Canada's Nuclear Regulator

Uranium Levels in Soil Samples Around GE Hitachi Nuclear Energy Canada Inc., Toronto Facility

Key finding: Uranium levels pose no health risk.

October 2013

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EXECUTIVE SUMMARY

The Canadian Nuclear Safety Commission (CNSC) regulates the use of nuclear energy and materials to protect health, safety, security and the environment, and to implement Canada's international commitments on the peaceful use of nuclear energy.

GE Hitachi Nuclear Energy Canada Inc. (GEH-C) is licensed and regulated by the CNSC. GEH-C has owned and operated a nuclear facility located at 1025 Lansdowne Ave. in Toronto, Ontario since 1955. The facility produces uranium dioxide (UO_2) pellets for use in nuclear power plants. In October 2012, residents living near the facility raised concerns about the concentration of uranium in soil resulting from the facility's air emissions. GEH-C provided soil sampling reports to the public that demonstrated uranium levels are below the applicable soil quality guidelines; however, concern continued to mount. To address the public concern, the Ontario Ministry of Environment (MOE) undertook independent soil sampling in public areas.

The MOE's soil sampling coincided with GEH-C's regularly scheduled annual sampling, and each performed its own soil sample collections in June 2013. The CNSC was present and requested split samples from both sampling campaigns so it could conduct its own independent analysis to verify results.

The CNSC's overall conclusion, based on the licensee's monitoring data and the analysis of the soil samples, is that uranium concentrations in soil around the GEH-C Toronto facility are well below the accepted standards for protection of human and environmental health. The public living near the facility and the environment are protected and safe from the facility's nuclear activities.

Naturally Occurring Uranium and Soil Quality Guidelines

Uranium is a naturally occurring alpha-emitting radioactive element; it is present at low levels in various rocks and ores, soil, water, air and plants as well as animal tissue. In Ontario, natural background levels of uranium in soil are generally below 2.5 µg/g (micrograms per gram).

To protect human health and the environment, soil quality guidelines have been established by the Canadian Council of Ministers of the Environment (CCME). The guidelines represent levels of uranium in soil below which no risk to human health is expected. For residential and parkland land use, the guideline is 23 µg/g; for commercial use, the guideline is 33 µg/g. Findings higher than these guidelines would suggest there may be a need for further investigation, to determine the source of the uranium in soil and the potential site-specific health risks.

GEH-C Soil Samples – Facility Perimeter

GEH-C collected samples at 49 locations around the facility's perimeter; from those, the CNSC requested eight split samples. The CNSC's laboratory analysis results of the 8 samples showed that concentrations of uranium at all but three sample locations were below the Ontario background level of 2.5 µg/g. The three soil samples with elevated concentrations ranged from 4.7 to 21.2 µg/g and are consistent with results submitted annually to the CNSC in the GEH-C annual compliance report. The highest concentration was found near the railroad tracks. However, all results were lower than the applicable CCME commercial soil quality guideline for uranium of 33 µg/g.

MOE Soil Samples – Public Areas

The MOE collected samples in 24 public area locations surrounding the Toronto facility. The CNSC's laboratory analysis results of these samples showed that concentrations of uranium at 22 out of 24 sample locations were below the Ontario background level of 2.5 µg/g. At two sample locations, the concentrations of uranium were only slightly elevated, ranging from 2.53 to 2.93 µg/g. All sample locations had uranium in soil concentrations lower than the applicable CCME residential soil quality guideline for uranium of 23 µg/g.

This report also provides a summary of the routine monitoring programs at GEH-C. All releases to the environment are well below regulatory limits.

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Uranium Levels in Soil Samples Around GE Hitachi Nuclear Energy Canada Inc., Toronto Facility

1. Context

The CNSC licenses and regulates GE Hitachi Nuclear Energy Canada Inc. (GEH-C). GEH-C has owned and operated a nuclear facility located in Toronto, Ontario since 1955. The facility produces uranium dioxide (UO_2) pellets for use in nuclear power plants. In October 2012, residents living near the facility raised concerns about the concentration of uranium in soil resulting from the facility's air emissions. GEH-C provided soil sampling reports to the public that demonstrated uranium levels below guidelines; however, concern continued to mount. To address the public concern, the Ontario Ministry of Environment (MOE) undertook independent soil sampling in public areas.

The MOE's soil sampling coincided with GEH-C's regularly scheduled annual sampling, and each performed its own soil sample collections in June 2013. The CNSC was present and requested split samples from both sampling campaigns in order to conduct its own independent analysis to verify results.

This report documents historical data of the GEH-C environmental monitoring program and the CNSC laboratory analysis results of uranium in soil samples.

2. Background

2.1 Description of GE Hitachi Nuclear Energy Canada

GEH-C's facility is located at 1025 Lansdowne Avenue in Toronto, Ontario and has operated since 1955. The facility produces UO_2 pellets from UO_2 powder received from Cameco's Port Hope uranium conversion plant. The majority of these pellets are shipped to GEH-C's Peterborough facility where they are assembled into nuclear fuel bundles. Small quantities of pellets are also shipped to GEH-C's nuclear fuel plant in Wilmington, North Carolina.

2.2 Uranium releases

Uranium release limits for the Toronto facility are prescribed in GEH-C's operating licence FFOL-3620.00/2020 issued by the CNSC. These limits are in place to control releases and ensure the protection of the heath and safety of the public and of the environment.

2.2.1 Air emission releases

GEH-C controls and monitors all air effluent releases at its Toronto facility by continuous in-stack sampling and boundary air monitoring at the perimeter of the facility.

The exhaust of the facility is filtered and sampled as it is being released to the atmosphere. The uranium released from the stack disperses through the air, and some uranium is deposited on the ground in small quantities. The total amount of uranium released in a year is expressed in kilograms/year (kg/yr) for comparison with the regulatory release limit.

As additional precautionary measures, uranium is monitored in air (expressed in micrograms per metre cubed ($\mu g/m^3$) for comparison with the MOE air quality standard) (see figure 1), and in soils (expressed in micrograms per gram (μg/g) for comparison with the CCME guidelines for uranium in soil) (see table 2).

The quantities of uranium released annually to the environment through air emissions for the past five years are shown in table 1.

Table 1: Uranium released through air emissions (2005–12)

Parameter	2005	2006	2007	2008	2009	2010	2011	2012	Licence limit
Toronto total uranium discharged to air (kg/yr)	0.013	0.013	0.013	0.015	0.013	0.017	0.009	0.013	**0.76**

2.3 Exposure to uranium

People can be exposed to uranium from the environment by inhaling air and dust and ingesting water, soil and vegetation. Naturally occurring uranium poses very little radiological danger because it is present in small amounts in the environment. Uranium is not considered a human carcinogen, and genetic effects of radiation from uranium have not been observed at any level of exposure.

The chemical toxicity of uranium is considered a greater health concern and has a greater potential to cause observable effects than its radioactive properties. Its toxicity depends on the route of exposure (inhaled or ingested) and the solubility of its chemical form (compounds). The most soluble, and therefore readily absorbed, uranium compounds are kidney toxicants if ingested or inhaled in large enough amounts. The primary potential health effect of high levels of uranium exposure is kidney disease.

Uranium exposure limits and guidelines developed by various government agencies to protect human health are based on the chemical toxicity properties of uranium, rather than its radiological properties. This is because the concentrations of uranium that would pose a chemical risk are lower and more restrictive than the concentrations that would pose a radiological risk. Exposure to uranium concentrations at or below the guidelines would result in a radiation dose below the CNSC dose limit in the *Radiation Protection Regulations* (1 mSv per year for members of the public).

2.4 Uranium soil quality guidelines

In 2007, the Canadian Council of Ministers of the Environment (CCME) published soil quality guidelines for uranium after a comprehensive review of its physical and chemical properties, sources and concentrations in the environment, behaviour and effects in biota and humans, and environmental behaviour.

According to the CCME protocol, both environmental and human health soil quality guidelines were developed for four land uses: agricultural, residential/parkland, commercial, and industrial. The lowest value generated by the two approaches (i.e., environmental and human health) for each of the four land uses is recommended by CCME as the soil quality guideline.

The CCME guidelines are 23 µg/g for agricultural use and for residential/parkland use, 33 µg/g for commercial use and 300 µg/g for industrial use. The most restrictive CCME guidelines (i.e., residential/parkland land use criterion) are based on assessment of non-cancer risk to critical receptor (young children) from the direct contact exposure to uranium in soil including oral ingestion and skin contact.

In 2011, the Ontario Ministry of the Environment released the Soil, Ground Water and Sediment Standards for Use under Part XV.1 of the *Environmental Protection Act*. These included the soil standards for uranium directly adopted from the CCME guidelines.

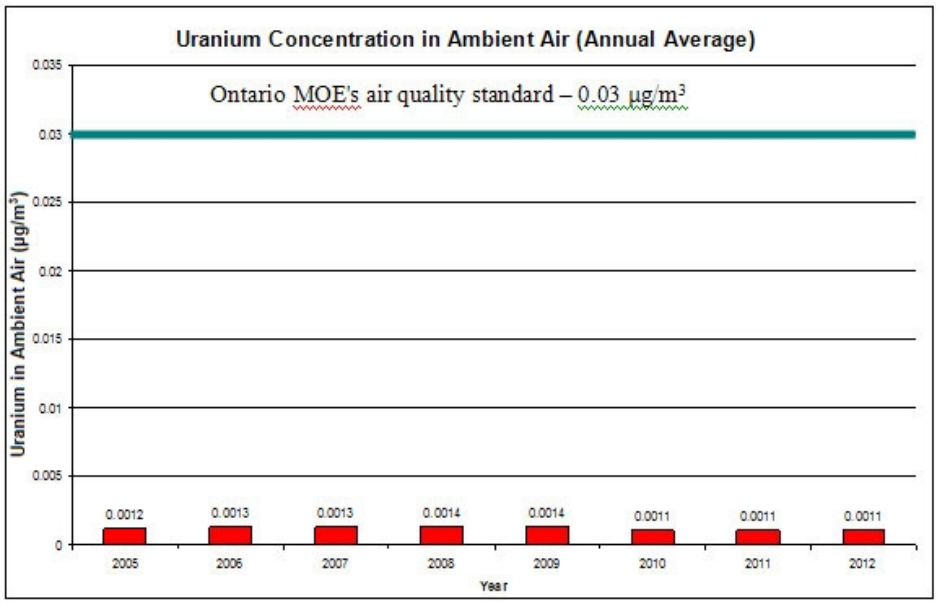
3. GEH-C Environmental Monitoring Program

GEH-C implements an environmental monitoring program at the Toronto facility, which consists of air quality monitoring along the facility boundary as well as a comprehensive soil monitoring program.

3.1 Air quality monitoring program results

There are five boundary air samplers installed at the GEH-C Toronto facility. The samplers run continuously 24 hours a day/365 days a year. Filter paper samples are collected daily for analysis by a qualified third party. GEH-C's monitoring results for the past five years are compared to the MOE air quality standard in figure 1. GEH-C's air emissions are more than 10 times lower than the MOE standard.

Figure 1: GEH-C boundary air quality results (2005–12)



3.2 Soil quality monitoring program results

GEH-C conducts soil sampling at its Toronto facility as part of its environmental program. Samples are taken annually from 49 locations around the facility and analyzed for uranium content. The average concentration of uranium in soil in 2012 was 1.9 µg/g. The maximum concentration of uranium in soil was 10.8 µg/g. The uranium concentrations in soil from 2005 to 2012 are summarized in table 2.

Table 2: GEH-C Soil sampling results (2005–12)

Parameter	2005	2006	2007	2008	2009	2010	2011	2012
Average uranium concentration (µg/g)	N/A	N/A	N/A	N/A	2.2	2.2	2.3	1.9
Maximum uranium concentration (µg/g)	4.31	3.71	5.22	19.7[1]	30.9[3]	13.7[3]	14.8[3]	10.8[3]

N/A – Not available
1 – GEH-C sample location 16 between facility fence-line and railroad tracks (i.e., commercial land use)
2 – GEH-C sample location 5 between facility fence-line and railroad tracks (i.e., commercial land use)
3 – GEH-C sample location 17 between facility fence-line and railroad tracks (i.e., commercial land use)

4. CNSC soil sample analysis

4.1 Sampling plan

GEH-C and MOE performed two separate soil sample collections in June 2013. Sampling locations are provided in maps A1 and A2 (see Appendix 1A). Split soil samples of both collections were sent to the CNSC laboratory for independent analysis and the results are discussed below.

4.1.1 GE Hitachi Nuclear Energy Canada Inc.

GEH-C staff, accompanied by CNSC staff, collected soil samples at locations identified in the GE Environmental monitoring program on June 5, 2013. Forty-nine samples of surface soil (a minimum of 25 grams each) were collected. CNSC staff selected eight soil samples, which were split upon collection. The eight split samples were received by the CNSC Laboratory on June 7, 2013.

4.1.2 Ontario Ministry of the Environment

The MOE developed a sampling plan and undertook a sampling campaign in June 2013. The sampling was conducted on June 12, 2013 using a global positioning system (GPS) to identify sampling locations (see figure 2) and a soil corer (see figure 3). The CNSC staff person was present during the sample collection. MOE staff collected samples from 24 locations. The samples were processed at the MOE laboratory, then sub-sampled (split) and 164 samples were sent to the CNSC laboratory on July 3, 2013.

Figure 2: GPS receiver measuring soil sampling location

Figure 3: Soil sample collected by Ontario MOE staff with soil corer

4.2 Methods for processing and analyzing samples

The eight GEH-C samples were split at the point of collection, and dried for 48 hours at 80^{o}C at the CNSC laboratory. The dried samples were passed through a 2-mm (millimetre) sieve to separate the soil fraction. The soil fraction was then milled in the Retsch vibration mill at 1000 rpm (rotations per minute) for 2 minutes. The milling homogenizes the sample and pulverizes the soil to particles less than ~40 μm (micrometres), which facilitates acid digestion of sample for uranium analysis.

The samples received from MOE were already processed by the MOE laboratory, so no further processing was deemed necessary.

Both the GEH-C and MOE pulverized samples were subjected to microwave digestion using a CNSC laboratory method based on the US Environmental Protection Agency method 3052. Briefly, 0.1 g (gram) of each soil sample was subjected to a two-step digestion, using the combination of nitric, hydrochloric and hydrofluoric acid in the first step and 5 percent boric acid in the second step. A 5-mL (millilitre) aliquot of the digest was then diluted to 100 mL with 2 percent nitric acid and analyzed using the inductive coupled plasma mass spectrometer (ICP-MS) (see figure 4). In each run, eight soil samples were digested with a digestion blank and a quality control sample (standard reference material obtained from NIST, Highly Contaminated Montana Soil, 2710a).

Most soil samples obtained from MOE were analyzed by an energy-dispersive X-ray fluorescence spectrometer (see figure 5), since this method is faster and yields comparable results to those obtained by the digestion plus the ICP-MS. A 5-g aliquot of a soil sample was mixed with 1 g of Licowax (organic binder) and pressed into a 32-mm pellet using a hydraulic press. The samples were then analyzed in an Epsilon 5 X-ray fluorescence spectrometer using the method validated for uranium concentrations from 0 to 70,000 µg/g.

Figure 4: Inductive coupled plasma mass spectrometer

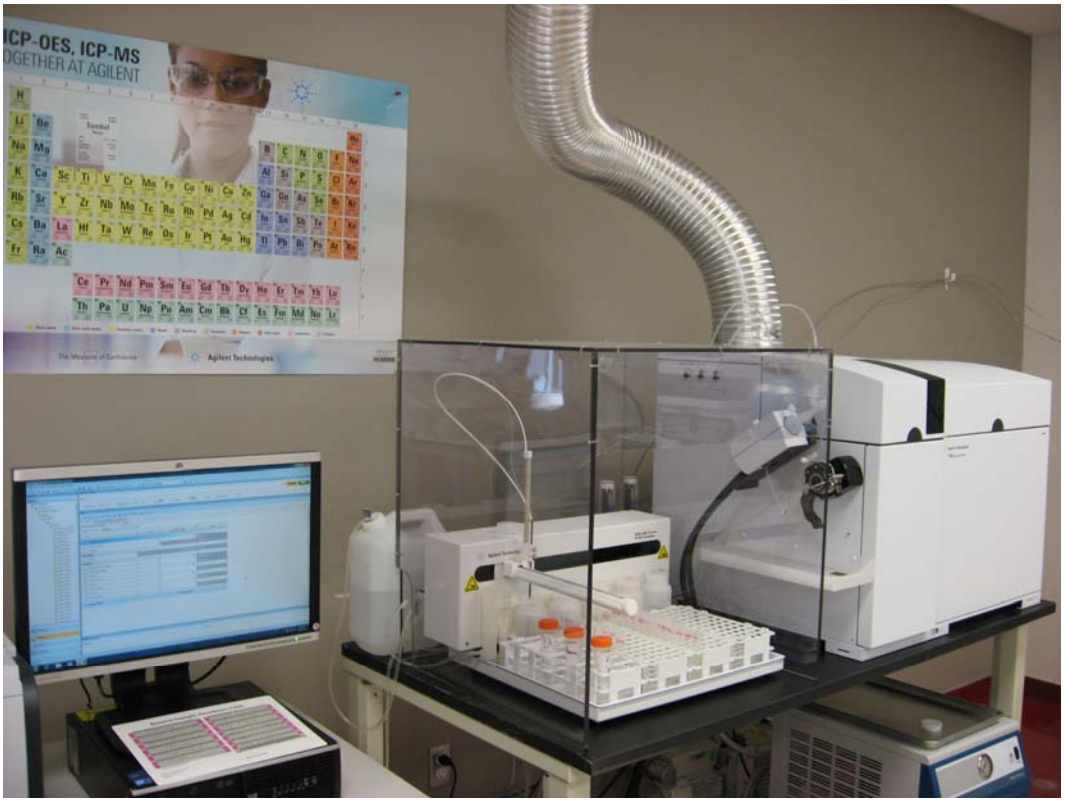


Figure 5: X-ray fluorescence spectrometer

4.3 Results

The CNSC laboratory analytical results for both the GEH-C and MOE samples are described in the following subsections and provided in Tables B1 and B2 (appendix B), respectively.

4.3.1 Samples collected by GE Hitachi Nuclear Energy Canada Inc.

The results of the GEH-C samples are presented in the CNSC laboratory analysis report in table B1. The reported values are the average of two independent runs. It should be noted that sample splitting employed in this case may have resulted in non-homogeneous sub-samples, since a typical soil sample has different layers that are difficult to properly mix and homogenize at the point of collection. Hence individual results may be different than those obtained by GEH-C.

The concentration of uranium in the samples was found to vary from 0.7 to 21.2 µg/g. The highest concentration of 21.2 µg/g was found in sample location 17, which was located at the perimeter of the facility close to the railroad tracks.

4.3.2 Samples collected by the Ontario Ministry of the Environment

The results of the analysis of the samples, collected by the MOE staff and processed by the MOE Laboratory, are summarized in table B2. The individual data points represent the average of at least two independent measurements. The descriptive statistics data analysis (from Excel) of the 164 values gives a range of 0.3 to 2.9 µg/g, with an average value of 1.4 µg/g.

The highest concentrations of uranium were found in samples collected along the municipal right of way next to a sidewalk on St. Clarens Avenue (sample location 19). It should be noted that only one site (sample location 23) showed a strong gradient of decreasing uranium concentrations with soil depth.

4.4 Quality assurance and quality control

The principal objective of the analysis is the production of high quality data. This is achieved through the use of analytical measurements that are accurate and reliable. The uranium certified standard reference materials, background control standards for instrument performance and method blank standards for method performance are used to achieve this objective.

The measured digestion blank contained less than 0.0001 µg/g of uranium and the recovery of uranium in standard reference material NIST 2710a was within 20 percent of the certified value.

The limit of detection for uranium in soil samples by the ICP-MS method is calculated as 0.4 µg/g. This value is obtained by multiplying the average concentration of uranium in the digestion blanks (16 values) by three and correcting for the dilution.

The uncertainty of the ICPM-MS and XRF method was estimated to be ±0.4 µg/g, based on the errors in the calibration curve.

5. Interpretation of Results

5.1 Comparison with natural background

Uranium is a naturally occurring alpha-emitting radioactive element, which is present at low levels in various rocks and ores, soil, water, air, plants and in animal tissue.

The current MOE background standards for Ontario soils not contaminated by a point source of uranium are 1.9 µg/g for agricultural use and 2.5 µg/g for residential/parkland and commercial/industrial land use.

All samples collected by the MOE staff demonstrated that the uranium concentrations are below the background standards in Ontario, except for location 23 (up to 2.56 µg/g for surface soil: 0-5 cm) and for location 19 (up to 2.93 µg/g for deeper layers of soil). These two sampling locations (19 and 23) are in close vicinity to the facility, at 70 m and 110 m from the facility, respectively.

5.2 Comparison with CCME soil quality guidelines

The CCME criteria for uranium in soil depend on land use as shown in table 3. The most restrictive guideline is 23 µg/g for residential, agricultural and parkland land use. The measured uranium soil concentrations in all MOE sampling locations range from 0.27 µg/g to 2.93 µg/g, and are therefore well below the most restrictive soil guideline for uranium.

Table 3: CCME soil quality guidelines for uranium

CCME soil quality guidelines	Residential (µg/g)	Commercial (µg/g)	Industrial (µg/g)
Uranium	**23**	**33**	**300**

The measured concentrations of uranium in GEH-C samples also fall below the most restrictive CCME guideline for residential/parkland use. It should be noted, however, that GEH-C staff used a non-standard methodology to collect soil samples; consequently, it is very difficult to compare the GEH-C results with those of the MOE and the CCME guidelines, which are based on a standard sampling methodology.

6. Conclusion

Uranium analysis in soil samples around the Toronto GEH-C Plant was performed by the CNSC laboratory, using ICP-MS and XRF techniques. The results show that:

- The GEH-C samples ranged from 0.7 to 21.2 µg/g, with five out of the eight sample locations having soil concentrations below the Ontario background level.
- The MOE samples varied from 0.3 to 2.9 µg/g , with all sample locations having uranium in soil concentrations below the Ontario background level (2.5 µg/g) with the exception of two sample locations having concentrations slightly above the Ontario background level;
- All GEH-C and MOE sample results were below the most restrictive CCME soil quality guidelines for residential land use of 23 µg/g, as well as the commercial guidelines of 33 µg/g as applicable.

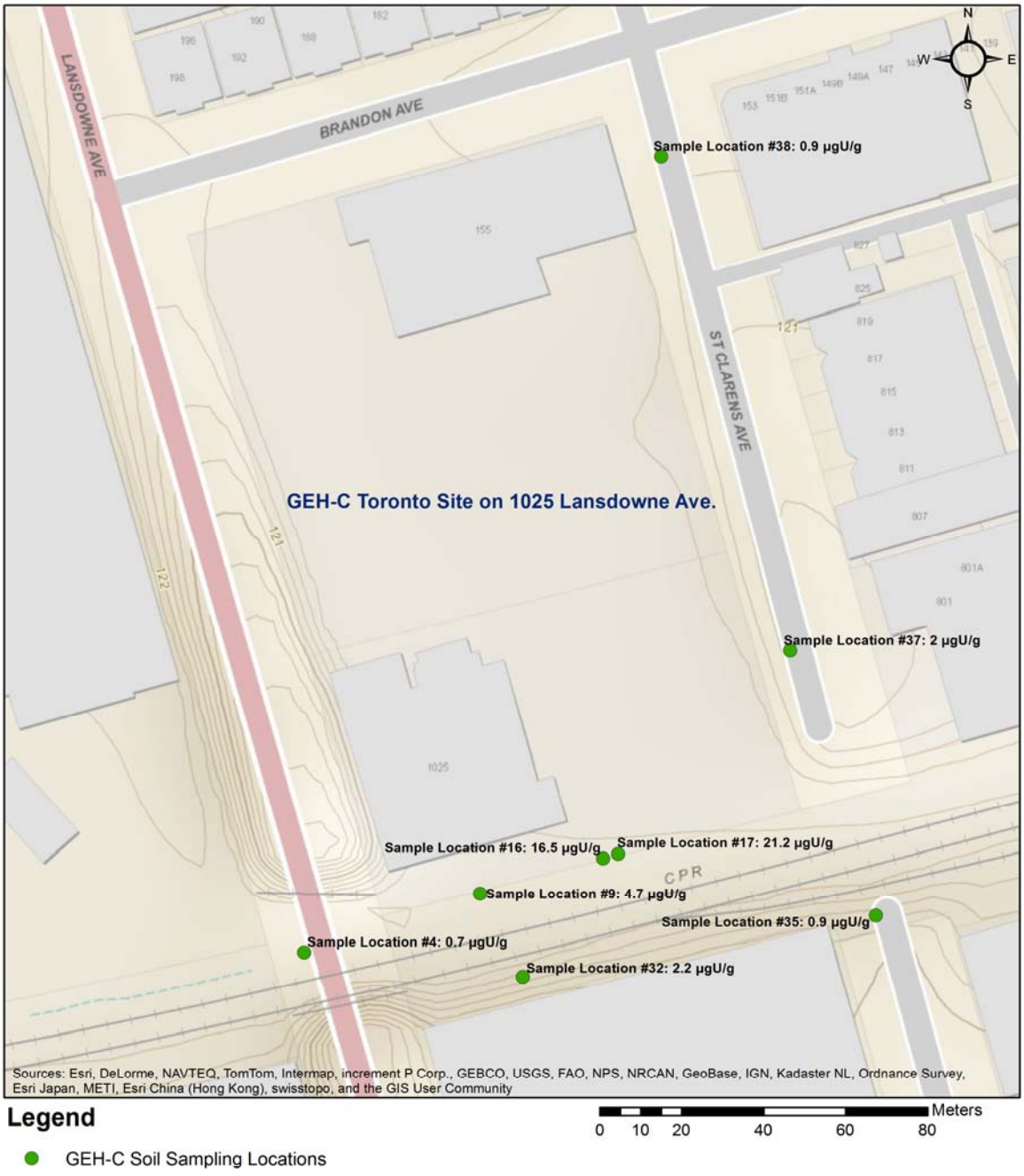
In addition, in 2012, the GE-Hitachi licence soil monitoring program showed that the average and maximum concentrations of uranium are 1.9 and 10. µg/g, respectively.

These results demonstrate that the uranium concentrations around the GE-Hitachi Nuclear Energy Canada Toronto facility are well below the accepted standards for protection of human health, including children.

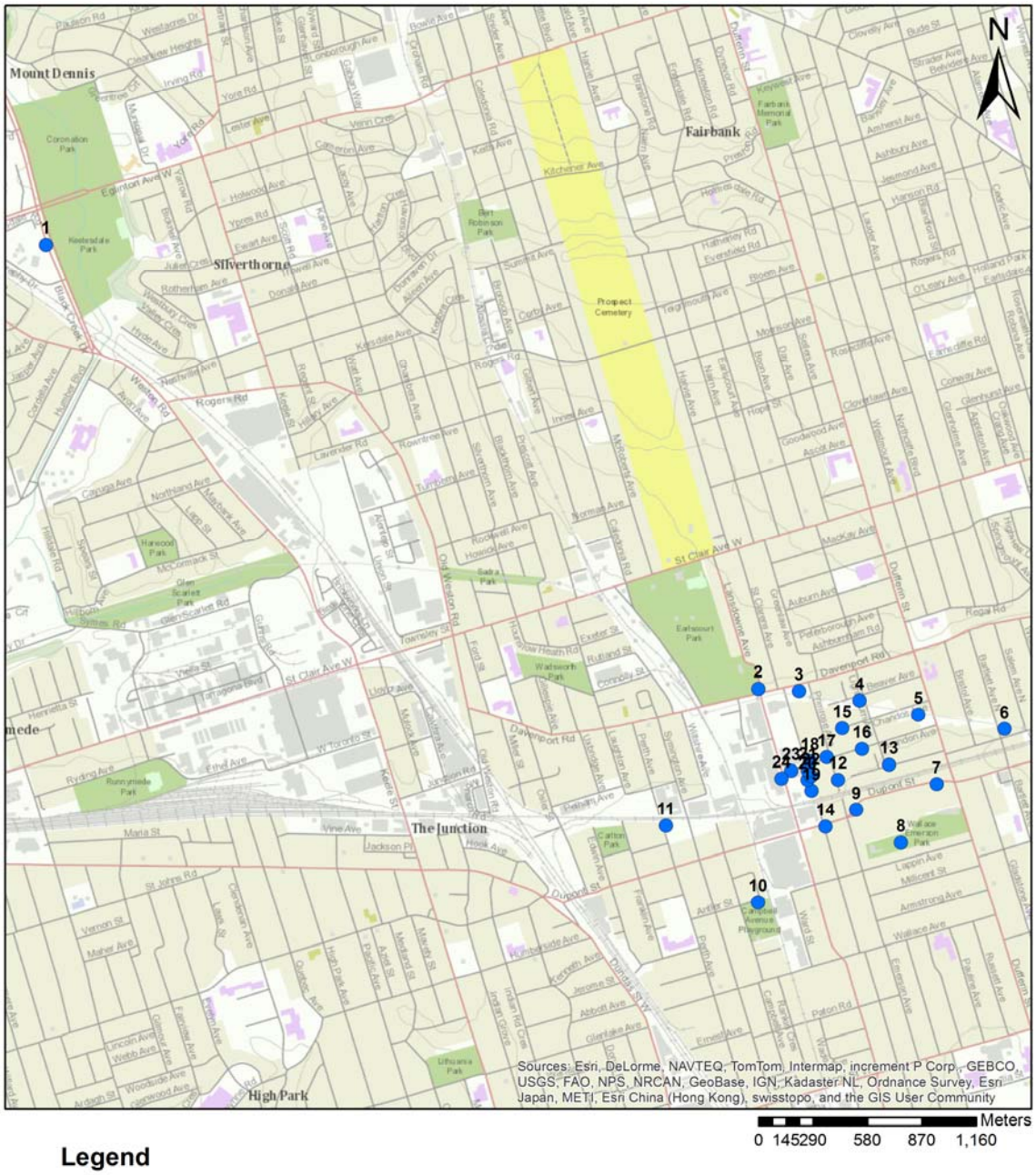
In conclusion, uranium releases from the GEH-C facility are not having any adverse impacts on human health or the environment.

Appendix A: Maps

Map 1: GEH-C soil sampling locations



Map 2: Ontario MOE soil sampling locations



Appendix B: CNSC Laboratory Results of Uranium Concentration in Soil Samples Obtained from the Ontario Ministry of the Environment and GE Hitachi Nuclear Energy Canada

Table B.1: CNSC Laboratory analysis results of GEH-C soil samples collected in June 2013

GEH-C sample location #	Uranium (µg/g)*
4	0.7
9	4.7
16	16.5
17	21.2
32	2.2
35	0.9
37	2.0
38	0.9

*uncertainty (to 95% confidence) is ±0.1 µg/g

Table B.2 : CNSC Laboratory analysis results of MOE soil samples collected in June 2013

MOE sample location #	Depth (cm)	Distance from source (m)	UTM Zone	Easting	Northing	Accuracy (±)	Description	[U] (µg/g)*
1	0-5	3600 NW	17	622301	4838238	2.9	Municipal right of way next to sidewalk	1.52
1	0-5	3600 NW	17	622301	4838238	2.9	Municipal right of way next to sidewalk	1.78
1	5-10	3600 NW	17	622301	4838238	2.9	Municipal right of way next to sidewalk	2.00
1	5-10	3600 NW	17	622301	4838238	2.9	Municipal right of way next to sidewalk	1.81
1	10-15	3600 NW	17	622301	4838238	2.9	Municipal right of way next to sidewalk	1.84
1	10-15	3600 NW	17	622301	4838238	2.9	Municipal right of way next to sidewalk	1.51
1	15-20	3600 NW	17	622301	4838238	2.9	Municipal right of way next to sidewalk	2.07
1	15-20	3600 NW	17	622301	4838238	2.9	Municipal right of way next to sidewalk	1.65
2	0-5	440 NNW	17	625082	4836579	3.7	Park	1.76
2	0-5	440 NNW	17	625082	4836579	3.7	Park	0.56
2	5-10	440 NNW	17	625082	4836579	3.7	Park	2.04

MOE sample location #	Depth (cm)	Distance from source (m)	UTM Zone	Easting	Northing	Accuracy (±)	Description	[U] (µg/g)*
2	5-10	440 NNW	17	625082	4836579	3.7	Park	1.67
2	10-15	440 NNW	17	625082	4836579	3.7	Park	1.69
2	10-15	440 NNW	17	625082	4836579	3.7	Park	1.99
2	15-20	440 NNW	17	625082	4836579	3.7	Park	1.49
2	15-20	440 NNW	17	625082	4836579	3.7	Park	1.57
3	0-5	400 N	17	625239	4836573	4	Park	1.25
3	0-5	400 N	17	625239	4836573	4	Park	1.94
3	5-10	400 N	17	625239	4836573	4	Park	1.16
3	5-10	400 N	17	625239	4836573	4	Park	1.57
3	10-15	400 N	17	625239	4836573	4	Park	1.15
3	10-15	400 N	17	625239	4836573	4	Park	1.10
3	15-20	400 N	17	625239	4836573	4	Park	1.37
3	15-20	400 N	17	625239	4836573	4	Park	1.63
4	0-5	440 NNE	17	625474	4836541	2.9	Park	0.94
4	0-5	440 NNE	17	625474	4836541	2.9	Park	1.36
4	5-10	440 NNE	17	625474	4836541	2.9	Park	0.97
4	5-10	440 NNE	17	625474	4836541	2.9	Park	0.84
4	10-15	440 NNE	17	625474	4836541	2.9	Park	0.80
4	10-15	440 NNE	17	625474	4836541	2.9	Park	0.57
5	0-5	570 NE	17	625701	4836491	2.2	Park	1.46
5	0-5	570 NE	17	625701	4836491	2.2	Park	0.88
5	5-10	570 NE	17	625701	4836491	2.2	Park	1.59
5	5-10	570 NE	17	625701	4836491	2.2	Park	1.95
5	10-15	570 NE	17	625701	4836491	2.2	Park	0.65
5	10-15	570 NE	17	625701	4836491	2.2	Park	0.77
5	15-20	570 NE	17	625701	4836491	2.2	Park	1.03
5	15-20	570 NE	17	625701	4836491	2.2	Park	0.63
6	0-5	850 E	17	626035	4836442	1.3	Park	1.64
6	0-5	850 E	17	626035	4836442	1.3	Park	0.89
6	5-10	850 E	17	626035	4836442	1.3	Park	1.90
6	5-10	850 E	17	626035	4836442	1.3	Park	1.72
6	10-15	850 E	17	626035	4836442	1.3	Park	1.84
6	10-15	850 E	17	626035	4836442	1.3	Park	1.27
7	0-5	540 E	17	625777	4836223	4	Boulevard	0.29
7	0-5	540 E	17	625777	4836223	4	Boulevard	0.32
8	0-5	440 SE	17	625644	4835994	2.5	Park	1.31
8	0-5	440 SE	17	625644	4835994	2.5	Park	1.75
8	5-10	440 SE	17	625644	4835994	2.5	Park	2.29
8	5-10	440 SE	17	625644	4835994	2.5	Park	2.64
8	10-15	440 SE	17	625644	4835994	2.5	Park	1.60
8	10-15	440 SE	17	625644	4835994	2.5	Park	1.77
8	15-20	440 SE	17	625644	4835994	2.5	Park	1.78
8	15-20	440 SE	17	625644	4835994	2.5	Park	1.24
9	0-5	100 SE	17	625469	4836118	3	Boulevard	1.25
9	0-5	100 SE	17	625469	4836118	3	Boulevard	1.30

MOE sample location #	Depth (cm)	Distance from source (m)	UTM Zone	Easting	Northing	Accuracy (±)	Description	[U] (µg/g)*
9	5-10	100 SE	17	625469	4836118	3	Boulevard	1.49
9	5-10	100 SE	17	625469	4836118	3	Boulevard	0.51
9	10-15	100 SE	17	625469	4836118	3	Boulevard	1.23
9	10-15	100 SE	17	625469	4836118	3	Boulevard	0.35
9	15-20	100 SE	17	625469	4836118	3	Boulevard	1.13
9	15-20	100 SE	17	625469	4836118	3	Boulevard	1.24
12	0-5	180 ENE	17	625396	4836233	3	Municipal right of way next to sidewalk	1.97
12	0-5	180 ENE	17	625396	4836233	3	Municipal right of way next to sidewalk	1.16
12	5-10	180 ENE	17	625396	4836233	3	Municipal right of way next to sidewalk	0.75
12	5-10	180 ENE	17	625396	4836233	3	Municipal right of way next to sidewalk	0.82
12	10-15	180 ENE	17	625396	4836233	3	Municipal right of way next to sidewalk	0.79
12	10-15	180 ENE	17	625396	4836233	3	Municipal right of way next to sidewalk	0.70
12	15-20	180 ENE	17	625396	4836233	3	Municipal right of way next to sidewalk	0.76
12	15-20	180 ENE	17	625396	4836233	3	Municipal right of way next to sidewalk	0.64
13	0-5	385 ENE	17	625592	4836295	3.3	Municipal right of way next to sidewalk	1.93
13	0-5	385 ENE	17	625592	4836295	3.3	Municipal right of way next to sidewalk	1.18
13	5-10	385 ENE	17	625592	4836295	3.3	Municipal right of way next to sidewalk	1.62
13	5-10	385 ENE	17	625592	4836295	3.3	Municipal right of way next to sidewalk	1.19
13	10-15	385 ENE	17	625592	4836295	3.3	Municipal right of way next to sidewalk	1.15
13	10-15	385 ENE	17	625592	4836295	3.3	Municipal right of way next to sidewalk	1.85
13	15-20	385 ENE	17	625592	4836295	3.3	Municipal right of way next to	1.27

MOE sample location #	Depth (cm)	Distance from source (m)	UTM Zone	Easting	Northing	Accuracy (±)	Description	[U] (µg/g)*
							sidewalk	
13	15-20	385 ENE	17	625592	4836295	3.3	Municipal right of way next to sidewalk	2.18
10	0-5	200 SSW	17	625096	4835755	2.2	Park	0.51
10	0-5	200 SSW	17	625096	4835755	2.2	Park	0.27
10	5-10	200 SSW	17	625096	4835755	2.2	Park	0.54
10	5-10	200 SSW	17	625096	4835755	2.2	Park	0.50
10	10-15	200 SSW	17	625096	4835755	2.2	Park	1.47
10	10-15	200 SSW	17	625096	4835755	2.2	Park	1.59
10	15-20	200 SSW	17	625096	4835755	2.2	Park	0.47
10	15-20	200 SSW	17	625096	4835755	2.2	Park	0.64
11	0-5	500 W	17	624735	4836043	2.9	Park	1.61
11	0-5	500 W	17	624735	4836043	2.9	Park	1.74
11	5-10	500 W	17	624735	4836043	2.9	Park	1.66
11	5-10	500 W	17	624735	4836043	2.9	Park	1.71
11	10-15	500 W	17	624735	4836043	2.9	Park	1.57
11	10-15	500 W	17	624735	4836043	2.9	Park	1.46
11	15-20	500 W	17	624735	4836043	2.9	Park	1.13
11	15-20	500 W	17	624735	4836043	2.9	Park	1.07
14	0-5	160 SW	17	625351	4836051	3.2	Municipal right of way next to sidewalk	0.83
14	0-5	160 SW	17	625351	4836051	3.2	Municipal right of way next to sidewalk	0.51
14	5-10	160 SW	17	625351	4836051	3.2	Municipal right of way next to sidewalk	0.66
14	5-10	160 SW	17	625351	4836051	3.2	Municipal right of way next to sidewalk	0.79
14	10-15	160 SW	17	625351	4836051	3.2	Municipal right of way next to sidewalk	0.80
14	10-15	160 SW	17	625351	4836051	3.2	Municipal right of way next to sidewalk	0.80
14	15-20	160 SW	17	625351	4836051	3.2	Municipal right of way next to sidewalk	2.24
14	15-20	160 SW	17	625351	4836051	3.2	Municipal right of way next to sidewalk	2.44
15	0-5	310 NE	17	625409	4836433	3.2	Boulevard	2.03
15	0-5	310 NE	17	625409	4836433	3.2	Boulevard	1.86
15	5-10	310 NE	17	625409	4836433	3.2	Boulevard	1.64
15	5-10	310 NE	17	625409	4836433	3.2	Boulevard	1.79

MOE sample location #	Depth (cm)	Distance from source (m)	UTM Zone	Easting	Northing	Accuracy (±)	Description	[U] (µg/g)*
15	10-15	310 NE	17	625409	4836433	3.2	Boulevard	1.82
15	10-15	310 NE	17	625409	4836433	3.2	Boulevard	1.18
15	15-20	310 NE	17	625409	4836433	3.2	Boulevard	1.74
15	15-20	310 NE	17	625409	4836433	3.2	Boulevard	1.09
16	0-5	320 ENE	17	625486	4836354	3.7	Boulevard	0.82
16	0-5	320 ENE	17	625486	4836354	3.7	Boulevard	2.53
16	5-10	320 ENE	17	625486	4836354	3.7	Boulevard	2.53
16	5-10	320 ENE	17	625486	4836354	3.7	Boulevard	2.40
16	10-15	320 ENE	17	625486	4836354	3.7	Boulevard	1.46
16	10-15	320 ENE	17	625486	4836354	3.7	Boulevard	2.34
17	0-5	200 NE	17	625351	4836319	3.2	Boulevard	1.32
17	0-5	200 NE	17	625351	4836319	3.2	Boulevard	1.71
17	5-10	200 NE	17	625351	4836319	3.2	Boulevard	1.27
17	5-10	200 NE	17	625351	4836319	3.2	Boulevard	2.33
17	10-15	200 NE	17	625351	4836319	3.2	Boulevard	2.86
17	10-15	200 NE	17	625351	4836319	3.2	Boulevard	1.03
17	15-20	200 NE	17	625351	4836319	3.2	Boulevard	1.27
17	15-20	200 NE	17	625351	4836319	3.2	Boulevard	2.13
18	0-5	150 NNE	17	625287	4836303	3.1	Boulevard	1.64
18	0-5	150 NNE	17	625287	4836303	3.1	Boulevard	0.86
18	5-10	150 NNE	17	625287	4836303	3.1	Boulevard	1.62
18	5-10	150 NNE	17	625287	4836303	3.1	Boulevard	0.92
18	10-15	150 NNE	17	625287	4836303	3.1	Boulevard	1.91
18	10-15	150 NNE	17	625287	4836303	3.1	Boulevard	1.82
18	15-20	150 NNE	17	625287	4836303	3.1	Boulevard	1.66
18	15-20	150 NNE	17	625287	4836303	3.1	Boulevard	0.31
19	0-5	70 E	17	625295	4836188	2.7	Municipal right of way next to sidewalk	2.07
19	0-5	70 E	17	625295	4836188	2.7	Municipal right of way next to sidewalk	1.96
19	5-10	70 E	17	625295	4836188	2.7	Municipal right of way next to sidewalk	2.60
19	5-10	70 E	17	625295	4836188	2.7	Municipal right of way next to sidewalk	2.73
19	10-15	70 E	17	625295	4836188	2.7	Municipal right of way next to sidewalk	2.93
19	10-15	70 E	17	625295	4836188	2.7	Municipal right of way next to sidewalk	2.55
19	15-20	70 E	17	625295	4836188	2.7	Municipal right of way next to sidewalk	2.62
19	15-20	70 E	17	625295	4836188	2.7	Municipal right of	2.02

MOE sample location #	Depth (cm)	Distance from source (m)	UTM Zone	Easting	Northing	Accuracy (±)	Description	[U] (µg/g)*
							way next to sidewalk	
20	0-5	80 NE	17	625279	4836230	3.1	Municipal right of way next to sidewalk	0.85
20	0-5	80 NE	17	625279	4836230	3.1	Municipal right of way next to sidewalk	1.66
20	5-10	80 NE	17	625279	4836230	3.1	Municipal right of way next to sidewalk	1.45
20	5-10	80 NE	17	625279	4836230	3.1	Municipal right of way next to sidewalk	0.81
20	10-15	80 NE	17	625279	4836230	3.1	Municipal right of way next to sidewalk	2.21
20	10-15	80 NE	17	625279	4836230	3.1	Municipal right of way next to sidewalk	1.47
21	0-5	110 NNE	17	625279	4836267	3.5	Municipal right of way next to sidewalk	1.45
21	0-5	110 NNE	17	625279	4836267	3.5	Municipal right of way next to sidewalk	0.78
22	0-5	100 NE	17	625291	4836245	2.4	Boulevard	1.93
22	0-5	100 NE	17	625291	4836245	2.4	Boulevard	1.63
22	5-10	100 NE	17	625291	4836245	2.4	Boulevard	1.13
22	5-10	100 NE	17	625291	4836245	2.4	Boulevard	1.16
22	10-15	100 NE	17	625291	4836245	2.4	Boulevard	1.03
22	10-15	100 NE	17	625291	4836245	2.4	Boulevard	1.63
23	0-5	110 N	17	625215	4836264	2.9	Boulevard	2.53
23	0-5	110 N	17	625215	4836264	2.9	Boulevard	2.56
23	5-10	110 N	17	625215	4836264	2.9	Boulevard	2.37
23	5-10	110 N	17	625215	4836264	2.9	Boulevard	1.65
23	10-15	110 N	17	625215	4836264	2.9	Boulevard	2.69
23	10-15	110 N	17	625215	4836264	2.9	Boulevard	1.30
23	15-20	110 N	17	625215	4836264	2.9	Boulevard	1.86
23	15-20	110 N	17	625215	4836264	2.9	Boulevard	1.00
24	0-5	90 NNE	17	625178	4836233	3	Municipal right of way next to sidewalk	1.22
24	0-5	90 NNE	17	625178	4836233	3	Municipal right of way next to sidewalk	0.83

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