

# Environmental Emissions Data for Darlington Nuclear

Q2 2018

## OVERVIEW

This report summarizes Darlington Nuclear’s environmental emissions data for Q2 2018. Darlington Nuclear Generating Station has four reactor units and a total generation capacity of 3,512 megawatts. The station is located in the Municipality of Clarington in Durham Region. Refurbishment of Darlington Unit 2 started in October 2016.

This report includes:

- Radioactive Effluents: Releases to air and water were less than one per cent of regulatory limits.
- Darlington Waste Management Facility: Monitoring results for air emissions, storm water, and perimeter dose rate confirmed the integrity of the facility.
- Groundwater Monitoring: OPG continued to analyze groundwater results to examine trends.
- Spills to the Environment: There were no spills to the environment that were reportable to a regulatory authority.

Note: The contents of this report are consistent with environmental data OPG is required to provide to the Canadian Nuclear Safety Commission (CNSC) on a quarterly basis. These reporting requirements are periodically revised.

## ENVIRONMENTAL EMISSIONS MANAGEMENT

OPG has an environmental management program to ensure its activities are conducted in a manner that minimizes any adverse impact on the public and the environment. OPG’s environmental program conforms to CNSC requirements for environmental protection and the International Organization for Standardization (ISO) standard for environmental management systems. The quality assurance programs for OPG’s chemistry and health physics laboratories conform to the requirements of national and international standards.

As part of OPG’s environmental management program, OPG has established an effluent monitoring and control program that is based on the “ALARA” principle. That is, measures are in place to ensure emissions to the environment are kept As Low As Reasonably Achievable while taking social and economic factors into account.

## MONITORING OF RADIOACTIVE EFFLUENTS

### Release Limits & Action Levels

OPG uses radiation dose limits specified in federal legislation to derive Release Limits for the radionuclides that may be released to air and water from its nuclear facilities. Darlington Nuclear must maintain its radiological emissions well below these limits to meet the terms of its operating licence.

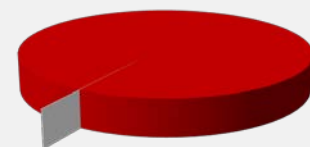
OPG also sets Action Levels that are much lower than the Release Limits to identify and control emissions before a limit can be reached.

### Public Radiation Dose Data

*The radiation dose to the public resulting from the operation of Darlington Nuclear is a very small fraction of the estimated annual average background radiation dose around the station.*

*Annual environmental monitoring program results for Darlington Nuclear, including an assessment of radiation dose to the public, are available at:*  
[www.opg.com/news-and-media/Pages/reports.aspx](http://www.opg.com/news-and-media/Pages/reports.aspx)

Natural Background Radiation > 99.9%



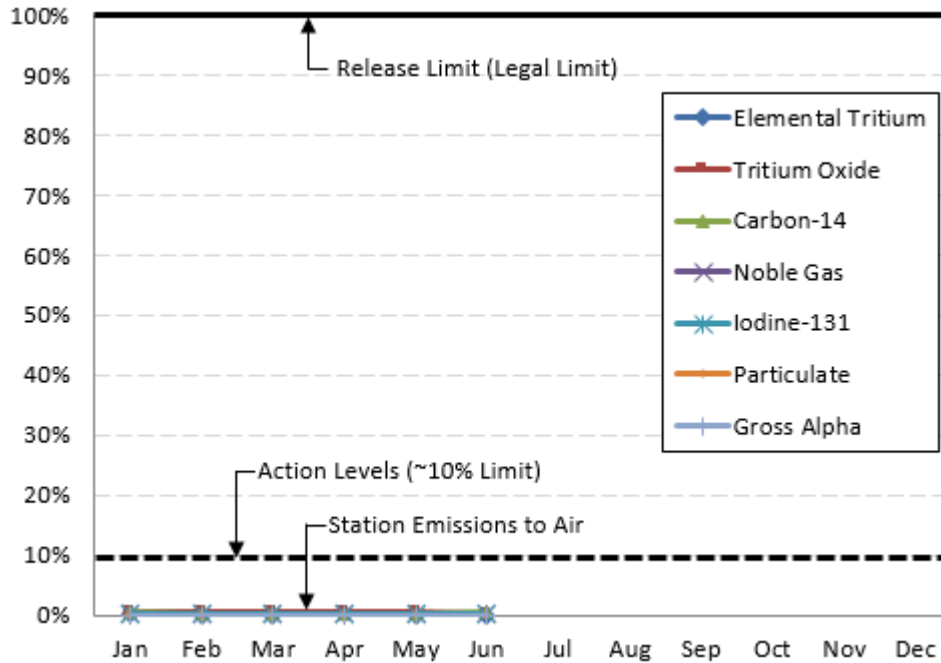
Darlington Nuclear Contribution < 0.1%

# Environmental Emissions Data for Darlington Nuclear

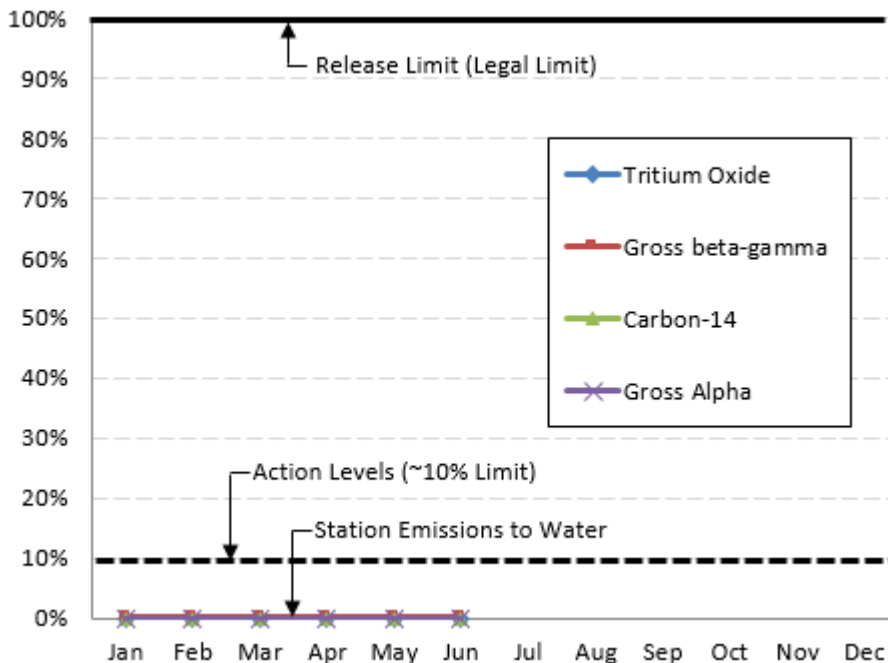
## Performance Results

Darlington Nuclear’s emissions are monitored to track performance. For Q2 2018, Darlington Nuclear’s radiological emissions to air and water remained less than one per cent of the Release Limits and no Action Levels were exceeded. (Appendix A, Tables A.1 and A.2) The following graphs show Darlington Nuclear’s radiological emissions for the year to date as a percentage of the Release Limits.

### Air Emissions as a Per Cent of Release Limits



### Water Emissions as a Per Cent of Release Limits



**DARLINGTON WASTE MANAGEMENT FACILITY**

Radiological air emissions, storm water, and radiation dose monitoring requirements for the Darlington Waste Management Facility were met in Q2 2018 and no issues were identified. (Appendix A, Tables A.3, A.4 and A.5)

**GROUNDWATER MONITORING**

Groundwater monitoring is conducted at monitoring wells around the Darlington site perimeter, including along the Lake Ontario shoreline, to confirm that there are no adverse off-site impacts from tritium in groundwater. (Appendix A, Table A.6)

**RELEASES OF HAZARDOUS SUBSTANCES (NON-RADIOACTIVE)**

Darlington Nuclear complies with numerous regulatory requirements for controlling and monitoring releases of hazardous substances to the environment. Darlington Nuclear reports releases of hazardous substances to Environment Canada's National Pollutant Release Inventory (NPRI). Tools and resources for accessing, analyzing and interpreting NPRI data are available on the [NPRI website](#). Darlington Nuclear's carbon dioxide emissions are well below the threshold for mandatory reporting to federal and provincial authorities. Greenhouse gas data and information for reporting facilities are available on the [Greenhouse Gas Emissions Reporting Program \(GHGRP\) website](#).

**SPILLS TO THE ENVIRONMENT**

OPG has extensive programs to ensure the risk of spills to the environment is effectively assessed and managed. All spills are reported by OPG to the appropriate federal, provincial and municipal authorities as required.

OPG classifies its reportable spills as Category A, B or C spills based on the actual or potential impacts. Category A spills are considered very serious due to the scale of injury or damage, health effects, or safety impairment. Category B spills are considered serious due to localized injury or impacts to property. Category C spills are all other reportable spills that are less serious than Category A and B spills.

There were no reportable spills at Darlington Nuclear in Q2 2018.

## APPENDIX A

### ENVIRONMENTAL EMISSIONS DATA

# Environmental Emissions Data for Darlington Nuclear

Table A.1: Airborne Radionuclide Releases

	Elemental Tritium (Bq)	Tritium Oxide (Bq)	Carbon-14 (Bq)	Noble Gas (Bq-MeV)	Iodine-131 (Bq)	Particulate (Bq)	Gross Alpha (Bq)	
<b>SUMMARY: ANNUAL</b>								
Release Limit (Bq/year) <sup>(a)</sup>	$8.5 \times 10^{17}$	$5.9 \times 10^{16}$	$3.5 \times 10^{14}$	$4.5 \times 10^{16}$	$1.4 \times 10^{12}$	$6.7 \times 10^{11}$	$1.0 \times 10^{11}$	
Total Releases as of Q2 2018	$4.0 \times 10^{13}$	$1.4 \times 10^{14}$	$4.8 \times 10^{11}$	$2.5 \times 10^{13}$	$<7.1 \times 10^7$	$1.2 \times 10^7$	$6 \times 10^5$	
<b>DETAILS: WEEKLY<sup>(b)</sup></b>								
Action Level (Bq/week) <sup>(c)</sup>	$1.7 \times 10^{15}$	$1.2 \times 10^{14}$	$7.0 \times 10^{11}$	$8.9 \times 10^{13}$	$2.8 \times 10^9$	$1.3 \times 10^9$	Not specified <sup>(d)</sup>	
Jan. <sup>(e)</sup>	Week 1	$1.2 \times 10^{13}$	$3.7 \times 10^{12}$	$1.2 \times 10^{10}$	$5.4 \times 10^{11}$	$<2.5 \times 10^6$	$3.2 \times 10^5$	$2 \times 10^4$
	Week 2	$6.2 \times 10^{11}$	$6.7 \times 10^{12}$	$2.5 \times 10^{10}$	$5.9 \times 10^{11}$	$<2.6 \times 10^6$	$3.1 \times 10^5$	$2 \times 10^4$
	Week 3	$2.3 \times 10^{11}$	$7.1 \times 10^{12}$	$3.9 \times 10^{10}$	$4.7 \times 10^{11}$	$<2.5 \times 10^6$	$4.8 \times 10^5$	$2 \times 10^4$
	Week 4	$2.7 \times 10^{11}$	$7.6 \times 10^{12}$	$3.0 \times 10^{10}$	$3.4 \times 10^{11}$	$<2.6 \times 10^6$	$2.1 \times 10^5$	$2 \times 10^4$
Feb.	Week 5	$2.1 \times 10^{11}$	$6.2 \times 10^{12}$	$2.1 \times 10^{10}$	$5.4 \times 10^{11}$	$<2.5 \times 10^6$	$2.8 \times 10^5$	$2 \times 10^4$
	Week 6	$3.1 \times 10^{11}$	$4.1 \times 10^{12}$	$1.8 \times 10^{10}$	$4.4 \times 10^{11}$	$<2.6 \times 10^6$	$3.1 \times 10^5$	$2 \times 10^4$
	Week 7	$4.7 \times 10^{11}$	$5.0 \times 10^{12}$	$1.2 \times 10^{10}$	$3.3 \times 10^{11}$	$<2.6 \times 10^6$	$3.5 \times 10^5$	$2 \times 10^4$
	Week 8	$4.5 \times 10^{11}$	$5.5 \times 10^{12}$	$1.2 \times 10^{10}$	$3.7 \times 10^{11}$	$<2.6 \times 10^6$	$3.4 \times 10^5$	$2 \times 10^4$
Mar.	Week 9	$2.8 \times 10^{11}$	$4.1 \times 10^{12}$	$1.1 \times 10^{10}$	$3.1 \times 10^{11}$	$<2.6 \times 10^6$	$4.2 \times 10^5$	$2 \times 10^4$
	Week 10	$2.7 \times 10^{11}$	$4.4 \times 10^{12}$	$1.1 \times 10^{10}$	$3.7 \times 10^{11}$	$<2.5 \times 10^6$	$2.9 \times 10^5$	$2 \times 10^4$
	Week 11	$5.1 \times 10^{11}$	$6.2 \times 10^{12}$	$1.4 \times 10^{10}$	$4.0 \times 10^{11}$	$<2.8 \times 10^6$	$4.4 \times 10^5$	$2 \times 10^4$
	Week 12	$6.3 \times 10^{11}$	$7.5 \times 10^{12}$	$1.2 \times 10^{10}$	$4.7 \times 10^{11}$	$<3.0 \times 10^6$	$4.1 \times 10^5$	$2 \times 10^4$
	Week 13	$2.3 \times 10^{11}$	$8.7 \times 10^{12}$	$1.3 \times 10^{10}$	$2.9 \times 10^{11}$	$<2.8 \times 10^6$	$4.0 \times 10^5$	$2 \times 10^4$
Apr.	Week 14	Not detectable	$5.0 \times 10^{12}$	$1.5 \times 10^{10}$	$8.8 \times 10^{11}$	$<2.9 \times 10^6$	$4.6 \times 10^5$	$3 \times 10^4$
	Week 15	$8.2 \times 10^{12}$	$6.6 \times 10^{12}$	$1.9 \times 10^{10}$	$6.4 \times 10^{11}$	$<2.8 \times 10^6$	$2.7 \times 10^5$	$3 \times 10^4$
	Week 16	$9.3 \times 10^{12}$	$4.7 \times 10^{12}$	$1.1 \times 10^{10}$	$2.4 \times 10^{12}$	$<3.0 \times 10^6$	$6.5 \times 10^5$	$3 \times 10^4$
	Week 17	$2.0 \times 10^{12}$	$5.2 \times 10^{12}$	$1.5 \times 10^{10}$	$1.8 \times 10^{12}$	$<2.8 \times 10^6$	$5.7 \times 10^5$	$3 \times 10^4$
May	Week 18	$2.1 \times 10^{12}$	$5.7 \times 10^{12}$	$1.3 \times 10^{10}$	$5.1 \times 10^{11}$	$<2.8 \times 10^6$	$7.3 \times 10^5$	$3 \times 10^4$
	Week 19	$4.3 \times 10^{11}$	$5.9 \times 10^{12}$	$1.8 \times 10^{10}$	$2.3 \times 10^{12}$	$<2.8 \times 10^6$	$2.9 \times 10^5$	$3 \times 10^4$
	Week 20	$1.2 \times 10^{11}$	$9.5 \times 10^{12}$	$1.8 \times 10^{10}$	$4.5 \times 10^{12}$	$<2.7 \times 10^6$	$5.7 \times 10^5$	$3 \times 10^4$
	Week 21	$2.2 \times 10^{11}$	$4.2 \times 10^{12}$	$1.8 \times 10^{10}$	$2.0 \times 10^{12}$	$<2.8 \times 10^6$	$7.7 \times 10^5$	$3 \times 10^4$
Jun.	Week 22	$1.4 \times 10^{11}$	$6.9 \times 10^{12}$	$2.8 \times 10^{10}$	$9.2 \times 10^{11}$	$<2.7 \times 10^6$	$4.1 \times 10^5$	$3 \times 10^4$
	Week 23	$9.4 \times 10^{10}$	$3.0 \times 10^{12}$	$3.2 \times 10^{10}$	$1.7 \times 10^{12}$	$<2.7 \times 10^6$	$5.9 \times 10^5$	$3 \times 10^4$
	Week 24	$1.5 \times 10^{11}$	$3.2 \times 10^{12}$	$2.1 \times 10^{10}$	$7.5 \times 10^{11}$	$<2.8 \times 10^6$	$6.1 \times 10^5$	$3 \times 10^4$
	Week 25	$3.0 \times 10^{10}$	$2.5 \times 10^{12}$	$2.2 \times 10^{10}$	$8.7 \times 10^{11}$	$<2.7 \times 10^6$	$7.3 \times 10^5$	$3 \times 10^4$
	Week 26	$2.9 \times 10^{11}$	$2.7 \times 10^{12}$	$2.1 \times 10^{10}$	$3.4 \times 10^{11}$	$<2.9 \times 10^6$	$1.1 \times 10^6$	$2 \times 10^4$

- (a) The derived Release Limit for a given radionuclide is the release rate of that radionuclide to air or surface water during normal operation of a nuclear facility over the period of a calendar year, which would result in an individual receiving a dose equal to the regulatory annual dose limit for a member of the public.
- (b) Analysis of air emissions is conducted weekly to monitor against internal performance targets. Emissions are reported using the fiscal calendar and months contain either four or five weeks. Values prefixed by an “<” indicate that reported results were less than the instrument detection limits.

# Environmental Emissions Data for Darlington Nuclear

Q2 2018

- (c) Exceedances of Action Levels must be reported by OPG to the CNSC. To prevent an Action Level from being reached, OPG has set Internal Investigation Levels that require emissions to be reviewed when they reach the high end of the normal range. Corrective actions are taken if necessary. There were no CNSC Action Level exceedance events in the second quarter of 2018.
- (d) Action Level for gross alpha is not specified because it is not a routinely monitored radionuclide group at Darlington Nuclear as the activity is below the threshold value for monitoring.
- (e) The increase in elemental tritium releases in January (week 1) was primarily due to higher releases from the Tritium Removal Facility during operation of the Air Cleanup System at the end of 2017. The releases have come down the following week.

**Table A.2: Waterborne Radionuclide Releases**

	<b>Tritium Oxide (Bq)</b>	<b>Gross Beta-Gamma (Bq)</b>	<b>Carbon-14 (Bq)</b>	<b>Gross Alpha (Bq)</b>
<b>SUMMARY: ANNUAL</b>				
<b>Release Limit (Bq/year)<sup>(a)</sup></b>	5.3 x 10 <sup>18</sup>	7.1 x 10 <sup>13</sup>	9.7 x 10 <sup>14</sup>	3.2 x 10 <sup>14</sup>
Total Releases as of Q2 2018	6.8 x 10 <sup>13</sup>	1.2 x 10 <sup>10</sup>	6.3 x 10 <sup>8</sup>	<2 x 10 <sup>5</sup>
<b>DETAILS: MONTHLY<sup>(b)</sup></b>				
<b>Action Level (Bq/month)<sup>(c)</sup></b>	4.3 x 10 <sup>16</sup>	5.7 x 10 <sup>11</sup>	7.8 x 10 <sup>12</sup>	Not specified <sup>(d)</sup>
January	1.0 x 10 <sup>13</sup>	1.4 x 10 <sup>9</sup>	5.2 x 10 <sup>8</sup>	4 x 10 <sup>4</sup>
February	8.3 x 10 <sup>12</sup>	1.8 x 10 <sup>9</sup>	2.2 x 10 <sup>7</sup>	<2 x 10 <sup>4</sup>
March	1.4 x 10 <sup>13</sup>	2.3 x 10 <sup>9</sup>	1.0 x 10 <sup>7</sup>	3 x 10 <sup>4</sup>
April	7.9 x 10 <sup>12</sup>	1.5 x 10 <sup>9</sup>	1.4 x 10 <sup>7</sup>	3 x 10 <sup>4</sup>
May	8.2 x 10 <sup>12</sup>	2.0 x 10 <sup>9</sup>	1.1 x 10 <sup>7</sup>	2 x 10 <sup>4</sup>
June	1.9 x 10 <sup>13</sup>	2.5 x 10 <sup>9</sup>	5.5 x 10 <sup>7</sup>	4 x 10 <sup>4</sup>

- (a) The derived Release Limit for a given radionuclide is the release rate of that radionuclide to air or surface water during normal operation of a nuclear facility over the period of a calendar year, which would result in an individual receiving a dose equal to the regulatory annual dose limit for a member of the public.
- (b) Analysis of water emissions is conducted monthly to monitor against internal performance targets. Monthly emissions are reported using the fiscal calendar and months contain either four or five weeks. Months with five weeks typically report higher releases relative to months with four weeks. For 2018, March, June, September and December have five weeks.
- (c) Exceedances of Action Levels must be reported by OPG to the CNSC. To prevent an Action Level from being reached, OPG has set Internal Investigation Levels that require emissions to be reviewed when they reach the high end of the normal range. Corrective actions are taken if necessary. There were no CNSC Action Level exceedance events in the second quarter of 2018.
- (d) Action Level for gross alpha is not specified because it is not a routinely monitored radionuclide group at Darlington Nuclear as the activity is below the threshold value for monitoring.

# Environmental Emissions Data for Darlington Nuclear

**Table A.3:** Darlington Waste Management Facility Emissions

		Air - Particulate (Bq) <sup>(a)</sup>	Storm Water - Tritium (Bq/L) <sup>(b)</sup>	Storm Water - Gross Gamma (Bq/L) <sup>(b)</sup>
Apr.	Week 14	333	333	<7.03
	Week 15	370	814	<7.03
	Week 16	222	1332	<7.03
	Week 17	333	370	<7.03
May	Week 18	296	777	<6.66
	Week 19	333	259	<6.66
	Week 20	296	259	9.99
	Week 21	259	555	<6.66
Jun.	Week 22	148	370	<6.66
	Week 23	333	666	<6.66
	Week 24	333	296	<6.66
	Week 25	407	296	<6.66
	Week 26	370	259	<6.66

(a) All weekly results were below the Action Level of  $1.3 \times 10^9$ Bq.

(b) Storm water at the Darlington Waste Management Facility is sampled to assess the integrity of waste storage structures. Results were less than the internal administrative limits set to detect potential leaks.

*A becquerel (Bq) is the standard international unit for measuring radioactive decay or radioactivity. One becquerel is the decay of one atom of a radioisotope per second, and is an extremely small amount of radioactivity. Becquerel is a measure of the rate (not energy) of radiation emission from a source.*

*Another unit of measuring radioactivity is the curie (Ci).  $1 \text{ Ci} = 3.7 \times 10^{10} \text{ Bq}$ .*

*While station emissions typically remain at consistently low levels, small fluctuations do occur because of changing operating conditions (e.g. unit outages), work activities, and equipment issues.*

# Environmental Emissions Data for Darlington Nuclear

**Table A.4:** Darlington Waste Management Facility Perimeter Fence Dose Rates

	Average Air Kerma Rate ( $\mu\text{Gy}/\text{hour}$ ) <sup>(a)</sup>
Location	Q2
DW1, Pole 1	0.059
DW2, Pole 20	0.067
DW3, Pole 19	0.095
DW4, Pole 18	0.106
DW5, Pole 17	0.097
DW6, Pole 13	0.071
DW7, Pole 9	0.103
DW8, Pole 8	0.116
DW9, Pole 7	0.094
DW10, Pole 6	0.072
DW11, Pole 5	0.057
DW12, Pole 3	0.058

(a) Average ambient dose rates are measured at perimeter fences by Thermoluminescent Dosimeters to demonstrate that potential doses due to radiation fields from waste management facility operations are well within allowable limits and pose a negligible risk for the public, the workers and the environment. Dose rate monitoring results are compared to an internal target dose rate standard of 0.5  $\mu\text{Gy}/\text{hour}$ . This target is derived from the 1 mSv/year dose limit specified in federal legislation for a member of the public and assumes exposure for a working year (2,000 hours).

**Table A.5:** Retube Waste Storage Building Perimeter Dose Rates

	Average Air Kerma Rate ( $\mu\text{Gy}/\text{hour}$ ) <sup>(a)</sup>
Location	Q2
DRW1	0.057
DRW2	0.073
DRW3	0.080
DRW4	0.077
DRW5	0.076
DRW6	0.056
DRW7	0.064
DRW8	0.073
DRW9	0.053
DRW10	0.055

(a) Average ambient dose rates are measured at the exterior walls of the Retube Waste Storage Building by Thermoluminescent Dosimeters to demonstrate that potential doses due to radiation fields from waste management facility operations are well within allowable limits and pose a negligible risk for the public, the workers and the environment. Dose rate monitoring results are compared to an internal target dose rate standard of 0.5  $\mu\text{Gy}/\text{hour}$ . This target is derived from the 1 mSv/year dose limit specified in federal legislation for a member of the public and assumes exposure for a working year (2,000 hours).



# Environmental Emissions Data for Darlington Nuclear

**Table A.6:** Results for Tritium in Groundwater at Darlington Site Perimeter Monitoring Locations

	Tritium (Bq/L) <sup>(a)</sup>
	2017 <sup>(b)</sup>
MW-006-9	<100
MW-007-2	<100
MW-008-20	<100
MW-015A-19	<100
MW-016A-10	<100
MW-016C-4 <sup>(c)</sup>	480
MW-017B-15	<100
MW-018A-11	<100
MW-018C-4	<100
MW-032-13	<100
MW-033-8	<100
MW-042-20	<100
MW-043-8	<100
MW-045-10	<100
MW-046-6	<100
MW-052-15	<100
MW-058-6	<100
MW-059-12	<100
MW-078-18	<100
MW-079-4	<100
MW-081-17	<100
MW-082-6	<100
MW-095-13	<100
MW-096-6	<100
MW-170-34 <sup>(d)</sup>	<100
MW-171-13 <sup>(d)</sup>	<100
MW-172-6 <sup>(d)</sup>	<100
MW-174-56 <sup>(d)</sup>	<100
MW-175-41 <sup>(d)</sup>	<100
MW-176-03 <sup>(d)</sup>	<100

- a) Values prefixed by an “<” indicate that reported results were less than the instrument detection limits.
- b) In 2017, monitoring wells were sampled on an annual basis. The wells are labelled as “MW-XXX-YY”: the first number (XXX) identifies the well and the second number (YY) is the depth of the well in metres.
- c) The slightly higher tritium concentration at MW-016C-4 is attributed to a spill which occurred in 2009, and is expected to continue to decrease over time as the source term diminishes.
- d) Monitoring wells MW-027-29, MW-028-14, MW-029-6, MW-070-55, MW-071-37 and MW-072-3 have been replaced and renumbered in 2017 to MW-170-34, MW-171-13, MW-172-6, MW-174-56, MW-175-41 and MW-176-03 respectively.