

OVERVIEW

This report summarizes Darlington Nuclear’s environmental emissions data for Q3 2019. 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 remained well below the 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 was 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.

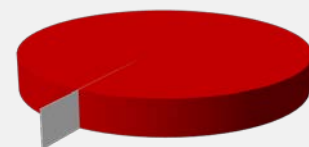
OPG also sets Action Levels that are much lower than the Release Limits to identify and control emissions before a limit can be reached.

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

Natural Background Radiation > 99.9%



Darlington Nuclear Contribution < 0.1%

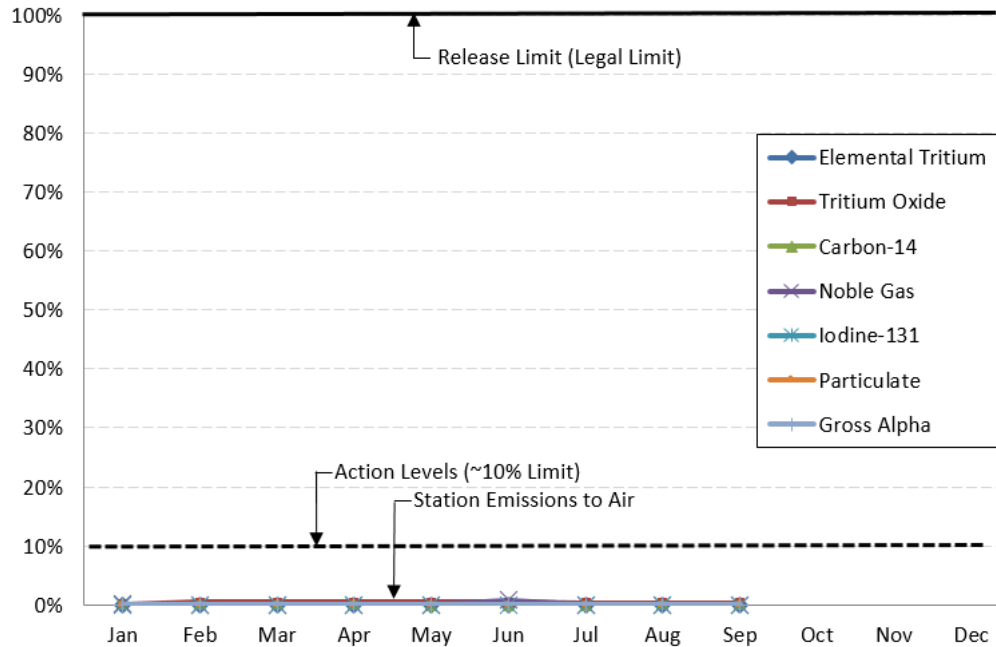
Environmental Emissions Data for Darlington Nuclear

Q3 2019

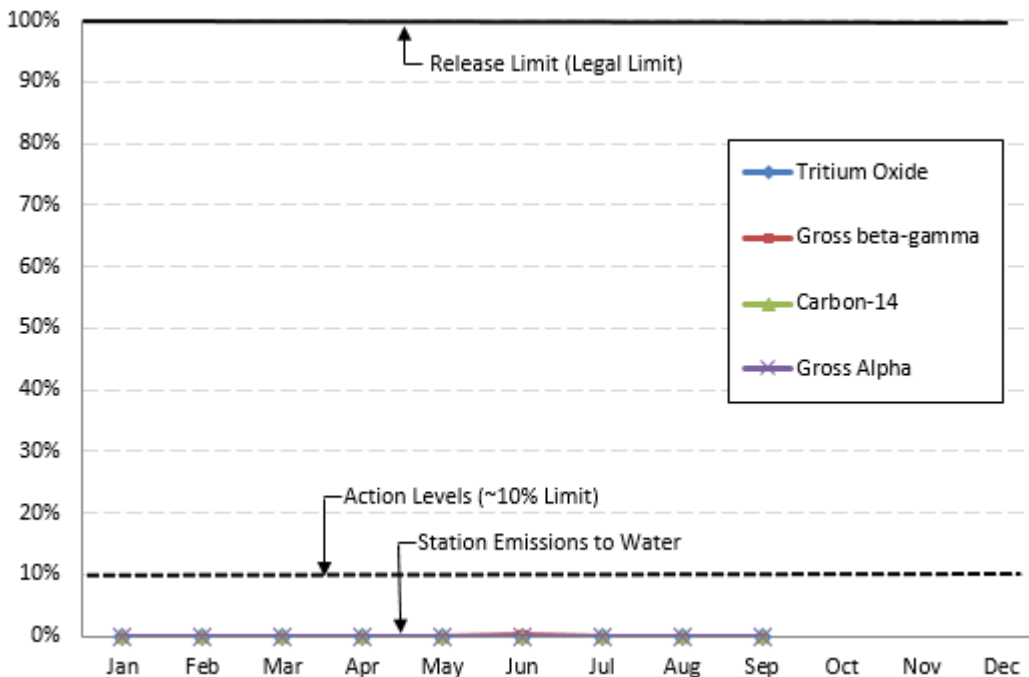
Performance Results

Darlington Nuclear’s emissions are monitored to track performance. For Q3 2019, Darlington Nuclear’s radiological emissions to air and water remained well below 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



Environmental Emissions Data for Darlington Nuclear

Q3 2019

DARLINGTON WASTE MANAGEMENT FACILITY

Radiological air emissions, storm water, and radiation dose monitoring requirements for the Darlington Waste Management Facility were met in Q3 2019 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. 2018 groundwater monitoring report is available at: www.opg.com/reporting/regulatory-reporting/

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 Q3 2019.

APPENDIX A

ENVIRONMENTAL EMISSIONS DATA

Environmental Emissions Data for Darlington Nuclear

Q3 2019

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)	
SUMMARY: ANNUAL								
Release Limit (Bq/year) ^(a)	8.23 x 10 ¹⁷	4.94 x 10 ¹⁶	1.21 x 10 ¹⁵	3.80 x 10 ¹⁶	1.77 x 10 ¹²	6.06 x 10 ¹¹	1.08 x 10 ¹¹	
Total Releases as of Q3 2019	1.7 x 10 ¹³	1.5 x 10 ¹⁴	7.9 x 10 ¹¹	4.2 x 10 ¹³	<1.1 x10 ⁸	1.9 x 10 ⁷	1 x 10 ⁶	
DETAILS: WEEKLY^(b)								
Action Level (Bq/week) ^(c)	1.65 x 10 ¹⁵	9.88 x 10 ¹³	2.42 x 10 ¹²	7.60 x 10 ¹³	3.53 x 10 ⁹	1.21 x 10 ⁹	Not specified ^(d)	
Jan.	Week 1	2.0 x 10 ¹¹	1.7 x 10 ¹²	2.9 x 10 ¹⁰	3.3 x 10 ¹¹	<2.5 x 10 ⁶	3.2 x 10 ⁵	2 x 10 ⁴
	Week 2	1.2 x 10 ¹¹	1.8 x 10 ¹²	3.6 x 10 ¹⁰	1.1 x 10 ¹²	<2.6 x 10 ⁶	3.7 x 10 ⁵	2 x 10 ⁴
	Week 3	2.2 x 10 ¹¹	1.6 x 10 ¹²	3.5 x 10 ¹⁰	8.0 x 10 ¹¹	<2.7 x 10 ⁶	2.5 x 10 ⁵	2 x 10 ⁴
	Week 4	5.5 x 10 ¹¹	1.8 x 10 ¹²	3.5 x 10 ¹⁰	3.5 x 10 ¹¹	<2.5 x 10 ⁶	2.7 x 10 ⁵	2 x 10 ⁴
Feb.	Week 5	4.5 x 10 ¹¹	1.7 x 10 ¹²	2.9 x 10 ¹⁰	4.7 x 10 ¹¹	<2.7 x 10 ⁶	3.7 x 10 ⁵	2 x 10 ⁴
	Week 6	1.2 x 10 ¹¹	2.5 x 10 ¹²	3.1 x 10 ¹⁰	2.7 x 10 ¹¹	<2.8 x 10 ⁶	2.6 x 10 ⁵	3 x 10 ⁴
	Week 7	2.7 x 10 ¹²	5.9 x 10 ¹²	1.6 x 10 ¹⁰	3.0 x 10 ¹¹	<2.7 x 10 ⁶	2.4 x 10 ⁵	2 x 10 ⁴
	Week 8	2.3 x 10 ¹¹	6.3 x 10 ¹²	3.2 x 10 ¹⁰	4.9 x 10 ¹¹	<3.0 x 10 ⁶	3.5 x 10 ⁵	3 x 10 ⁴
Mar.	Week 9	3.0 x 10 ¹¹	5.0 x 10 ¹²	2.2 x 10 ¹⁰	5.0 x 10 ¹¹	<2.9 x 10 ⁶	3.7 x 10 ⁵	3 x 10 ⁴
	Week 10	2.6 x 10 ¹¹	4.7 x 10 ¹²	2.2 x 10 ¹⁰	3.9 x 10 ¹¹	<2.9 x 10 ⁶	3.5 x 10 ⁵	3 x 10 ⁴
	Week 11	Not Detectable	5.0 x 10 ¹²	1.6 x 10 ¹⁰	2.9 x 10 ¹¹	<2.8 x 10 ⁶	4.4 x 10 ⁵	2 x 10 ⁴
	Week 12	1.1 x 10 ¹¹	3.3 x 10 ¹²	1.6 x 10 ¹⁰	2.5 x 10 ¹¹	<2.8 x 10 ⁶	3.4 x 10 ⁵	3 x 10 ⁴
	Week 13	7.1 x 10 ¹¹	2.6 x 10 ¹²	2.6 x 10 ¹⁰	2.5 x 10 ¹¹	<2.9 x 10 ⁶	2.8 x 10 ⁵	3 x 10 ⁴
Apr.	Week 14	6.8 x 10 ¹¹	3.3 x 10 ¹²	3.6 x 10 ¹⁰	2.6 x 10 ¹¹	<2.7 x 10 ⁶	3.3 x 10 ⁵	3 x 10 ⁴
	Week 15	1.4 x 10 ¹¹	4.3 x 10 ¹²	2.8 x 10 ¹⁰	2.6 x 10 ¹¹	<2.8 x 10 ⁶	3.4 x 10 ⁵	2 x 10 ⁴
	Week 16	1.5 x 10 ¹¹	4.7 x 10 ¹²	1.8 x 10 ¹⁰	2.6 x 10 ¹¹	<2.8 x 10 ⁶	4.3 x 10 ⁵	3 x 10 ⁴
	Week 17	8.7 x 10 ⁹	5.0 x 10 ¹²	1.6 x 10 ¹⁰	1.7 x 10 ¹¹	<2.8 x 10 ⁶	3.3 x 10 ⁵	2 x 10 ⁴
May	Week 18	3.1 x 10 ¹¹	5.2 x 10 ¹²	1.1 x 10 ¹⁰	2.6 x 10 ¹¹	<3.0 x 10 ⁶	4.4 x 10 ⁵	3 x 10 ⁴
	Week 19	2.4 x 10 ¹¹	2.9 x 10 ¹²	1.5 x 10 ¹⁰	3.5 x 10 ¹¹	<2.9 x 10 ⁶	2.5 x 10 ⁵	3 x 10 ⁴
	Week 20	2.4 x 10 ¹¹	4.1 x 10 ¹²	9.8 x 10 ¹⁰	4.5 x 10 ¹¹	<2.8 x 10 ⁶	1.8 x 10 ⁵	3 x 10 ⁴
	Week 21	3.3 x 10 ¹¹	6.2 x 10 ¹²	1.7 x 10 ¹⁰	2.5 x 10 ¹¹	<2.8 x 10 ⁶	3.5 x 10 ⁵	3 x 10 ⁴
Jun.	Week 22	4.9 x 10 ¹¹	4.8 x 10 ¹²	1.6 x 10 ¹⁰	6.5 x 10 ¹¹	<2.8 x 10 ⁶	4.9 x 10 ⁵	2 x 10 ⁴
	Week 23	1.2 x 10 ¹²	4.4 x 10 ¹²	1.6 x 10 ¹⁰	5.2 x 10 ¹¹	<2.8 x 10 ⁶	3.2 x 10 ⁵	3 x 10 ⁴
	Week 24	1.1 x 10 ¹²	3.9 x 10 ¹²	1.3 x 10 ¹⁰	2.8 x 10 ¹³	<2.8 x 10 ⁶	3.5 x 10 ⁵	2 x 10 ⁴
	Week 25	7.7 x 10 ¹¹	3.5 x 10 ¹²	1.4 x 10 ¹⁰	2.5 x 10 ¹¹	<2.5 x 10 ⁶	2.3 x 10 ⁵	2 x 10 ⁴
	Week 26	6.1 x 10 ¹¹	4.5 x 10 ¹²	1.4 x 10 ¹⁰	2.2 x 10 ¹¹	<2.7 x 10 ⁶	7.7 x 10 ⁵	2 x 10 ⁴
Jul.	Week 27	3.8 x 10 ¹¹	3.9 x 10 ¹²	1.0 x 10 ¹⁰	7.2 x 10 ¹¹	<2.7 x 10 ⁶	8.8 x 10 ⁵	2 x 10 ⁴
	Week 28	2.9 x 10 ¹¹	3.9 x 10 ¹²	1.3 x 10 ¹⁰	3.2 x 10 ¹¹	<2.6 x 10 ⁶	4.1 x 10 ⁵	2 x 10 ⁴
	Week 29	2.0 x 10 ¹¹	3.2 x 10 ¹²	1.2 x 10 ¹⁰	1.7 x 10 ¹¹	<2.4 x 10 ⁶	7.5 x 10 ⁵	2 x 10 ⁴
	Week 30	5.2 x 10 ¹¹	3.1 x 10 ¹²	1.4 x 10 ¹⁰	2.5 x 10 ¹¹	<2.4 x 10 ⁶	6.4 x 10 ⁵	2 x 10 ⁴
Aug.	Week 31	2.6 x 10 ¹¹	2.9 x 10 ¹²	1.2 x 10 ¹⁰	1.3 x 10 ¹¹	<2.6 x 10 ⁶	8.6 x 10 ⁵	2 x 10 ⁴
	Week 32	1.3 x 10 ¹¹	2.6 x 10 ¹²	1.7 x 10 ¹⁰	2.6 x 10 ¹¹	<2.6 x 10 ⁶	1.3 x 10 ⁶	3 x 10 ⁴

Environmental Emissions Data for Darlington Nuclear

Q3 2019

	Elemental Tritium (Bq)	Tritium Oxide (Bq)	Carbon-14 (Bq)	Noble Gas (Bq-MeV)	Iodine-131 (Bq)	Particulate (Bq)	Gross Alpha (Bq)
Week 33	3.8×10^{11}	4.1×10^{12}	1.8×10^{10}	2.5×10^{11}	$<2.6 \times 10^6$	6.1×10^5	3×10^4
Week 34	3.3×10^{11}	3.5×10^{12}	2.3×10^{10}	2.4×10^{11}	$<2.7 \times 10^6$	6.2×10^5	3×10^4
Sep. Week 35	8.3×10^{10}	3.8×10^{12}	2.5×10^{10}	2.3×10^{11}	$<2.6 \times 10^6$	9.6×10^5	2×10^4
Week 36	3.2×10^{11}	3.7×10^{12}	2.9×10^{10}	3.4×10^{11}	$<2.6 \times 10^6$	7.8×10^5	3×10^4
Week 37	3.9×10^{11}	3.3×10^{12}	2.4×10^{10}	2.4×10^{11}	$<2.7 \times 10^6$	6.4×10^5	3×10^4
Week 38	4.0×10^{11}	3.5×10^{12}	1.3×10^{10}	1.8×10^{11}	$<2.6 \times 10^6$	6.3×10^5	2×10^4
Week 39	6.9×10^{11}	3.1×10^{12}	1.2×10^{10}	1.8×10^{11}	$<2.4 \times 10^6$	6.4×10^5	2×10^4

- (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. New Release Limits have been implemented for the Darlington Nuclear starting in 2019.
- (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.
- (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 third quarter of 2019. New Action Levels have been implemented for the Darlington Nuclear starting in 2019.
- (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.

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.

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). $1 \text{ Ci} = 3.7 \times 10^{10} \text{ Bq}$.

Environmental Emissions Data for Darlington Nuclear

Q3 2019

Table A.2: Waterborne Radionuclide Releases

	Tritium Oxide (Bq)	Gross Beta-Gamma (Bq)	Carbon-14 (Bq)	Gross Alpha (Bq)
SUMMARY: ANNUAL				
Release Limit (Bq/year)^(a)	6.43×10^{18}	3.47×10^{13}	6.97×10^{14}	4.39×10^{11}
Total Releases as of Q3 2019	7.7×10^{13}	1.8×10^{10}	2.4×10^8	4×10^5
DETAILS: MONTHLY^(b)				
Action Level (Bq/month)^(c)	5.14×10^{16}	2.77×10^{11}	5.58×10^{12}	Not specified ^(d)
January	6.7×10^{12}	1.6×10^9	8.9×10^7	5×10^4
February	7.6×10^{12}	1.4×10^9	1.4×10^7	6×10^4
March	9.9×10^{12}	1.6×10^9	1.7×10^7	6×10^4
April	8.8×10^{12}	1.8×10^9	8.1×10^6	4×10^4
May	9.1×10^{12}	2.0×10^9	1.1×10^7	3×10^4
June	9.3×10^{12}	3.2×10^9	4.1×10^7	3×10^4
July	7.4×10^{12}	1.9×10^9	4.6×10^6	3×10^4
August	1.0×10^{13}	2.0×10^9	9.5×10^5	5×10^4
September	8.1×10^{12}	2.4×10^9	5.9×10^7	4×10^4

- (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. New Release Limits have been implemented for the Darlington Nuclear starting in 2019.
- (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 2019, 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 third quarter of 2019. New Action Levels have been implemented for the Darlington Nuclear starting in 2019.
- (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) ^(a)	Storm Water - Tritium (Bq/L) ^(b)	Storm Water - Gross Gamma (Bq/L) ^(b)
Jul.	Week 27	74	370	<7.03
	Week 28	74	259	<6.66
	Week 29	74	333	<8.14
	Week 30	37	925	<7.03
Aug.	Week 31	74	481	<8.14
	Week 32	74	370	<7.03
	Week 33	74	518	<7.03
	Week 34	74	296	<6.66
Sep.	Week 35	74	407	<8.14
	Week 36	37	333	<6.66
	Week 37	74	370	<7.03
	Week 38	74	333	<6.66
	Week 39	74	333	<6.66

- (a) All weekly results were below the Action Level of 1.21×10^9 Bq for air Particulate.
- (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.

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

Location	Average Air Kerma Rate (μ Gy/hour) ^(a)
	Q3
DW1, Pole 1	0.060
DW2, Pole 20	0.068
DW3, Pole 19	0.097
DW4, Pole 18	0.106
DW5, Pole 17	0.096
DW6, Pole 13	0.079
DW7, Pole 9	0.096
DW8, Pole 8	0.109
DW9, Pole 7	0.093
DW10, Pole 6	0.075
DW11, Pole 5	0.060
DW12, Pole 3	0.056

- (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 0.5μ Gy/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 ($\mu\text{Gy}/\text{hour}$) ^(a)
Location	Q3
DRW1	0.054
DRW2	0.069
DRW3	0.073
DRW4	0.071
DRW5	0.072
DRW6	0.055
DRW7	0.064
DRW8	0.066
DRW9	0.051
DRW10	0.054

- (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 $1 \text{ mSv}/\text{year}$ dose limit specified in federal legislation for a member of the public and assumes exposure for a working year (2,000 hours).