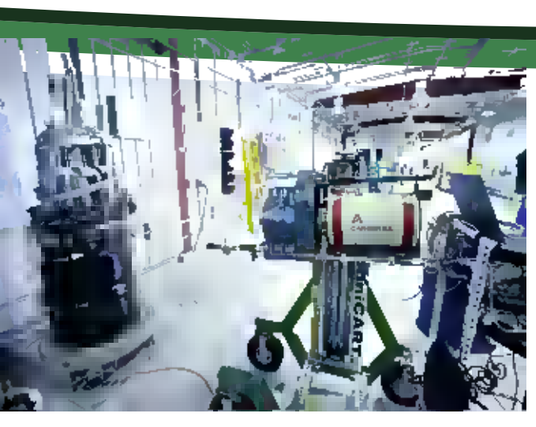
All CNL sites demonstrate a commitment to reducing, reusing and recycling waste, with waste performance metrics that demonstrate continuous improvement. The off-site disposition of waste for recycling or disposal strengthens or establishes mutually beneficial relationships with surrounding municipalities and/or supply chain vendors.

Clean Waste Strategy Overview:

All waste that is released from CNL-operated sites as 'Clean Waste' meets unconditional radiological clearance criteria as per the *Nuclear Substances and Radiation Devices Regulations* [Government of Canada, 2015]. Clean Waste will be managed with a focus on reducing, reusing (or repurposing), recycling, recovering, and residual disposal. CNL sites will dedicate resources and prioritize efforts to minimize the quantities of waste that cannot be reused or recycled. CNL will continue to use existing or new partnerships with local municipalities or supply chain partners for recycling or disposal capabilities and capacities.

Key Elements of the Clean Waste Strategy:

1. CNL's radiological clearance program is implemented to ensure all wastes released from site meet unconditional radiological release criteria.
2. The quantity of clean waste that requires disposal is minimized by reusing and repurposing as much waste as practical, and recycling as much waste that cannot be reused as practical.
3. Opportunities to leverage user-friendly sorting systems at the source/point of generation are identified and implemented.
4. Existing assets are utilized to convert decommissioning waste into a reusable form.
5. Procurement of goods and materials factor in waste minimization objectives by considering durability, packaging, reusability, recyclability, and end-of-life waste management.
6. There is an ongoing investment into awareness, communication, and education campaigns to optimize clean waste management practices focused on reducing, reusing, and recycling.
7. There are continued efforts to physically sort and segregate legacy, operational, and decommissioning wastes to maximize the amount of waste that can be managed as clean, as opposed to radioactive waste.
8. Long-term agreements with local recycling facilities are established and/or maintained to ensure recycling throughput capacities and capabilities are sufficient to support various CNL-operated sites.
9. Residual waste is disposed of in off-site landfills.
10. Long-term agreements with local municipalities or supply chain partners are maintained and/or expanded to provide local disposal capacities (e.g., landfill expansion or lifecycle extension projects).
11. Waste audits and surveillance activities are performed to identify opportunities for improvement.






3. CNL'S WASTE STRATEGIES

3.2 HAZARDOUS WASTE STRATEGY

Vision of Excellence for Hazardous Waste Management:

All CNL sites demonstrate a commitment to safely managing Hazardous Wastes in accordance with the inherent hazardous characteristic through compliance monitoring, focused efforts on waste minimization, and demonstrated continued improvement. The off-site disposition of Hazardous Wastes for processing or disposal strengthens or establishes mutually beneficial relationships with surrounding municipalities and/or supply chain vendors.

Hazardous Waste Strategy Overview:

All waste that is released from CNL-operated sites as 'Hazardous Waste' meets radiological clearance criteria. All Hazardous Wastes are managed throughout the lifecycle to meet regulatory requirements. Hazardous Wastes are minimized to the extent practical, starting with initial procurement efforts through end-of-life segregation activities. Hazardous Waste are transferred to regulated third-party sites (operated at the municipal or by supply chain vendors) for processing and/or disposal.

Key Elements of the Hazardous Waste Strategy:

1. CNL's radiological clearance program is implemented to ensure all Hazardous Wastes released from sites meet unconditional radiological release criteria.
2. Hazardous Wastes are handled (packaged, segregated, stored, and disposed) in accordance with the inherent chemical hazard characteristics present or potentially present.
3. The quantities of Hazardous Wastes are minimized, to the extent practical, throughout the Waste Management Lifecycle.
    a) Hazardous Wastes are minimized through "green procurements" strategies, in alignment with the national *Greening Government Strategy* [Government of Canada, 2020].
    b) Hazardous Wastes are minimized through limited use of hazardous materials for operational and cleanup activities.
    c) Hazardous Wastes are minimized through dedicated efforts to segregate hazardous from non-hazardous materials.
4. Hazardous Wastes are managed in compliance with the provincial regulations applicable to the CNL site of generation.
5. Hazardous Wastes are characterized, segregated, and packaged to meet Transportation of Dangerous Good Regulation.
6. Sort and segregate legacy, operational, and decommissioning wastes to maximize the amount of waste that can be managed as hazardous, as opposed to radioactive (mixed) waste.
7. Hazardous Wastes are characterized, segregated, and packaged to meet the Waste Acceptance Criteria of the off-site processing or disposal facility.
8. Waste audits and surveillance activities are performed to ensure compliance and identify opportunities for improvement.











3. CNL'S WASTE STRATEGIES

3.3 LOW-LEVEL (SOLID) RADIOACTIVE WASTE STRATEGY

Vision of Excellence for Radioactive LLW Management:

CNL is recognized as a national leader in LLW management with a shift from storage to safe disposal of LLW in the Near Surface Disposal Facility. Port Hope and Port Granby Long Term Waste Management Facilities continue to provide safe, long-term solutions for safe storage of LLW. The in-situ disposal of legacy reactors at NPD and WR-1 is approved and implemented. CNL demonstrates a commitment to innovation and continuous improvement for LLW management practices as part of the ongoing commitment to lifecycle environmental stewardship.

Radioactive LLW Strategy Overview:

LLW will be characterized, processed and packaged to enable passive safe storage. LLW from the Port Hope Area Initiative will be emplaced in the Port Hope Long-Term Waste Management Facility. LLW will be consolidated from other CNL-operated sites at the CRL site. Existing storage capacities will be utilized, with new facilities and capabilities established for LLW processing and storage. LLW will be disposed of in the proposed Near Surface Disposal Facility. Where a safety case can be demonstrated and approved, LLW may be disposed of in-situ (e.g., NPD and WR-1).

Key Elements of the Radioactive LLW Strategy:

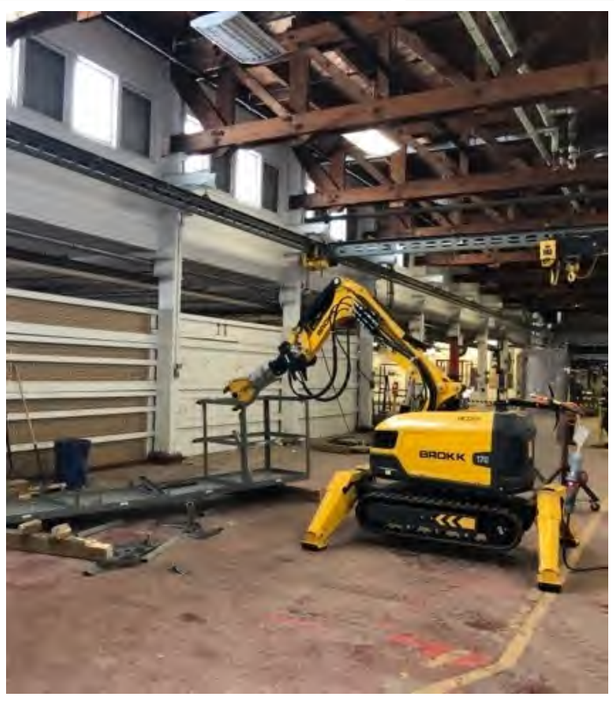
1. Minimize the volume of LLW requiring disposal to optimize storage and disposal liabilities.
2. Implement waste diversion strategies to minimize the quantity (volume) of waste requiring storage and future disposal, including the use of commercial third-party processing and/or recycling facilities.
3. Consolidate LLW from Gentilly-1, Douglas Point and Whiteshell Laboratories at CRL.
4. Characterize LLW identifying quantity and type of radioactive isotopes to enable fully informed decision making regarding safety, packaging, storage, transportation, treatment, and disposal.
5. To the extent practical, sort and segregate LLW at the point of generation, including segregation of LLW and clean waste which would require radiological clearance monitoring.
6. Pre-disposal management of LLW will minimize the need for future re-work or double-handling.
7. Process LLW destined for the Near Surface Disposal Facility, where, required, to ensure it is storage-ready and meets the Near Surface Disposal Facility Waste Acceptance Criteria.
8. Pursue in-situ disposal of suitable LLW through the proposed approaches for in-situ decommissioning of the NPD and WR-1 Reactors if the safety case is demonstrated and approved.
9. Align decommissioning and environmental remediation strategies and execution to LLW storage and disposal availabilities (e.g., deferral of major clean-up projects until the Near Surface Disposal Facility is operational).
10. Implement technical approaches that optimize the use of existing assets and infrastructure, where suitable, and ensure strategic compatibility between existing and planned facilities.
11. Establish new facilities and capabilities to enable the pre-disposal management of LLW, including enhanced sort and segregation capabilities.
12. Establish a robust Waste Certification Program to support future disposal in the Near Surface Disposal Facility.
13. Emplace LLW generated from the Port Hope Area Initiative into the Port Hope Long-Term Waste Management Facility.
14. Once operational, dispose of existing and future LLW in the Near Surface Disposal Facility.
15. Ensure LLW management strategies and supporting processes have flexibility to adapt to uncertainties with legacy waste and future CNL research and operations.
16. Ensure record management maintains accurate and comprehensive records that are maintained in perpetuity.

CNL Integrated Waste Strategy











The Near Surface Disposal Facility is being proposed to provide a permanent, safe and secure containment of LLW, most of which has and will continue to be generated at the CRL site due to ongoing scientific research. Today, the LLW is stored in compliance with regulations, but that storage is not a permanent solution. CNL recognizes the need to minimize the burden on future generations, and the Near Surface Disposal Facility demonstrates the commitment to safely disposition the legacy waste now. The Near Surface Disposal Facility is a key enabling capacity for the cleanup of CNL sites and to drive the transition from LLW storage to LLW disposal.

The proposed Near Surface Disposal Facility is a purpose-built facility that would feature an engineered containment mound built with multiple layers to fully encase up to 1 million cubic metres of solid LLW, effectively isolating the material from the environment. The design of this facility has effectively leveraged technical inputs from similar disposal facilities that are currently in operation around the world. The proposed Near Surface Disposal Facility would also include support facilities such as a Wastewater Treatment Plant.

The Near Surface Disposal Facility would only accept LLW. Any waste that is emplaced in the Near Surface Disposal Facility would be characterized and confirmed to meet the Waste Acceptance Criteria. CNL will develop and implement a formal Waste Certification Program as a key quality management element of Near Surface Disposal Facility operations.

It is important to recognize disposal does not mean abandonment. Following closure of the proposed Near Surface Disposal Facility , CNL would have institutional controls in place for at least 300 years, or as long as regulatory agencies deem necessary.

Near Surface Disposal Facility Rendering for the Operational Phase (2030-2080)

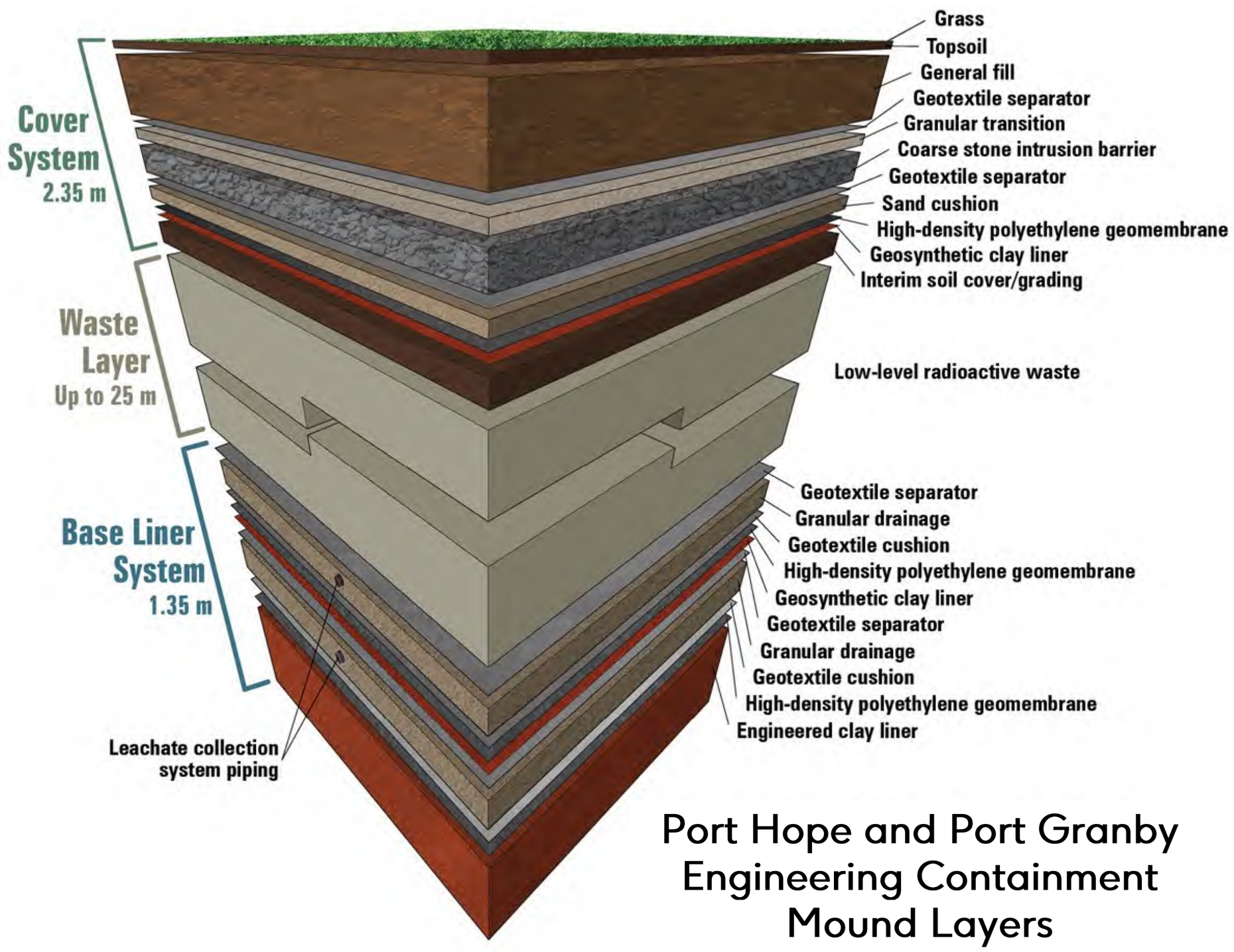
Near Surface Disposal Facility Rendering for the Post-Closure Monitoring Phase (Post 2080)

Port Granby Waste Water Treatment Plant and Long-Term Waste Management Facility









Port Hope and Port Granby Engineering Containment Mound Layers

3. CNL'S WASTE STRATEGIES

3.4 INTERMEDIATE-LEVEL (SOLID) RADIOACTIVE WASTE STRATEGY

Vision of Excellence for Radioactive ILW Management:

CNL is recognized as a global leader in radioactive waste (ILW) management. ILW is consolidated at the CRL site for safe interim storage until disposal infrastructure is in place, in alignment with Canadian *Integrated Strategy for Radioactive Waste* [NWMO, 2023]. The in-situ disposal of legacy reactors at NPD and WR-1 is approved and implemented. CNL demonstrates a commitment to innovation and continuous improvement of ILW management practices as part of the ongoing commitment to lifecycle environmental stewardship.

Radioactive ILW Strategy Overview:

ILW will be characterized, processed and packaged to enable passive safe storage until a geological disposal facility is available. ILW will be loaded into fit-for-use packages that optimize safety for workers and the environment, optimize storage capabilities, and will be designed and used in consideration of future disposal requirements. While existing infrastructure will continue to be utilized, there will be a continuous drive to evolve to above-ground and/or climate-controlled storage configurations that permit accessibility for long-term monitoring and surveillance of the integrity of the packages. There will be an increased focus on creating 'disposal ready' ILW. Disposal solutions for ILW will continue to be evaluated, with CNL focused on aligning with the development and implementation of the NWMO's *Integrated Strategy for Radioactive Waste*.

Key Elements of the Radioactive ILW Strategy:

1. Minimize the volume of ILW to optimize storage and disposal liabilities, with a focus on point of generation waste segregation and volume reduction technologies/approaches.
2. Consolidate ILW from Gentilly-1, Douglas Point and Whiteshell Laboratories at the CRL Waste Management Areas.
3. Characterize ILW to ensure accurate and comprehensive records are available to support storage, transportation and future disposal.
4. Process ILW, where required, to address hazardous constituents and ensure waste is storage-ready and transportation-ready, as well as disposal-ready to the extent possible.
5. Align decommissioning and remediation strategies and plans to ILW storage options and availability.
6. Align CNL's ILW Strategy to the national *Integrated Strategy for Radioactive Waste*:
    a) CNL recognizes the current recommendation for a single, national Deep Geological Repository for ILW, which provides a planning assumption for this Integrated Waste Strategy.
7. Implement Waste Diversion strategies to minimize the quantity of waste requiring storage and future disposal.
8. Pursue in-situ disposal of suitable ILW through the proposed approaches for in-situ decommissioning of the NPD and WR-1 Reactors if the safety case is demonstrated and approved.
9. Utilize processing approaches to produce waste forms suitable for storage and future disposal.
10. Implement technical approaches that optimize the use of existing assets and infrastructure, where suitable, and ensure strategic compatibility with existing and planned facilities.
11. Establish new facilities and capabilities to enable the pre-disposal management of ILW, including capabilities to recover legacy ILW, process (or condition) ILW into a disposal-ready configuration, and provide safe storage of ILW.
12. Drive continuous improvement and standardization to align with improved understanding of ILW disposal readiness.
13. Ensure ILW management strategies and supporting processes have flexibility to adapt to uncertainties with legacy waste and future CNL research and operations.



Chalk River Laboratories Waste Management Area B, which includes approximately 6000 Tile Holes that provide storage for ILW and/or HLW, and over 100 Bunkers (Cylindrical and Rectangular) that provide storage of ILW.

3. CNL'S WASTE STRATEGIES

3.5 HIGH-LEVEL RADIOACTIVE WASTE STRATEGY

Vision of Excellence for Radioactive HLW Management:

CNL develops and operates world-class facilities for used fuel management that enables accelerated recovery and conditioning of legacy HLW. CNL has credible and deliverable lifecycle plans for the entire inventory of AECL-owned HLW, resulting in the disposal of all HLW in the NWMO's Deep Geological Repository. CNL demonstrates a commitment to innovation and continuous improvement as part of the ongoing commitment to environmental stewardship.

Radioactive HLW Strategy Overview:

HLW, which is comprised of irradiated or used fuel, will be managed with the objective of disposing of the entire inventory of AECL-owned HLW in the NWMO's planned national Deep Geological Repository [NWMO, 2022]. The optimization of long-term safety and security for pre-disposal management of HLW involves the consolidation of this inventory at the CRL site. The majority of this inventory is similar to CANDU HLW and is expected to meet the NWMO's Waste Acceptance Criteria for the Deep Geological Repository, while a portion is anticipated to require conditioning. This portion of the inventory includes over 100 tonnes of non-CANDU uranium oxide fuel, chemically reactive fuel, mixed oxide fuel, and enriched fuel.

Key Elements of the Radioactive HLW Strategy:

1. Maintain comprehensive safety and security infrastructure and programs for all elements of HLW management.
2. Analyze HLW to ensure accurate and comprehensive records are available to support storage, transportation, and future disposal.
3. Meet all obligations for international agreements, such as the requirements of Safeguards Management oversight by the IAEA.
4. Consolidate HLW from Gentilly-1 and Whiteshell Laboratories at the CRL Waste Management Areas.
5. Utilize existing infrastructure for HLW storage and expand the capacities for HLW storage at the CRL site in a phased approach.
6. Establish new facilities and capabilities to enable the pre-disposal management of HLW, including:
    a) Retrieval capabilities to recover legacy HLW from existing storage configurations;
    b) Characterization capabilities to identify, classify, and quantify HLW;
    c) Conditioning and packaging capabilities to convert HLW (particularly research reactor fuels or other experimental fuels) into a storage and disposal-ready configuration;
    d) Storage capabilities for the storage of recovered and/or conditioned HLW until the waste can be transported to the NWMO Deep Geological Repository.
7. Communicate and collaborate with the NWMO on their progression of the Deep Geological Repository.
8. Ensure all HLW has been conditioned and/or packaged into a configuration that meets the NWMO Waste Acceptance Criteria no later than 2065.
9. Drive continuous improvement and standardization to align with best practices for HLW disposal readiness.
10. Ensure HLW management strategies and supporting processes have flexibility to adapt to uncertainties with legacy waste and future CNL research and operations.

Eligible fuels and fuel-containing materials have been and will continue to be repatriated to their country of origin, as applicable, which avoids creating HLW. Over the period of 2015 through 2022, over 180 repatriation shipments were safely and securely completed through various projects including the NRU/NRX Highly-Enriched Uranium Fuel Repatriation Project and Target Residue Material Repatriation Project [CNL, 2021]. *By definition, any material eligible for repatriation is not considered a waste.*

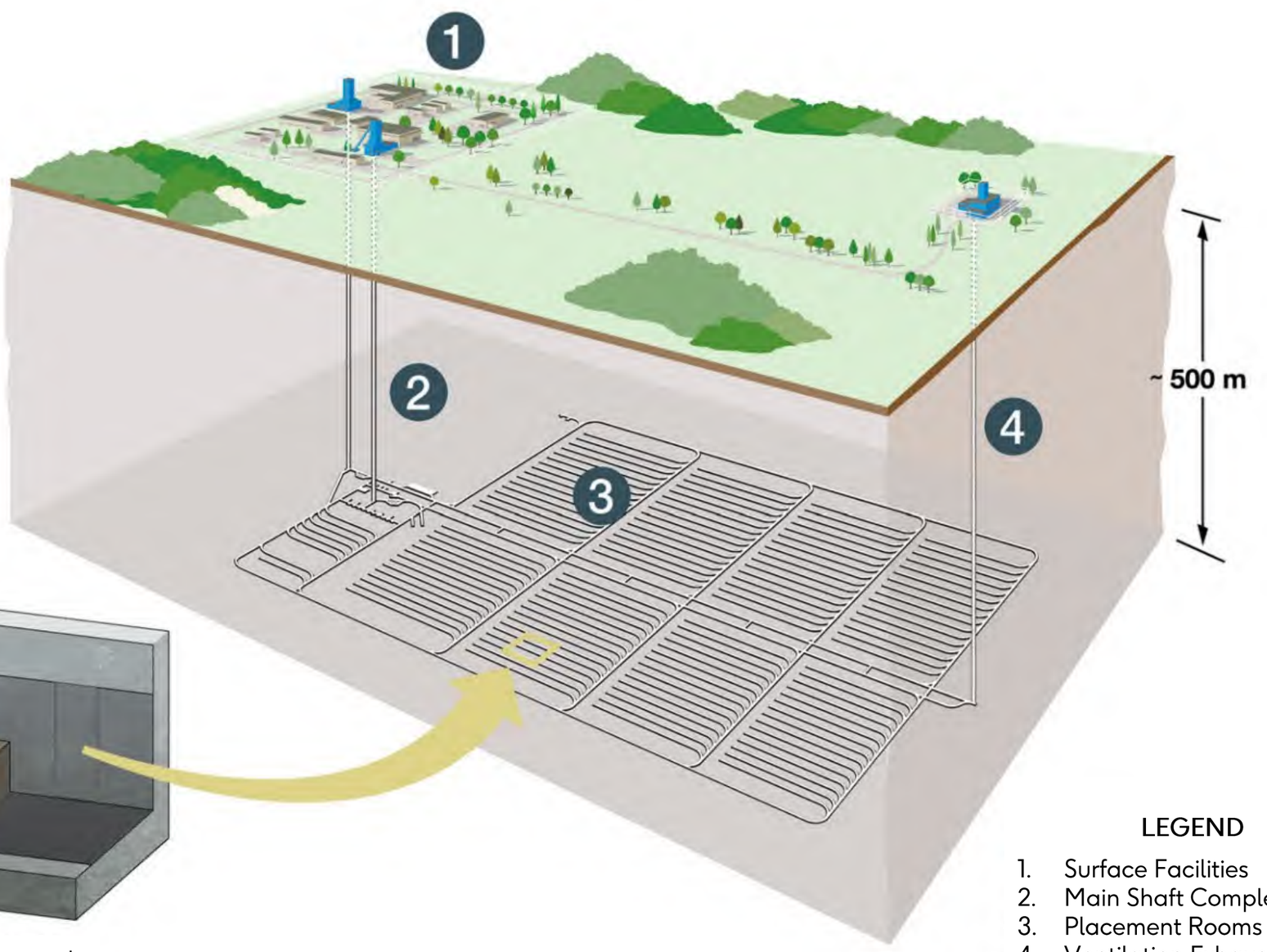
CNL Integrated Waste Strategy

Interior view of the CRL Fuel Packaging and Storage Building

CNL HLW Storage

Future HLW Disposal (NWMO)





LEGEND

1. Surface Facilities
2. Main Shaft Complex
3. Placement Rooms
4. Ventilation Exhaust Shaft

Graphic taken from the Nuclear Waste Management Organization

Evolution of Waste Management Practices at Chalk River Laboratories

Clean Waste

Landfill On-site: 1950s to present



Radiological Clearance Program: 2008 – Present



Waste Analysis Facility: 2009 to present



Landfill Off-site 2016 - Present



Concrete Crushing Facility: 2017 to present



LLW

In Ground Sand Trenches: 1946 - 2002



In Ground Asphalt Trenches: 1955 - 1959



Cylindrical Bunkers: 1979 – Present



Above Ground Container Storage: 2007 – Present



Sort & Segregation: 2020 - Present



Recoverable Surface Storage: 2017 -Present



NSDF: Future



ILW

Rectangular Bunkers: 1959 - 1979



Tile Holes: 1956 – Present



Cylindrical Bunkers: 1979 – Present



ILW Storage Array: 2026 -



Waste Processing Facilities: 2026 – 2075



Recommended Deep Geological Repository (Off-Site): 2050 -

HLW

Tile Hole Storage 1963 - Present



Fuel Packaging and Storage 2015 - Present



Concrete Canister Storage 1988 - Present



Waste Processing 2033 – 2065



Proposed NWMO Deep Geological Repository (Off-Site): 2055 - 2065



3. CNL'S WASTE STRATEGIES

3.6 RADIOACTIVE LIQUID WASTE STRATEGY

Vision of Excellence for Radioactive Liquid Waste Management:

CNL is implementing a plan to leverage modern, existing Radioactive Liquid Waste facilities, and establishing new capabilities and facilities at CRL and WL. CNL also demonstrates a commitment to continuous improvement, recognizing that new facilities will continue to provide quantifiably improved performance.

Radioactive Liquid Waste Strategy Overview:

Radioactive Liquid Waste will be minimized, characterized, processed, and dispositioned through existing facilities and future/planned facilities. Existing facilities include the CRL Waste Treatment Centre, CRL pump and treat buildings, and the Port Hope and Port Granby Waste Water Treatment Plants. Planned facilities include the Near Surface Disposal Facility Wastewater Treatment Plant. The disposition pathways for Radioactive Liquid Waste include solidification of liquids to solid LLW or ILW. Other treatment approaches will remove the contaminants, with treated liquids sampled to ensure they meet effluent discharge limits.

Key Elements of the Radioactive Liquid Waste Strategy:

1. Minimize the volume of Radioactive Liquids Wastes that are generated during operational and decommissioning activities.
2. Characterize Radioactive Liquid Wastes to identify and quantify radiological and non-radiological contaminants.
3. Optimize the use of technologies and treatment approaches that separate radioactivity from the liquids, enabling environmental discharges along with reduced volumes of post-processing (secondary) waste.
4. Identify, evaluate, and implement opportunities for select Radioactive Liquid Wastes to be reused/re-purposed at CRL, such as through the use of grout formulas for radioactive waste stabilization.
5. Consider any secondary wastes generated in the selection and implementation of Radioactive Liquid Waste treatment.
6. Process Radioactive Liquid Wastes generated from operational activities at CRL through the Waste Treatment Centre, resulting in an effluent that can be safely and compliantly discharged, or a solidified waste that can be managed as LLW or ILW.
7. Process Radioactive Liquid Waste generated from decommissioning and remediation at WL through either the Low-Level Liquid Waste Treatment System (focused on treatment and discharge) or the Intermediate-Level Liquid Waste Treatment System (focused on solidification).
8. Treat surface water and groundwater from the Port Hope Long-Term Waste Management Facility, the Port Granby Long-Term Waste Management Facility, and the future Near Surface Disposal Facility at their respective Waste Water Treatment Plants.
9. Establish new capabilities and/or facilities to treat and manage Radioactive Liquid Waste at CRL, recognizing the Waste Treatment Centre is nearing the end of the design life.
10. Establish a detritiation capability to convert the tritiated heavy water inventory from a liability into an asset (virgin heavy water) that can be reused for nuclear or non-nuclear applications.
11. Establish Radioactive Liquid Waste management contingency capabilities and capacities.
12. Ensure any Radioactive Liquid Waste solidification systems incorporate full consideration for disposal readiness of any output wastes.
13. Drive continuous improvement and standardization to align with industry innovations for Radioactive Liquid Waste management.
14. Ensure Radioactive Liquid Waste management strategies and supporting processes/capabilities have flexibility to adapt to uncertainties with legacy waste and future CNL research and operations.

Current Radioactive Liquid Waste Facilities

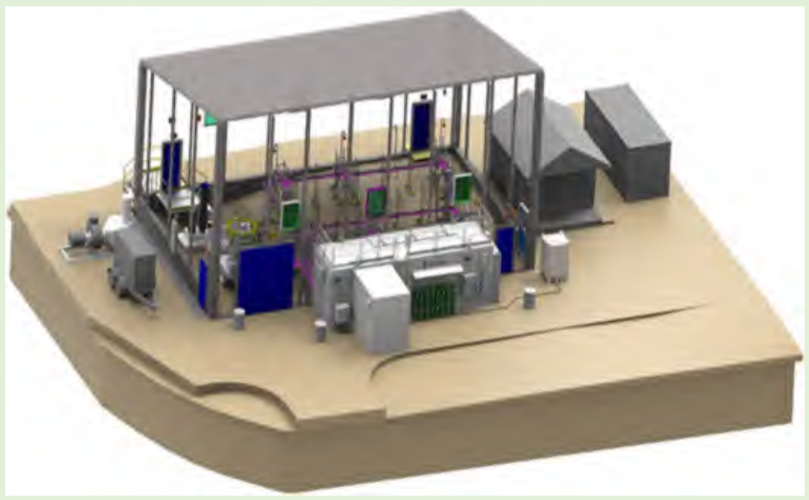








Future Radioactive Liquid Waste Facilities









Current Facilities Photographs: Port Granby Waste Water Treatment Plant; CRL Spring B Pump and Treat Building; Port Hope Waste Water Treatment Plant; CRL Waste Treatment Centre
Planned Facilities Graphics: Stored Liquid Waste Hazard Reduction System; Heavy Water Detritiation Facility (2); Near Surface Disposal Facility Waste Water Treatment Plant

Table 3A – Waste Management Lifecycle Overview by Class

Lifecycle Element	Clean Waste	Hazardous Waste	Radioactive Liquid Waste
Planning	Planning for the Waste Management Lifecycle, with implementation of the Waste Hierarchy.		
Characterization	Radiological clearance monitoring (surface and volumetric); Confirmation of no hazardous constituents	Gas Chromatography; Mass Spectrometry; Organic Vapour Analysis; Toxicity characteristic leaching procedure (TCLP), Radiological clearance monitoring (surface and volumetric)	Sample Analysis – Gamma Spectrometry, Gross Alpha/Beta Counting; Liquid Scintillation, Mass Spectrometry, pH Test
Generation	Segregation of waste streams for reuse, recycling, or disposal	Segregation of hazardous waste from clean waste; Segregation of different classes of hazardous waste (Class 1-6, and 8)	Collection and containment; Pre-treatment of solids
Packaging	Cardboard Boxes; Paper Bags Plastic Bags; Unpackaged	Pails (Plastic); Drums (Metal and Plastic)	Totes; Tanks
Transportation (On-Site)	Commercial waste collection vehicle	Commercial waste collection vehicle	Drain Line System(s), Totes (IP-1, IP-2, or Type A)
Transportation (Off-Site)	Commercial waste collection vehicle	Commercial waste collection vehicle	Drums (IP-1, IP-2, or Type A)
Storage	Staging for transportation	Hazardous Waste Storage Buildings	Drums; Tanks
Processing	Segregation of waste streams for reuse, recycling, or disposal	Biological treatments; Chemical treatments (e.g., neutralization); Physical treatments (e.g., separation or extraction); Thermal treatments (e.g., incineration)	Evaporation, Filtration, Ion Exchange, Physical Separation, Solidification (Bituminize, Cementation or Polymerization)
End of Life (Reuse or Recycle)	Reuse of surplus equipment and select materials (e.g., concrete rubble); Recycling of e-waste, glass, metals, organics, paper products, and plastics	Land treatments of impacted soils; Regeneration of acids/bases; Recovery of components/ organics; Recycling of batteries	Environmental discharge (of liquids that meet environmental release criteria); Reuse for solidification or decontamination
End of Life (Disposal)	Local municipal or commercial landfills regulated at the provincial level	Post-treatment disposal in municipal or commercial landfills regulated at the provincial level	Solidification as LLW or ILW; Secondary Waste as LLW or ILW
Implementing Organization for Disposal	CNL and Municipal Agencies	Municipal Agencies or Supply Chain Vendors	CNL

Table 3B – Waste Management Lifecycle Overview by Class

LLW	ILW	HLW	Lifecycle Element
Planning for the Waste Management Lifecycle, with a focus on waste minimization and diversion.			**Planning**
Alpha Spectroscopy, Dose Measurement, Gamma Spectroscopy, Liquid Scintillation Counting, Mass Spectroscopy, Neutron Counting, Radiochemical Analysis (Analytical and Wet Chemistry Techniques), Radiography; Toxicity Characteristic Leaching Procedure, Visual Examination		Computational models; Dose measurement; Radiochemical Analysis; Safeguards accounting (IAEA)	**Characterization**
Containment of contamination; Handling with respect to ALARA principle; Point-of-generation segregation into streams;	Contact or remote-handling; Containment of contamination; Point-of-generation segregation	Criticality control; Remote handling & monitoring	**Generation**
Drums, Engineered Waste Bags, Metal Containers (B-25s and B-1000s), Sealand Containers	Drums, Metal Containers (B-25s and B-1000s)	Element Storage Cans, Used Fuel Baskets	**Packaging**
Metal Overpacks (as required)	Shielded Transfer Flasks (as required)	Shielded Transfer Flasks (e.g., Fuel Basket Transfer Flask, F-055)	**Transportation (On-Site)**
IP-1 and IP-2 Containers (Drums, Engineered Waste Bags, Sealand Containers), Type A Packages	Type A Packages and Licensed Type B Packages (e.g., OPTIMUS L and H)	Licensed Type B Transportation Packages (e.g., OPTIMUS H, Used Fuel Transportation Package, NAC-LWT)	**Transportation (Off-Site)**
Historical WMAs (Trenches), Recoverable Surface Storage Areas, Shielded Modular Above Ground Storage (SMAGS) Buildings	Bunkers, SMAGS Buildings, Tile Holes	Concrete Canisters, MACSTORs, Tile Holes	**Storage**
Decontamination; Mechanical Segmentation and Size Reduction; Sorting and Segregation	Decontamination, Macroencapsulation; Microencapsulation (for CTM); Compaction; Waste Segregation	Cladding removal and stabilization; Disassembly and sectioning; Pellet formation; Reactivity reduction	**Processing**
Limited: off-site metal melt processing for reuse in the nuclear industry	Not applicable.	Not applicable for HLW (Potential repatriation of non-waste fuels)	**End of Life (Reuse or Recycle)**
Emplacement in Near Surface Disposal Facility or long-term waste management facility; In-situ disposal of NPD & WR-1	Emplacement in a national ILW Deep Geological Repository (disposal facility); In-situ disposal of NPD & WR-1	Emplacement in the national used fuel Deep Geological Repository (disposal facility)	**End of Life (Disposal)**
CNL	NWMO (Recommendation)	NWMO	**Implementing Organization for Disposal**

4. CNL'S FORWARD-LOOKING PLANS

CRL is the only CNL-operated site that has an enduring nuclear mission. The other sites are planning for, or are actively undergoing decommissioning and site closure. The CRL site also has the most substantial and complex radiological waste inventories, in comparison to other CNL sites. As a result, there is a strong focus on the CRL site for forward-looking plans for waste management.

The strategic long-term plan for CNL is enabled through a revitalized CRL site. The CRL main campus is being carefully restored through an integrated strategy of facility decommissioning, environmental remediation, and waste management, which are, in turn, coupled with the construction of new state-of–the-art research facilities. The decommissioning and waste management activities support this plan and improve accessibility to the site and ensure the protection of worker, the public, and the environment.

There are two broad themes:

1. Waste Management Processes, Operations, and Projects: *to support CNL missions;*
2. Waste Management Enabling Capabilities: *to enable the lifecycle management of all CNL managed current and future wastes.*

4.1 FUTURE VISION OF WASTE MANAGEMENT CAPABILITIES

In developing the lifecycle waste strategy for existing waste and future-generated waste, CNL has identified the following facility needs to complement existing capabilities and capacities:

- LLW: *Enhanced characterization capabilities/facilities; enhanced LLW processing capabilities/facilities; expanded LLW surface storage capacities; LLW disposal capability (i.e., Near Surface Disposal Facility)*
- ILW: *Enhanced characterization capabilities/facilities (including radiological monitoring); legacy ILW retrieval systems; ILW processing capabilities/facilities (for Cemented Target Material and Remote-Handled ILW); expanded and enhanced above-ground ILW storage capacities/facilities*
- HLW: *Enhanced characterization capabilities/facilities; HLW conditioning capabilities (to convert select fuels into a configuration eligible for disposal in the national NWMO Deep Geological Repository); expanded and enhanced above-ground HLW storage capacities/facilities*
- Radioactive Liquid Waste: *Enhanced characterization capabilities/facilities; processing capabilities for WL higher hazard liquids; processing facility for Near Surface Disposal Facility waste water, Stored Liquid Waste Treatment System(s), and the replacement capability for CRL's Waste Treatment Centre*

In 2022, CNL released *Vision 2030: A Strategy for a Sustainable CNL – A Vision for the Future of CNL* [CNL, 2022]. Vision 2030 articulates a path for CNL to become a more sustainable, high-performing national laboratory, recognized as a Canadian asset by the general public, viewed as a trusted supplier to customers in the private and public sector and a partner and collaborator with academia, and sought after as an employer of choice, delivering work of national importance.

The Vision 2030 strategy is intended to harness CNL expertise and realign organization focuses on three key priorities: restoring and protecting the environment, advancing clean energy for today and tomorrow, and contributing to the health of Canadians.

Integrated waste management is a key element of realizing Vision 2030; not just for the environmental clean-up mission but to support the efforts to advance clean energy and contribute to health sciences.

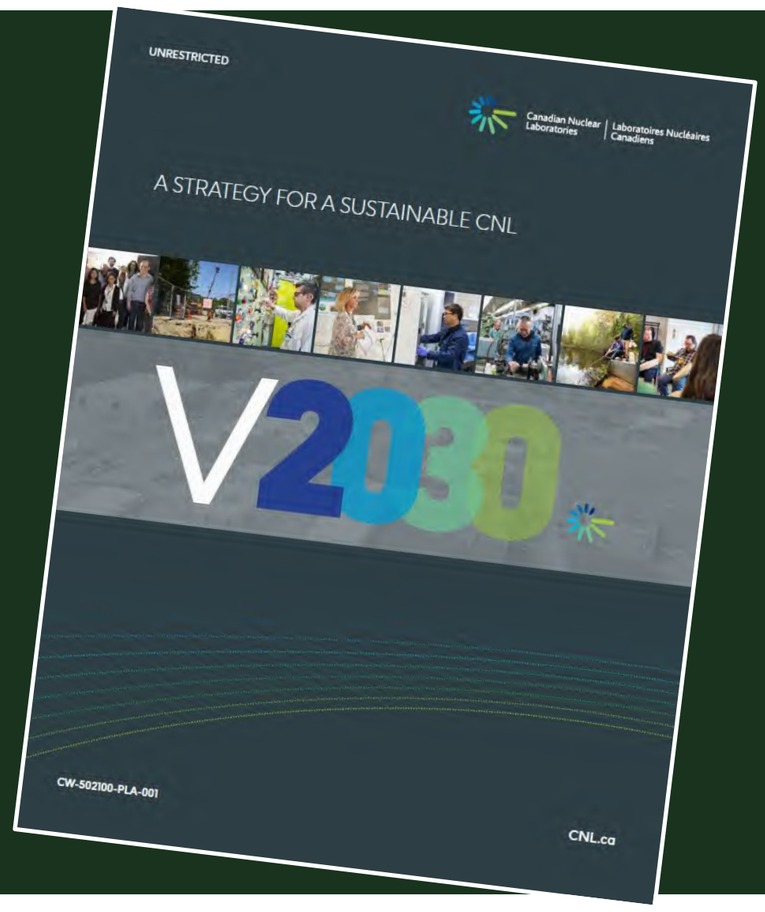


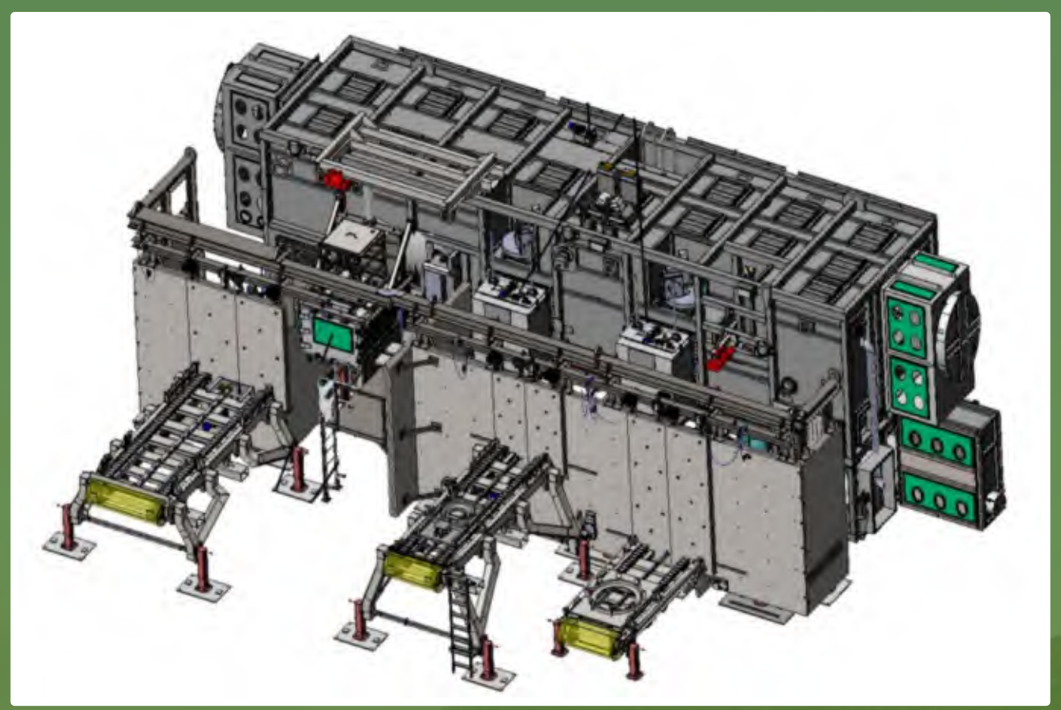
Table 4-1: Waste Infrastructure Summary (Current and Future)

	Lifecycle Element	Clean and Hazardous	LLW	ILW	HLW	Radioactive Liquid Waste
CURRENT	Characterization	Mobile Equipment; Waste Analysis Facility	Commercial Laboratories; Mobile Equipment; Sample Management Office; Waste Characterization Facility	Analytical Chemistry Laboratories; Commercial Laboratories	Analytical Chemistry Laboratories; Fuel and Materials Cells	Sample Management Office; Analytical Chemistry Laboratories
	Processing	Concrete Crushing Facility, Twin Lakes; Waste Analysis Facility	Sort and Segregation Facility; Waste Handling Building; Waste Processing Facility; Waste Reception Centre	NRU Rod Bays; Shielded Facilities; Universal Cells	Fuel Packaging and Storage Building; NRU Rod Bays; Shielded Facilities; Universal Cells	Passive Barriers ; Port Granby and Port Hope Waste Water Treatment Plants; Spring B Pump and Treat Facility; Waste Treatment Centre
	Storage	On-Site Landfills for Clean Waste; Hazardous Waste Storage Buildings	Bunkers, Legacy Trenches/Vaults; Quonsets, Recoverable Surface Storage; SMAGS Buildings;	Bunkers (Cylindrical and Rectangular), SMAGS Buildings; Mixed Waste Storage Buildings; Standpipes; Tile Holes	Concrete Canisters; Fuel Packaging and Storage Building; NRU Rod Bays; Tile Holes	La Prade Heavy Water Storage; NRU Rod Bay Tanks; Stored Liquid Waste Tanks; Waste Treatment Centre Tanks
FUTURE	Characterization	Mobile Equipment (New Technologies and Systems)	Mobile Equipment for In-Situ or Point-of-Generation Characterization; Waste Characterization Laboratory	Standpipes and Bunker Waste Retrieval System; Tile Hole Retrieval Systems; Waste Characterization Laboratory	In-Facility Capabilities; Tile Hole Retrieval Systems	Commercial Laboratories; Waste Characterization Laboratory; Waste Water Treatment Plants
	Processing	Asphalt Recycling and Reuse; Wood Shredding and Recycling	Waste Reduction and Processing Facility	ILW and Cemented Target Material Conditioning Capability/Facility; Sorting and Conditioning Unit; Waste Reduction and Processing Facility	HLW Conditioning Capability/Facility	Intermediate-Level Liquid Waste Treatment System; Waste Water Treatment Plant; Stored Liquid Waste Hazard Reduction System; Waste Treatment Centre Replacement Capability
	Storage	None planned.	Expanded Recoverable Surface Storage Areas	Conditioned ILW Storage Facility; ILW Storage Area; Reconfigured SMAGS	HLW Storage Facility; New Concrete Canisters	Waste Treatment Centre Replacement Capability

Facilities Being Built
(Construction Phase)



CRL HLW Concrete Canister Storage Expansion



WL Sorting and Conditioning Unit

Planned Facilities
(Detailed Design Phase)



Detritiation Capability



CRL Cask Facility

Conceptual Waste Management Capabilities
(Options Analysis Phase)



Modern Waste Management Campus Vision to support recovery and conditioning of legacy ILW and HLW

4. CNL'S FORWARD-LOOKING PLANS

4.2 STRATEGIC OPPORTUNITIES AND RISKS

Within CNL, there is an active commitment to risk and opportunity management for near-term and lifecycle plans and projects. The CNL Waste Strategy Program maintains a program-level Risk Register, with strategic risk mitigation plans and opportunity realization strategies. In alignment with recommended project management principles, Risk Registers are also actively maintained for each waste management project. At a program level, the top five risks and opportunities are presented in the following tables.

Table 4-2.1: Key Strategic Risks

Risk Description	Sites	Impacted Waste Class
If the proposed Near Surface Disposal Facility is not approved, there will be a lack of a disposal pathway for LLW, which would result in significant deferral of CNL's legacy cleanup mission.	CRL, DP, G-1, WL	LLW
If the in-situ decommissioning approach for the NPD and WR-1 reactors is not approved, new decommissioning and waste management approaches will be required, which would result in significant new scope for waste processing, transportation, storage and disposal.	CRL, NPD, WL	LLW & ILW
If there is a significant change to current planning assumptions related to clean-up criteria (land use end state), there is a risk that more waste will be generated, which would result in significant new scope for waste processing, transportation, storage and disposal.	CRL, WL	Hazardous & LLW
If there is an emergent driver to close the CRL Waste Treatment Centre as it nears the end of it's design life, there is a risk that CRL will have limited capacity to manage Radioactive Liquid Waste, which would result in the need to implement alternative approaches.	CRL	Radioactive Liquid Waste
If there is a deferral of current efforts to accelerate the remediation of CRL Waste Management Areas, there is an enhanced risk of storage integrity challenges, which would result in the need for remedial action to maintain safety and environmental protection.	CRL	LLW, ILW, & HLW

Table 4-2.2: Key Strategic Opportunities

Opportunity Description	Sites	Impacted Waste Class
Through the expansion of CNL's Environmental Remediation Mission Area capacities and capabilities, CNL has the opportunity to continue to accelerate CNL's legacy cleanup mission ahead of earlier timelines and commitments.	CRL, DP, G-1, WL	All
Through the construction of the Near Surface Disposal Facility, CNL has the opportunity to lead Canada in the transition from storage to permanent, safe disposal of radioactive waste.	CRL	LLW
Through the construction of new waste management enabling facilities, CNL has the opportunity to create significant economic benefits for the surrounding communities, including local Indigenous Peoples.	CRL	LLW, ILW, & HLW
Through the CNL Fuel Program, CNL has the opportunity to establish the capability to convert ILW and HLW (including fuel types from emerging technologies such as Small Modular Reactors) into a disposal-ready configuration to enable future (off-site) disposal.	CRL, G-1, DP, WL	HLW
Through CNL's Science and Technology Mission Area, CNL has the opportunity to develop and implement new technologies and approaches for discrete elements of the waste management lifecycle.	All	All

4. CNL'S FORWARD-LOOKING PLANS

4.4 WASTE STRATEGY NEAR-TERM ACTION PLAN

Through agreements with the Government of Canada via AECL, CNL is required to plan and deliver on broad commitments for safe, efficient and effective waste management in support of operations, decommissioning and environmental remediation programs. CNL's waste management strategy (Figure 1-1) requires significant resourcing and focus to bridge the strategy-to-execution gap. The Waste Strategy Program maintains a detailed Action Log, with select summary actions listed in the following table to represent key elements of the waste strategy implementation plan, which will continue to leverage the experience, knowledge and perspectives of CNL resources from across Canada.

Table 4-4: Integrated Waste Strategy Action Plan

Focus Action	Summary of Actions	Targeted Waste Class
Lifecycle Plans	Improve and optimize lifecycle plans with a focus on: • Transitioning from storage framework to disposal frameworks for radioactive wastes • Detailed lifecycle mapping of waste for discrete projects/programs • Minimizing the potential for re-work with a focus on creating "disposal ready" waste packages	All
Indigenous Engagement	Use the CNL Integrated Waste Strategy as a mechanism for engagement with Indigenous Peoples on the overall strategy and discrete projects.	All
Stakeholder Engagement	Use the CNL Integrated Waste Strategy as a mechanism for engagement with internal (CNL) and public stakeholders.	All
Sustainability	Track CNL's performance against key sustainability measures for waste management to identify, evaluate and implement continuous improvement actions.	All
Waste Forecasts	Continue to improve and optimize the CNL-wide Waste Forecast data based on improved characterization data and time-phased profiles.	All
Clean Waste Disposal	In collaboration with surrounding communities, establish long-term disposal solutions (e.g., landfill/capacity expansions) to enable the disposal of non-radiological waste.	Clean
CRL Enabling Facilities for Nuclear Liabilities	Progress the planning and implementation of the following enabling facilities/capabilities: • Environmental Remediation (including Groundwater Processing) • High-Level Waste (HLW) Conditioning • HLW & Intermediate-Level Waste (ILW) Storage • ILW and Low-Level Waste (LLW) Processing • Radioactive Liquid Processing System(s) • Retrieval Systems for legacy HLW and ILW • Transportation Package (Cask) Handling • Tritiated Heavy Water Management • Utility and Security Infrastructure Enhancement	LLW, ILW, HLW, Radioactive Liquids
ILW Disposal	Drive CNL's evolution from processing and packaging for *storage* to processing and packaging for *disposal*, while evolving CNL's plan to align with the national Integrated Strategy for Radioactive Waste.	ILW
In-Situ Disposal	Complete the regulatory approval processes for the in-situ disposal of the NPD and WR-1 Reactors, and implement the in-situ decommissioning approach.	LLW and ILW
LLW Disposal	Complete the regulatory approval process for the Near Surface Disposal Facility at the CRL site and begin construction.	LLW
Waste Certification	Improve and optimize the CNL waste assurance processes to include a Waste Certification process for disposal readiness.	LLW and ILW
HLW Disposal	Evaluate and confirm the approach/strategy to convert research reactor fuels and other enriched fuels into a configuration to meet the Waste Acceptance Criteria for the planned national Deep Geological Repository.	HLW

5. ENGAGEMENTS AND REGULATORY OVERSIGHT

5.1 REGULATORY OVERSIGHT

In Canada, matters related to nuclear activities and substances are under the jurisdiction of the Government of Canada. For all CNL-operated sites, the CNSC provides regulatory oversight.

The CNSC mandate is to regulate the use of nuclear energy and materials to protect health, safety, security and the environment; to implement Canada's international commitments on the peaceful use of nuclear energy; and to disseminate objective scientific, technical and regulatory information to the public.

The CNSC is responsible for the regulatory oversight of the management of radioactive waste, including, as applicable, handling, processing, transport, storage and disposal of that waste. The CNSC's regulatory framework consists of laws passed by Parliament, as well as licences and regulatory documents issued and/or used by the CNSC to regulate the nuclear industry. The following are the statutes used to regulate and oversee the nuclear industry in Canada; the statutes include the management of radioactive waste:

- *Nuclear Safety and Control Act*
- *Nuclear Energy Act*
- *Nuclear Fuel Waste Act*
- *Nuclear Liability and Compensation Act*
- *Impact Assessment Act*
- *Canadian Environmental Protection Act*
- *Fisheries Act*

Several Government of Canada departments are involved in administering this federal legislation. When multiple regulators are involved, the CNSC establishes joint regulatory groups to coordinate and optimize the regulatory efforts necessary. In addition, the nuclear industry is subject to the provincial legislation and regulations in force in the individual provinces and territories where nuclear-related activities are carried out. Where an overlap occurs in jurisdictions and responsibilities, the CNSC takes the lead in efforts to harmonize regulatory activities, including those of joint regulatory groups that involve provincial and territorial regulators.

When making regulatory decisions about the management of radioactive waste, the CNSC will seek to achieve its objectives by considering certain key principles in the context of the facts and circumstances of each case, as follows:

- The generation of radioactive waste is minimized to the extent practicable by the implementation of design measures, operating procedures and decommissioning practices.
- The management of radioactive waste is proportionate to its radiological, chemical and biological hazard to the health and safety of persons, to the environment and to national security.
- The assessment of future impacts of radioactive waste on the health and safety of persons and the environment encompasses the period of time during which the maximum impact is predicted to occur.
- The predicted impacts on the health and safety of persons and the environment from the management of radioactive waste are no greater than the impacts that are permissible in Canada at the time of the regulatory decision.
- The measures needed to prevent unreasonable risk to current and future generations from the hazards of radioactive waste are developed, funded and implemented as soon as reasonably practicable.
- The trans-border effects on the health and safety of persons and the environment that could result from the management of radioactive waste in Canada are not greater than the effects experienced in Canada.

All content in this section has been taken directly from the CNSC [CNSC, 2022].







5. ENGAGEMENTS AND REGULATORY OVERSIGHT

5.2 PUBLIC ENGAGEMENTS

CNL is committed to organizational transparency, ensuring that Indigenous Peoples, the general public, local communities, elected and appointed government officials, and other industry stakeholders are properly informed about activities carried out at CNL sites. This commitment is met through the company's Public Information Program, a communications program that was developed to build public awareness and trust, and to encourage transparent and proactive communication with its various stakeholders. CNL's Public Information Program includes specific communications to stakeholders, public access to information related to routine activities, radiological and non-radiological emissions, and non-routine items or events at the different sites managed by CNL [CNL, 2021].

Through the Public Information Program, CNL routinely reports the results of environmental management programs to sustain open and transparent communication with stakeholders and to assure that the impacts are below regulatory limits. For waste management, this Program enables communication on:

- Historical practices in recognition that CNL, and formerly AECL, have been safely managing radioactive wastes since 1952
- Current approaches to waste management at sites across Canada
- Future plans for waste management, recognizing the increasing desire and intention to engage as part of the decision-making process

For discrete projects, such as the Port Hope Area Initiative Project or Near Surface Disposal Facility, there are focused engagement efforts. For the strategic view of waste management across CNL, this Integrated Waste Strategy is intended to serve as an important communication tool for public and Indigenous Peoples awareness, and engagement.

Port Hope Area Initiative Public Information Program

The PHAI Public Information Program ensures effective communication with the Port Hope and Port Granby communities to build and maintain confidence in CNL and the PHAI. An adaptive approach allows CNL to proactively share information and remain responsive to a diverse audience including residents, property owners, businesses, municipalities, media and special interest groups.

CNL is committed to sharing information in a manner that earns public trust, identifies and understands issues and values, and builds and maintains community acceptance and support of the PHAI.

Ongoing dialogue and opportunities to provide feedback ensure that the communities are knowledgeable about upcoming work and project activities and questions, issues and concerns are identified and addressed [CNL, 2022].

5. ENGAGEMENTS AND REGULATORY OVERSIGHT

5.3 INDIGENOUS ENGAGEMENT

Engagement activities include meetings, information sharing, site tours and opportunities for observation and field demonstrations of project activities. CNL has also worked to establish memorandums of understanding, long-term relationship agreements, and environmental monitoring programs with Indigenous Peoples surrounding various CNL sites.

In 2016, CNL began an Indigenous Engagement Program to directly support the environmental assessment processes for three decommissioning and waste management projects (NPD, Near Surface Disposal Facility, and WR-1 projects). The Program has grown and encompasses CNL's entire operations where CNL conducts business across Canada. This work is guided by a commitment to developing strong relationships with First Nations, Métis and Indigenous organizations. This is cultivated through meaningful opportunities for dialogue and participation. This journey relies on listening and learning, and CNL has worked to better understand the culture, needs and challenges of Indigenous First Nations and Métis. This includes the manner in which communities wish to be engaged.

CNL is on a reconciliation journey to learn about the history of Indigenous Peoples in Canada and to take meaningful actions. CNL is building positive long-term relationships with Indigenous Peoples based on mutual understanding and respect. CNL and Indigenous Peoples are collaborating in several key areas, employment, training, economic development capacity building and environmental monitoring.

Looking forward, CNL recognizes that the participation of Indigenous People in our waste management work ensures that we properly consider traditional Indigenous knowledge, and that is a key consideration in our future planning. All of these engagements and activities are being carried out under a commitment to collaboration and mutual respect, and with the goal towards ongoing participation and relationship-building.











CNL Integrated Waste Strategy



Mechanisms for Engagement:

- Community Events
- Committees (Community Advisory Panel [CRL], Environmental Stewardship Council [CRL], Public Liaison Committee [WL])
- Long-Term Relationship Agreements and/or Memorandums of Understanding
- Open Houses
- Presentations
- Public Information Sessions
- Site Tours
- Social Media (Posts and YouTube videos)
- Webinars













6. SUSTAINABILITY IN WASTE MANAGEMENT

Across CNL, there is a clear understanding that the actions of today have implications for tomorrow. This is why CNL has embraced sustainability as an organization, and why sustainable principles and practices are incorporated into all of the CNL waste activities – to minimize the burden we place on future generations.

To organize these efforts, CNL has aligned with AECL's strategy to identify 14 focus areas of sustainability where CNL will deliver continuous improvement in our work. CNL has also adopted a holistic approach to this work which ensures that CNL planning and goals are fully aligned with the Government of Canada's vision for a more sustainable Canada.

CNL enterprise-wide waste management exemplifies key elements to directly enable improved performance is focus areas, with the CNL Integrated Waste Strategy as a key mechanism to drive environmental and social elements of CNL's sustainability strategy [CNL, 2022].

Recognizing CNL's need for new waste management enabling infrastructure, there are opportunities to incorporate elements of social and governance objectives into the strategy implementation. New facilities also have to demonstrate optimized lifecycle carbon accounting and energy efficiency targets.

Figure 6-1: CNL Sustainability Focus Areas and Objectives

Environmental	Social	Governance
Carbon Emissions Energy Efficiency Climate Resilience Biodiversity Radioactive Waste Management Waste Management Water & Wastewater Management	Diversity & Inclusion Heath & Safety Community Engagement Indigenous Relations Sustainable Work Environment	Economic Development Sustainable Procurement

Waste Management Objective: Prevent and Minimize the production of conventional waste, wherever possible, while reusing and recycling waste when it is generated.

Performance Target #1: Diversion of Operational Waste from Landfills:
Divert at least 75% by weight of non-hazardous operational waste from landfills by 2030.

Performance Target #2: Diversion of Plastic Waste:
Divert at least 75% by weight of plastic waste from landfills by 2030.

Performance Target #3: Diversion of Construction and Demolition Waste from Landfills:
Divert at least 90% by weight of all construction and demolition waste from landfills and striving to achieve 100% by 2030.

Radioactive Waste Management Objective: Support the Government of Canada's commitment to a clean and healthy environment for Canadians.

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APPENDIX A - GLOSSARY

Clean Waste	Non-hazardous material that is declared to be non-radioactive by its history, location and use; or non-hazardous material that has been determined to meet regulatory requirements for unconditional clearance.
Hazardous Waste	Solid, liquid or gaseous waste material, other than a radioactive material, that may pose a potential hazard to human health or the environment when improperly treated, stored, transported or disposed of, or otherwise managed, and as specified in applicable regulations.
High-Level Radioactive Waste	HLW is used nuclear fuel that has been declared as Radioactive Waste and/or is waste that generates significant heat via radioactive decay. HLW typically has levels of activity concentration in the range of 10^4 to 10^6 TBq/m^3. HLW is associated with penetrating radiation, and thus shielding is required. HLW also contains significant quantities of long-lived radionuclides necessitating long-term isolation.
Intermediate-Level Radioactive Waste	ILW generally contains long-lived radionuclides in concentrations that require isolation and containment for periods greater than several hundred years. ILW needs no provision, or only limited provision, for heat dissipation during its storage and disposal. Due to its long-lived radionuclides, ILW generally requires a higher level of containment and isolation than can be provided in near surface repositories.
Legacy Waste	Radioactive or non-radioactive wastes from discontinued historical activities and were managed (generated, characterized, processed, packaged and stored) in a manner that was appropriate at the time but may or may not meet modern standards.
Low-Level Radioactive Waste	LLW contains material with radionuclide content above established unconditional clearance levels and exemption quantities (set out in the *Nuclear Substances and Radiation Devices Regulations* [Government of Canada, 2015]), but generally has limited amounts of long-lived radionuclides. LLW requires isolation and containment for periods of up to a few hundred years and is suitable for disposal in near surface facilities.
Radioactive Waste	A gas, liquid, sludge, or solid that has been declared as a waste and contains a nuclear substance in excess of the clearance or exemption criteria and without foreseeable use
Waste	Residual material, generated as a result of a process, operation or activity that has no further use and is declared for reuse, recycling or disposal.
Waste Acceptance Criteria	Quantitative or qualitative criteria, specified by the Waste Receiver, for the waste to be accepted for processing, storage or disposal at a Waste Management Facility. In the case of Radioactive Waste, the Waste Acceptance Criteria is used to determine the acceptability of the Radioactive Waste and its packaging for storage or disposal in a receiving facility.

APPENDIX A - GLOSSARY

Waste Certification	The Quality Assurance System for ensuring Waste Management Processes are documented and monitored, and wastes are effectively managed to the degree necessary so the waste meet the acceptance criteria of its intended receiver.
Waste Characterization	The determination of the physical, chemical, biological, and Radiological Waste characteristics for use to determine further handling, processing, and storage or disposal requirements.
Waste Classification	Assigning waste class based on its physical, chemical, biological and radiological characteristics.
Waste Conditioning	Operations that produce a waste form suitable for handling, transport, storage and/or disposal.
Waste Disposal	Emplacement of waste in an appropriate facility without the intention of retrieval.
Waste Hierarchy	A framework for waste management decision making that applies waste minimization techniques to reduce the volume of all waste types, to as low as practicable. These techniques shall be considered in order, at the onset of all planned work, i.e., at source, and are: prevent, reduce, reuse, recycle, and dispose.
Waste Management Lifecycle	A series of stages including planning, generation, transport, processing, storage and disposal of waste.
Waste Minimization	The process of reducing the amount of waste (and activity of radioactive, if applicable) to a level as low as reasonably achievable, at all stages from the design of a facility or work activity to decommissioning through the Waste Hierarchy.
Waste Pre-Treatment	Any or all of the operations prior to waste treatment, such as collection, segregation, chemical adjustment and decontamination.
Waste Processing	Any operation that changes the characteristics of waste, including pre-treatment, treatment and conditioning.
Waste Storage	The holding of waste in a facility that provides for containment, with the intention of retrieval.
Waste Treatment	Operations intended to benefit safety and/or economy by changing the characteristics of the waste. Three basic treatment objectives are: volume reduction, removal of radionuclides from the waste, change of composition.

APPENDIX B - INTEGRATED WASTE STRATEGY PROGRESS REVIEW

Table B-1: Integrated Waste Strategy Progress Review from Last Revision

Integrated Waste Strategy Action	Progress since Integrated Waste Strategy Rev. 1 (2019)
Identify and prioritize waste characterization gaps.	CNL has established improved guidance (e.g., Waste Characterization Handbook) and expanded internal capabilities (e.g., CRL Waste Characterization Facility) in response to identified gaps.
Develop technical and programmatic improvements to address gaps with a focus on Facilities Decommissioning (FD) and Environmental Remediation (ER) across CNL.	CNL has established the Cleanup Function to provide consistent processes and procedures to enable decommissioning and remediation activities. The Cleanup Function includes the Land Use Program, the Decommissioning and Demolition Program, and the Environmental Remediation Program.
Produce long term strategies to enable reliable processes to be put in place to align with best practice.	CNL has continued to refine the development of credible, underpinned and deliverable lifecycle strategies in alignment with relevant good practices. For example, WL has a site-wide restoration and closure plan and CRL has a lifecycle liability management plan.
Ongoing inventory and forecast refinement as assumptions and risks identified are mitigated.	CNL has continued to revise and refine the quality (accuracy and precision) of both the existing waste inventories (i.e., what has been generated and is in storage) and waste forecasts (i.e., what is estimated to be generated in the future). The CNL inventories and forecasts will continue to be refined through characterization activities across all CNL-operated sites.
Review processing technology requirements (based upon previous studies), identify areas requiring further assessment and develop standard waste treatment approaches for specific waste streams and waste types.	Since 2019, CNL has implemented new capabilities for legacy LLW management, with a focus on sorting and segregation through the centralized Sort and Segregation Facility at CRL. CNL has reviewed processing techniques for various types of LLW, ILW, HLW, and Radioactive Liquid Waste. Some approaches have been selected (e.g., heavy water detritiation, approach for processing the contents of ILW Standpipes at WL), while options evaluations are ongoing for various other discrete waste challenges (e.g., used fuel conditioning).
Carry out option studies as required.	CNL has initiated or completed options studies on Cemented Target Material management, heavy water management, HLW conditioning, HLW storage, ILW processing, ILW storage, transportation package (cask) management, and various decommissioning and remediation projects. CNL regularly uses the Best Available Techniques approach for multi-criteria decision-analysis.
Review and implement interim storage and waste package options to support missions.	CNL has completed various storage options analyses to review available and planned capacities and capabilities, including an ILW Storage Strategy Review and an ongoing plan to maintain optimized LLW storage prior to the operations of the proposed Near Surface Disposal Facility. CNL has also developed a “Waste Packaging Catalogue” to document approved packages for various types of waste.

Table B-1 (continued): Integrated Waste Strategy Progress Review from Last Revision

Integrated Waste Strategy Action	Progress since Integrated Waste Strategy Rev. 1 (2019)
Proposed Near Surface Disposal Facility Project.	CNL has made significant progress on the Near Surface Disposal Facility, including the following achievements: 2019 November: *CNL submitted the revised draft Environmental Impact Statement to the CNSC that addressed comments on the previous draft* 2021 May: *CNL submitted the final Environmental Impact Statement to the CNSC with responses to public and Indigenous comments* 2021 July: *CNSC Staff confirm the licensing application package is acceptable* 2022 February: *CNSC Commission Hearing Part 1* 2022 May/June: *CNSC Commission Hearing Part 2* 2022 July: *Procedural Direction announced to enable more engagement with two Indigenous Nations*
Identify right size solution for management of waste destined for a yet to be determined ILW disposal facility.	CNL has utilized waste inventory and forecast data to improve the organizational understanding of the storage need, reflective of the various levels of ILW (i.e., Contact-Handled ILW and Remote-Handled ILW). The storage needs include consideration of pre-disposal management activities, such as processing and packaging, and include scenario analysis to reflect variability.
Continue to cooperate and coordinate with Nuclear Waste Management Organization regarding all CNL managed fuel.	CNL has continued to work closely with the NWMO to ensure the AECL-owned inventory will be disposed of in the national Deep Geological Repository. In particular, CNL has worked collaboratively on identifying, evaluating, and defining solutions for conditioning of research reactor fuels (with various physical characteristics and enrichment levels) to ensure it can be safely and compliant disposed in the NWMO Deep Geological Repository.
Prioritize projects requiring option studies, which have been identified and agreed upon with internal stakeholders and subject matter experts.	With a multi-decade plan of remediation of sites across Canada, CNL has continued to evaluate project priorities. Multiple options evaluations, of various complexity, have been completed that leverage inputs from a broad array of experts (both internal and external to CNL) and stakeholders. Further, building upon the learning from the Near Surface Disposal Facility Project, CNL has progressed relationships with Indigenous Peoples in recognition of the value that their knowledge and perspective can add to the decision-making process.
Continue to identify and assess projects until complete.	CNL continues to identify and assess a portfolio of projects with varying levels of scale and complexity, with a focus on continuous improvement of project governance, delivery and performance. For nuclear liability projects, there is a focus on lifecycle planning (e.g., any enabling facility has a project phase, an operational phase, and a decommissioning phase). Key waste management or waste generating projects that are being proactively monitored include the CRL B250 Decommissioning, CRL Cask Facility Project, CRL Controlled Area Decommissioning Project, CRL Environmental Remediation Projects (including Waste Management Areas), CRL Heavy Water Detritiation Facility Project, CRL Near Surface Disposal Facility Project, CRL NRU and NRX Decommissioning Projects, CRL Stored Liquid Waste Management Project, Douglas Point Reactor Site Decommissioning, Fuel Repatriation Projects, Gentilly-1 Reactor Site Decommissioning, Off-Site Fuel Consolidation Projects, Port Hope Area Initiative, Waste Data Tracking Systems Project, and the Whiteshell Restoration Project.

Table B-1 (continued): Integrated Waste Strategy Progress Review from Last Revision

Integrated Waste Strategy Action	Progress since Integrated Waste Strategy Rev. 1 (2019)
Roll out strategy to ensure the appropriate parties are engaged and aware of the Integrated Waste Strategy	In 2022, CNL established a new Waste Strategy Program Team. In alignment with Guiding Principle #3, this team completed over eighty (80) engagements with internal and external stakeholders and Indigenous Peoples. These engagements included presentations, workshops, discussions, and tours. The engagements were intended to both provide an overview of the Integrated Waste Strategy for awareness, and also to solicit feedback and perspectives to be incorporated in the Integrated Waste Strategy future revisions.
Ensure that all wastes continue to be captured in the Integrated Waste Strategy, and progress on identified gaps is ongoing	The scope of the CNL Integrated Waste Strategy involves all wastes at all sites. However, the CNL Integrated Waste Strategy is a summary-level document that is underpinned by hundreds of other references. The technical details on specific waste stream are within the scope of CNL's overall Waste Strategy (Figure 1-1). CNL actively monitors the implementation of preferred options to resolve technical gaps, recognizing the monitoring varies with complexity of the solution. The CNL Waste Strategy Program Team, along with the hundreds of CNL employees involved in waste management, continue to identify lifecycle gaps, risks and opportunities.
NPD Project Progress	The NPD-based team has worked closely with regulatory agencies, public stakeholders and Indigenous Peoples to progress this Project. The Environmental Impact Statement was submitted to the CNSC in 2021; a revised version will be re-submitted in 2023.
WR-1 Project Progress	The WL-based team has worked closely with regulatory agencies, public stakeholders and Indigenous Peoples to progress this Project. The Environmental Impact Statement was submitted to the CNSC in 2022 with a completeness check completed in early 2023.
Port Granby Long-Term Waste Management Facility Progress	The engineered above-ground storage mound at the Port Granby Long-Term Waste Management facility was capped and closed in 2021. This Facility now provides safe long-term management of ~800,000 m^3 (1.3 million tonnes) of waste.
Port Hope Long-Term Waste Management Facility Progress	As of 2022, approximately ~850,000 m^3 (1.4 million tonnes) of historic waste has been excavated from several sites in Port Hope and safely placed in the Port Hope Long-Term Waste Management Facility as remediation and restoration work continues.
Northern Transportation Route Project Progress	In 2021, CNL completed Phase 1 to establish temporary storage areas in Fort Fitzgerald (Alberta) and Fort Smith (Northwest Territories). Phase 2 is current underway.

Figure B-1: Northern Transportation Route Project – Phased Project Plan



APPENDIX C - CNL WASTE MANAGEMENT SUCCESS STORIES



CNL'S REPATRIATION PROGRAM

Over the period of 2015-2022, CNL safely and successfully completed over 170 repatriation shipments of used fuel (highly enriched fuel from CRL reactors) and highly-enriched uranyl nitrate (also referred to as Target Residue Material) to the United States. These materials represented some of the highest hazard nuclear liabilities in Canada and were permanently dispositioned off-site for recycling and reuse.



FUEL PACKAGING AND STORAGE FACILITY

In 2020, CNL completed the Fuel Packaging and Storage (FPS) Project to retrieve, dry, and store 96 legacy historic used fuel cans. This Project was initiated in 2004 in response to the identification of moisture in early tile holes from the 1950s and 1960s. The FPS Project safely recovered the historic used fuel cans, which were then transferred to the FPS Building to dry each of the cans and then place them into a passive and safe storage configuration.



PORT GRANBY LONG-TERM WASTE MANAGEMENT FACILITY

In 2021, CNL completed the capping and closure of the engineered aboveground mound at the Port Granby Project Long-Term Waste Management Facility. This mound was closed after the emplacement of approximately 800,000 m^3 (1.3 million tonnes) of contaminated soil and industrial waste that was excavated and transferred from the Lake Ontario shoreline.



SORT AND SEGREGATION FACILITY

Over the period of 2018-2021, CNL designed, licensed, constructed and commissioned a facility to sort, segregate, and package legacy LLW. The Sort and Segregation Facility, located at CRL's Waste Management Area, is currently operational and is actively used to segregate clean waste from LLW, volume reduce suitable LLW, package LLW, and confirm it is disposal-ready.





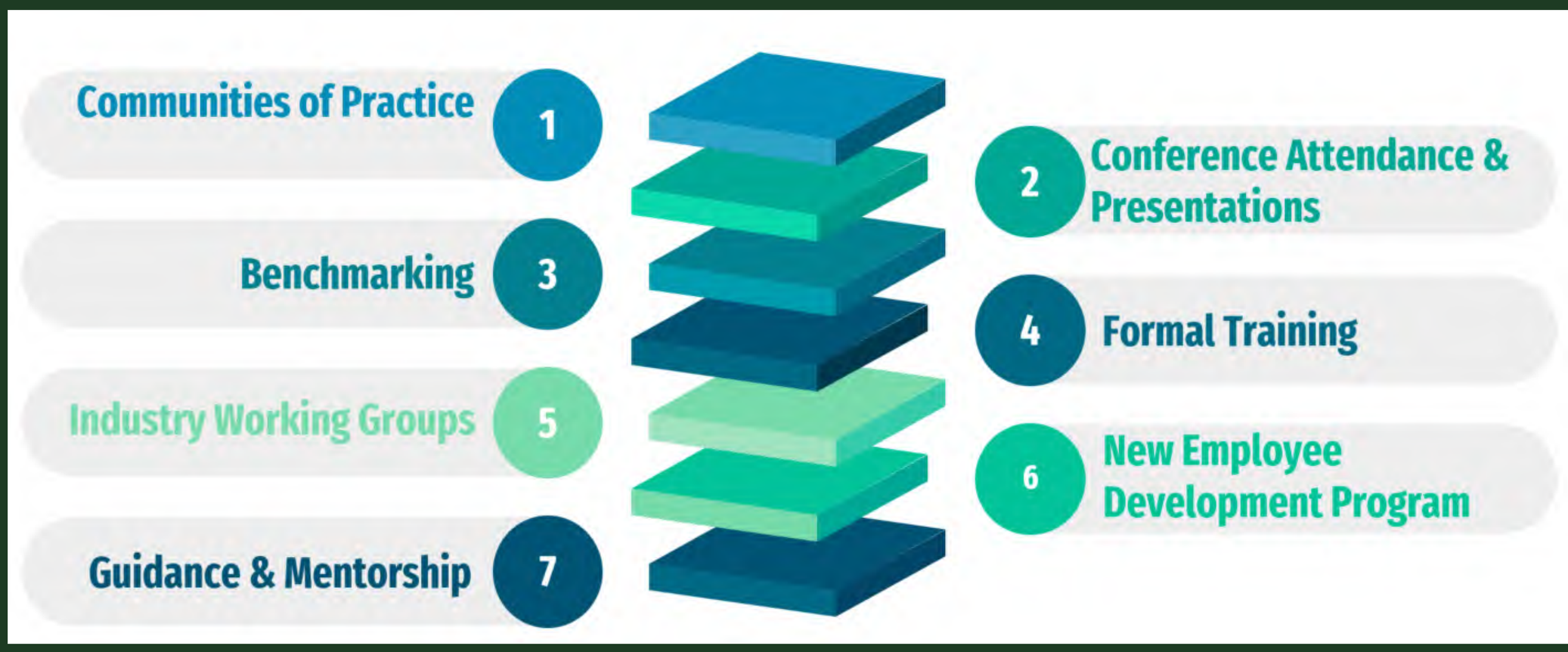


APPENDIX D - WASTE MANAGEMENT KNOWLEDGE MANAGEMENT FRAMEWORK

Waste Management Knowledge and Expertise Creation and Acquisition

Culture of Knowledge Sharing

Core Components of Expertise and Knowledge Transfer



Implementation of Lessons Learned

Knowledge Transfer Between CNL-Operated Sites

Chalk River Laboratories | Douglas Point | Gentilly-1 | Nuclear Power Demonstration | Port Hope | Whiteshell Laboratories

Transparency and Availability of Information

UNRESTRICTED

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

This is a stylized version of: Canadian Nuclear Laboratories. (2023 September). *Canadian Nuclear Laboratories Integrated Waste Strategy*. CW-508600-PLA-002, Revision 2.1.

This revision of the CNL Integrated Waste Strategy was developed and written by Jérôme Besner, Dr. James Doyle, Sean Gamley, Lynne Jones, and Paul Saunders, with extensive input from across CNL.