

Document Number: NK38-REP-10140-10028	Usage Classification: N/A
Sheet Number: N/A	Revision: R000

Title:

2018 DARLINGTON NUCLEAR GROUNDWATER MONITORING PROGRAM RESULTS

© Ontario Power Generation Inc., 2019. This document has been produced and distributed for Ontario Power Generation Inc. purposes only. No part of this document may be reproduced, published, converted, or stored in any data retrieval system, or transmitted in any form or by any means (electronic, mechanical, photocopying, recording, or otherwise) without the prior written permission of Ontario Power Generation Inc.

**2018 Darlington Nuclear Groundwater
Monitoring Program Results****NK38-REP-10140-10028-R000**
2019-07-17Order Number: N/A
Other Reference Number:**Internal Use Only**Prepared By: T. Ghosh
Environmental Advisor
Environment Programs - NuclearReviewed By: A. Esmaily
Section Manager
Environment Programs - NuclearReviewed By: L. Yiu
Section Manager
Environment Operations Support
– Darlington, and Darlington
RefurbishmentReviewed By: K. Brama
Senior Manager
Environment Operations
Support - NuclearApproved By: R. McCalla
Director
Environment - Nuclear

Report

Internal Use Only		
Document Number:	NK38-REP-10140-10028	Usage Classification: N/A
Sheet Number:	Revision Number: R000	Page: 2 of 30

Title: 2018 DARLINGTON NUCLEAR GROUNDWATER MONITORING PROGRAM RESULTS

Table of Contents

	Page
Executive Summary	4
1.0 INTRODUCTION	5
2.0 PROGRAM DESIGN	5
2.1 Objective 1 Methodology	5
2.2 Objective 2 Methodology	5
2.3 Objective 3 Methodology	6
3.0 2018 PROGRAM RESULTS	9
3.1 Objective 1 Results.....	9
3.2 Objective 2 Results.....	12
3.2.1 Protected Area Groundwater Quality	12
3.2.2 Controlled Area Groundwater Quality	18
3.2.3 Petroleum Hydrocarbons and BTEX in Groundwater	18
3.3 Objective 3 Results.....	19
4.0 QUALITY ASSURANCE AND QUALITY CONTROL.....	22
4.1 Quality Assurance Program for Laboratories	22
4.2 Quality Control Results	22
5.0 SUPPLEMENTARY STUDIES AND AUDITS	22
6.0 CSA N288.7 UPDATE.....	23
7.0 ACRONYMS	23

Report

Internal Use Only		
Document Number: NK38-REP-10140-10028	Usage Classification: N/A	
Sheet Number: N/A	Revision Number: R000	Page: 3 of 30

Title: 2018 DARLINGTON NUCLEAR GROUNDWATER MONITORING PROGRAM RESULTS

List of Figures (within Report)

Figure 1: 2018 Groundwater Monitoring Locations.....	7
Figure 2: 2018 Protected Area Groundwater Monitoring Locations.....	8
Figure 3: 2018 Q2 Shallow Groundwater Contours.....	11
Figure 4: 2018 Protected Area Annual Maximum Tritium by Location.....	17
Figure 5: 2018 Controlled Area and Site Perimeter Maximum Tritium by Location.....	21

List of Graphs (within Report)

Graph 1: MW-142-16 Tritium Data.....	13
Graph 2: MW-143-12 Tritium Data.....	13
Graph 3: MW-144-7 Tritium Data.....	13
Graph 4: MW-114-18 Tritium Data.....	14
Graph 5: MW-115-12 Tritium Data.....	14
Graph 6: MW-116-6 Tritium Data.....	14
Graph 7: MW-157-16 Tritium Data.....	15
Graph 8: MW-158-12 Tritium Data.....	15
Graph 9: MW-159-7 Tritium Data.....	15
Graph 10: MW-154-16 Tritium Data... ..	16
Graph 11: MW-003-7 Tritium Data.....	18
Graph 12: MW-025-8 Tritium Data.....	18
Graph 13: MW-016C-4 Tritium Data	20

List of Appendices

Appendix A: Tables A-1 to A-6.....	24
------------------------------------	----

Report

Internal Use Only		
Document Number: NK38-REP-10140-10028	Usage Classification: N/A	
Sheet Number: N/A	Revision Number: R000	Page: 4 of 30

Title:
2018 DARLINGTON NUCLEAR GROUNDWATER MONITORING PROGRAM RESULTS

Executive Summary

Darlington Nuclear Generating Station (DNGS) has a mature and robust groundwater monitoring program in place to address the following primary objectives:

1. Confirm predominant on-site groundwater flow characteristics at the DNGS site;
2. Monitor changes to on-site groundwater quality to ensure timely detection of inadvertent releases to groundwater; and
3. Ensure that there are no adverse off-site impacts from DNGS groundwater.

In 2018, groundwater samples were collected as per the Sampling and Analysis Plan (SAP) developed for the site, from a total of 81 sampling locations.

The findings with respect to the above objectives are:

- The predominant shallow groundwater flow patterns remain unchanged in 2018 from the original site groundwater flow interpretations. Outside the protected area, groundwater generally flows from the north towards the Lake. Inside the protected area (in the vicinity of the powerhouse), the groundwater flows northwest towards the Forebay. Further south of the powerhouse, there is a component of groundwater flow that is directed towards Lake Ontario.
- The groundwater data collected from key areas at DNGS indicate that tritium concentrations have remained constant or decreased over time, which points to stable or improved environmental performance. Groundwater monitoring will continue in these areas.
- In 2018, there were no indications of adverse off-site impacts from DNGS groundwater. Tritium concentrations at perimeter groundwater monitoring locations remained very low. Municipal drinking water samples collected from downstream Water Supply Plants (WSP), as part of the annual OPG DNGS Environmental Monitoring Program (EMP), were well below the Ontario Drinking Water Quality Standard (ODWQS) for tritium of 7,000 Bq/L.

Report

Internal Use Only		
Document Number:	Usage Classification:	
NK38-REP-10140-10028	N/A	
Sheet Number:	Revision Number:	Page:
N/A	R000	5 of 30

Title:

2018 DARLINGTON NUCLEAR GROUNDWATER MONITORING PROGRAM RESULTS

1.0 INTRODUCTION

Ontario Power Generation (OPG), Darlington Nuclear Generating Station (DNGS), has a mature and robust annual groundwater monitoring program in place. The program examines the chemical, radiological, and physical characteristics of the groundwater beneath the site.

The specific objectives of this program are:

1. **Objective 1:** Confirm predominant on-site groundwater flow characteristics at the DNGS site;
2. **Objective 2:** Monitor changes to on-site groundwater quality to ensure timely detection of inadvertent releases to groundwater; and
3. **Objective 3:** Ensure that there are no adverse off-site impacts from DNGS groundwater.

This report presents groundwater data collected at DNGS for the period from January 1st to December 31st, 2018, and the associated interpretation of this data.

2.0 PROGRAM DESIGN

The design of the DNGS groundwater monitoring program is risk-based in nature. The 2018 groundwater Sampling and Analysis Plan (SAP) was developed to meet the three objectives listed above.

The 2018 SAP specified the sampling locations, the frequency of sampling, (e.g. quarterly, annually), and the parameters for analysis.

The methodology used to collect data and subsequently draw conclusions for each objective is discussed in further detail below.

2.1 Objective 1 Methodology

Groundwater flow interpretations for DNGS were first established in 2010. On an annual basis, the SAP requires that a set of water levels be collected from specific groundwater monitoring wells in order to verify that the original interpretations have not changed, and that OPG continues to have a sound understanding of groundwater flow patterns at the site. In the second quarter of 2018 (2018 Q2), water level readings were collected from selected monitoring locations. The data was subsequently used to calculate the groundwater elevation at each monitoring well and generate contour illustrations to visually verify the flow patterns.

2.2 Objective 2 Methodology

In 2018, as per the SAP, groundwater samples were collected from a total of 81 monitoring wells, as shown on Figures 1 and 2 (Pages 7 and 8 of this report). The

Report

Internal Use Only		
Document Number:	NK38-REP-10140-10028	Usage Classification:
Sheet Number:	N/A	Page:
	R000	6 of 30

Title:
2018 DARLINGTON NUCLEAR GROUNDWATER MONITORING PROGRAM RESULTS

monitoring wells are distinguished by location; protected area (near the reactor buildings), controlled area (farther away from the reactor buildings but within the fence), and the site perimeter.

Groundwater samples were collected by qualified technicians. Prior to sample collection, each monitoring well was purged to remove standing water, ensuring that representative groundwater flowed into the well. Collected samples were predominantly analyzed for tritium. Selected samples were analyzed for petroleum hydrocarbons (PHCs) and benzene / toluene / ethylbenzene / xylenes (BTEX). Groundwater samples were analyzed by Maxxam Analytics.

The groundwater data generated from the sampling program was subsequently analyzed to either support previous conclusions, identify adverse trends, or demonstrate no significant change.

2.3 Objective 3 Methodology

The 2018 SAP included the sampling of monitoring wells at the site boundary in order to confirm that there are no adverse off-site impacts from DNGS groundwater. These locations can also be seen on Figure 1 (Page 7). The methodology for groundwater collection and analysis, as well as for data evaluation, was the same for the site perimeter wells as what is described above for Objective 2.

Report

Internal Use Only	
Document Number:	Usage Classification:
NK38-REP-10140-10028	N/A
Sheet Number:	Revision Number:
N/A	R000
	Page:
	7 of 30

Title: 2018 DARLINGTON NUCLEAR GROUNDWATER MONITORING PROGRAM RESULTS



DARLINGTON NUCLEAR GENERATING STATION



Figure 1
2018 Groundwater Monitoring Locations

Report

Internal Use Only		
Document Number:	NK38-REP-10140-10028	Usage Classification:
Sheet Number:	Revision Number:	Page:
N/A	R000	9 of 30

Title:
2018 DARLINGTON NUCLEAR GROUNDWATER MONITORING PROGRAM RESULTS

3.0 2018 PROGRAM RESULTS

3.1 Objective 1 Results

The predominant groundwater flow patterns remain unchanged in 2018 from the original site groundwater flow interpretations made in 2010.

DNGS's groundwater flow systems are categorized into three hydrostratigraphic units (HU) based on previous hydrogeological investigations:

- Shallow/Water Table;
- Interglacial Deposits; and
- Shallow Bedrock.

Groundwater level measurements collected from the wells installed in each HU were used to confirm the groundwater flow directions. Figure 3 (Page 11) shows the shallow groundwater contours. Groundwater flow directions are interpreted to be perpendicular to the contour lines.

The predominant groundwater flow patterns are summarized as follows:

- In general, groundwater on the site flows from the north and discharges toward Lake Ontario.
- The eastern half of the DNGS site has a component of groundwater flow directed to the east from the north, and then south towards Lake Ontario.
- General flow in the interglacial deposits HU and the shallow bedrock HU are similar to that of water table HU described above. Vertically, groundwater flows predominantly downward from the water table (shallow groundwater) to interglacial deposits or to shallow bedrock.
- Groundwater flow direction is complex inside the protected area due to anthropogenic subsurface features as detailed below:
 - The powerhouse extends to bedrock and acts as a barrier to groundwater flow; therefore, groundwater flow at the water table on the north side of the powerhouse may not be connected or poorly connected to groundwater flow at the water table on the south side of the powerhouse.
 - Groundwater on the north side of the powerhouse discharges into the Forebay Channel as the Condenser Cooling Water pumps lower the Forebay Channel water level, creating a hydraulic gradient directed to the Forebay Channel.

Report

Internal Use Only		
Document Number: NK38-REP-10140-10028	Usage Classification: N/A	
Sheet Number: N/A	Revision Number: R000	Page: 10 of 30

Title:
2018 DARLINGTON NUCLEAR GROUNDWATER MONITORING PROGRAM RESULTS

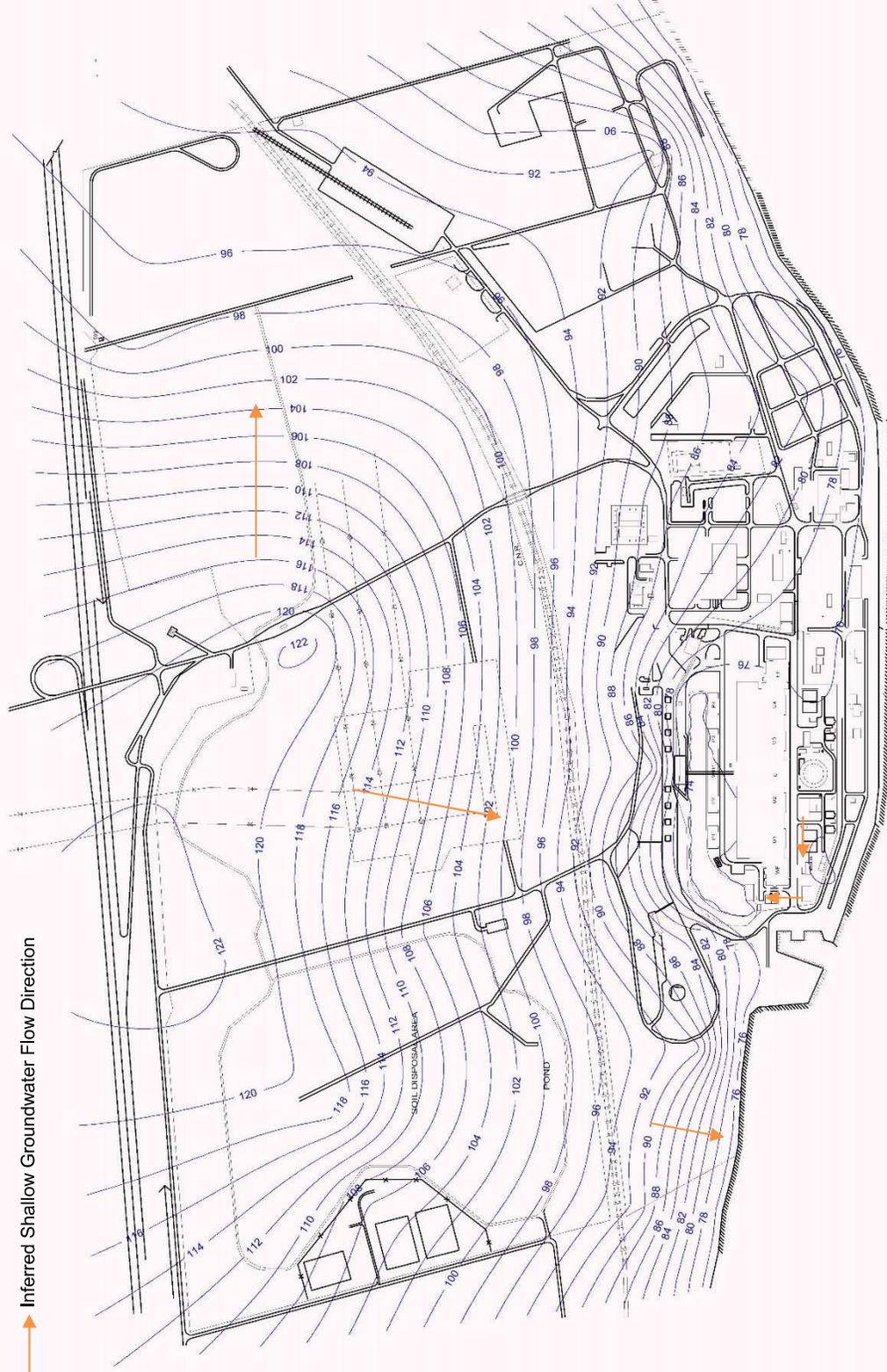
- On the south side of the powerhouse, groundwater flows from the east to the Forebay Channel; however, a component of that groundwater flow is directed to the lake.

In previous years, it was apparent that due to the dewatering activities related to the construction of buildings for the Darlington Refurbishment Project (especially the new Heavy Water Management Building south of Unit 2), there had been a lowering of groundwater levels within much of the protected area. As a result, there was a discrete, local change to the groundwater flow condition within the protected area. It is likely that some groundwater within the protected area, which would have historically discharged to the Forebay, instead flowed back towards the excavation/dewatering area. Groundwater levels in the protected area have now recovered, given that the most significant dewatering activities have ceased.

Report

Internal Use Only	
Document Number: NK38-REP-10140-10028	Usage Classification: N/A
Sheet Number: N/A	Revision Number: R000
	Page: 11 of 30
Title: 2018 DARLINGTON NUCLEAR GENERATING STATION MONITORING PROGRAM RESULTS	

➔ Inferred Shallow Groundwater Flow Direction



ONTARIO POWER
GENERATION

SCALE 1: 10768 (m)
0 200 400

LAKE ONTARIO

DARLINGTON NUCLEAR GENERATING STATION

Figure 3
2018 Q2 Shallow Groundwater Contours

Report

Internal Use Only		
Document Number: NK38-REP-10140-10028	Usage Classification: N/A	
Sheet Number: N/A	Revision Number: R000	Page: 12 of 30

Title:
2018 DARLINGTON NUCLEAR GROUNDWATER MONITORING PROGRAM RESULTS

3.2 Objective 2 Results

In 2018, the groundwater data collected from the key areas at DNGS indicate that tritium concentrations have remained constant or decreased over time, which points to stable or improved environmental performance.

There were no deviations from the sampling and analysis plan in 2018. All groundwater samples and water level measurements were collected as required.

3.2.1 Protected Area Groundwater Quality

In 2018, 38 monitoring wells were sampled in the protected area to assess tritium concentrations and trends.

The presence of elevated tritium in groundwater in the protected area is attributed to the Injection Water Storage Tank (IWST) spill, which occurred southwest of Unit 0, in December 2009. Overall, tritium concentrations have declined since the spill, confirming that there are no new sources of tritium in groundwater. At certain locations, slight increases in tritium concentrations were observed in 2018, which are attributed to the stabilization of groundwater elevations in the protected area. Groundwater monitoring wells within the protected area will continue to be monitored to verify the tritium concentration trends.

The results are further discussed below, and presented on Figure 4 (Page 17) and Table A-1 (Appendix A). For Figure 4, to simplify the presentation of data, and maintain a conservative approach, the annual maximum tritium concentration at each monitoring well cluster/nest is presented.

For the ease of discussion, the protected area groundwater results are sub-divided into five smaller areas: Unit 2 (U2) area, West Fueling Facility Auxiliary (WFFA) area, Emergency Power Generator (EPG) Fuel Management Building area, Emergency Power Service (EPS) Building area, and the northern side of the powerhouse. These areas are also shown on Figure 4 (Page 17).

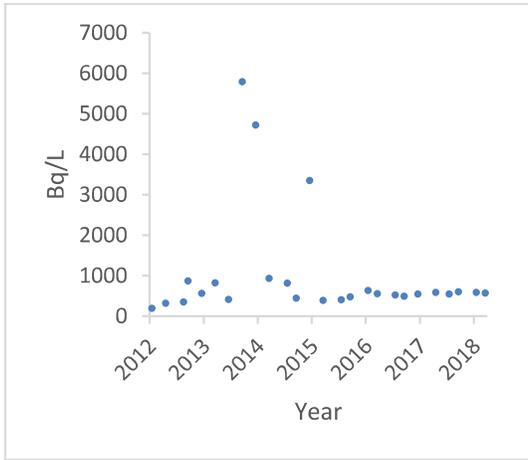
U2 Area

The core of the IWST spill plume, found in the area southwest of Unit 0 and in the vicinity of U2, is declining. In 2018, the highest tritium concentration seen at the monitoring well nest consisting of MW-142-16, MW-143-12 and MW-144-7 was 2.14 x 10³ Bq/L (0.058 µCi/L). Overall, the tritium concentration in this area is expected to continue to show a declining trend. Graphs 1 to 3 depict the data for these monitoring wells.

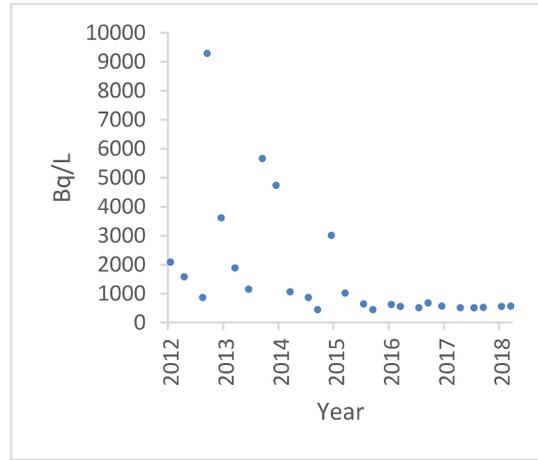
Report

Internal Use Only		
Document Number: NK38-REP-10140-10028	Usage Classification: N/A	
Sheet Number: N/A	Revision Number: R000	Page: 13 of 30

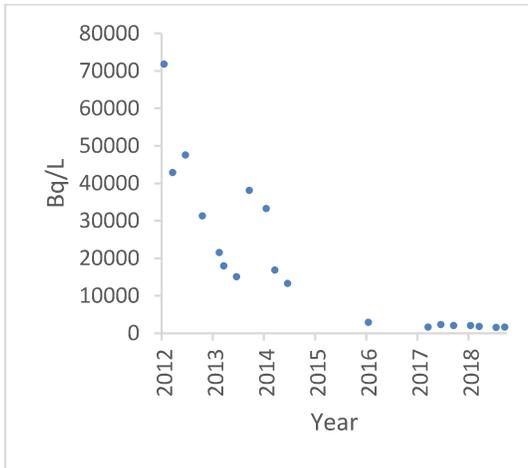
Title:
2018 DARLINGTON NUCLEAR GROUNDWATER MONITORING PROGRAM RESULTS



Graph 1: MW-142-16 Tritium Data



Graph 2: MW-143-12 Tritium Data



Graph 3: MW-144-7 Tritium Data

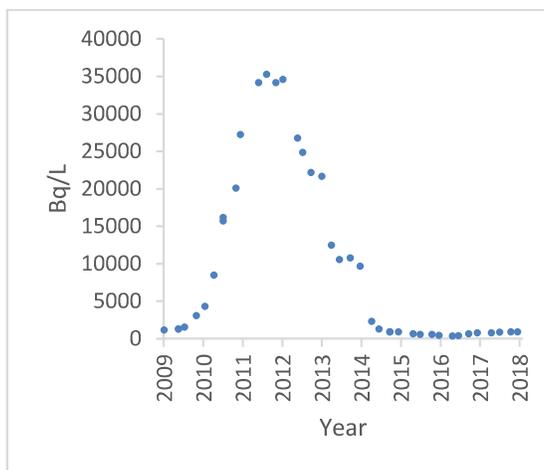
WFFA Area

The tritiated groundwater from the spill area has flowed along the southern wall of the powerhouse to the west. The monitoring well cluster consisting of MW-114-18, MW-115-12 and MW-116-6, located in the vicinity of the WFFA, had tritium concentrations ranging from 7.90×10^2 Bq/L (0.021 μ Ci/L) to 9.80×10^2 Bq/L (0.026 μ Ci/L) in 2018. Tritium concentrations peaked in 2012 and the concentrations have been generally decreasing since then (Graphs 4 to 6). This decline in tritium concentrations is expected to continue.

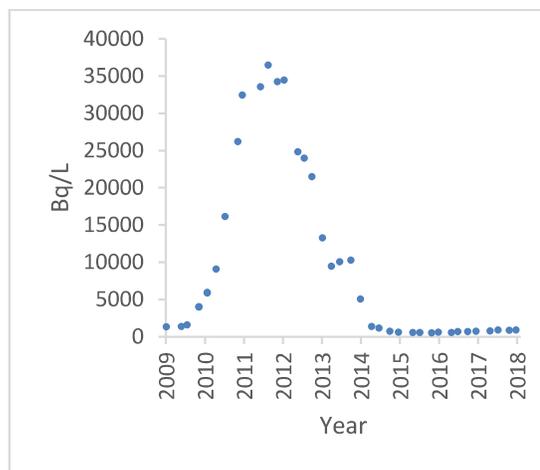
Report

Internal Use Only		
Document Number: NK38-REP-10140-10028		Usage Classification: N/A
Sheet Number: N/A	Revision Number: R000	Page: 14 of 30

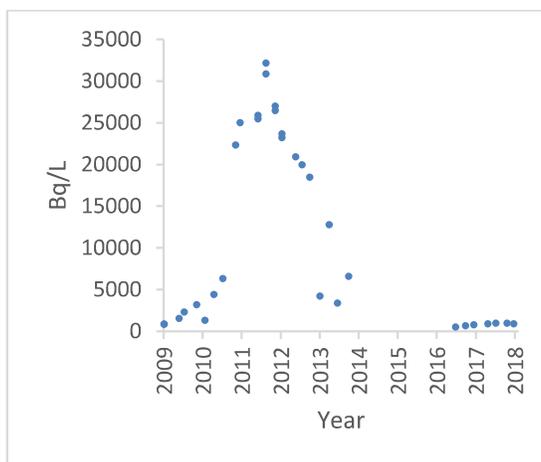
Title:
2018 DARLINGTON NUCLEAR GROUNDWATER MONITORING PROGRAM RESULTS



Graph 4: MW-114-18 Tritium Data



Graph 5: MW-115-12 Tritium Data



Graph 6: MW-116-6 Tritium Data

EPG Fuel Management Building Area

A small component of the tritium in groundwater has migrated west towards the EPG area.

At MW-157-16, an overall downward trend is apparent (Graph 7). In 2018, concentrations ranged from 5.50×10^2 Bq/L (0.015 μ Ci/L) to 6.70×10^2 Bq/L (0.018 μ Ci/L).

The adjacent deep overburden monitoring well (MW-158-12) has historically shown tritium concentrations at less than the method detection limit of 100 Bq/L (0.0027 μ Ci/L). In 2016, there was a slight increase in tritium concentrations at this well. In 2018, the concentrations were still above the method detection limit, but have

Report

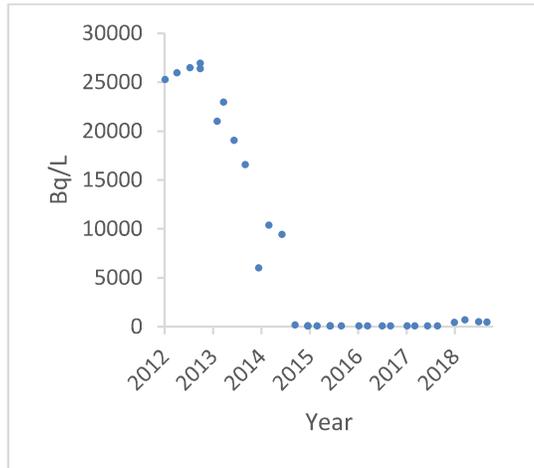
Internal Use Only		
Document Number: NK38-REP-10140-10028	Usage Classification: N/A	
Sheet Number: N/A	Revision Number: R000	Page: 16 of 30

Title:
2018 DARLINGTON NUCLEAR GROUNDWATER MONITORING PROGRAM RESULTS

EPS Building Area

The majority of the tritium in groundwater from the WFFA area has historically flowed downgradient towards the EPS building area and discharged into the Forebay Channel. Results from MW-154-16, which is located closest to the Forebay, showed a slight increase in tritium concentrations in 2018, ranging from 4.60×10^2 Bq/L (0.012 μ Ci/L) to 7.10×10^2 Bq/L (0.019 μ Ci/L). Overall, a declining trend is still apparent, as compared to concentrations seen historically (Graph 10).

The slow discharge of groundwater into the Forebay Channel mixes with the large inflow of lake water and this Forebay water is monitored before it is discharged back to the lake. As a result, the tritium plume will not have an adverse impact on ecological or human health.



Graph 10: MW-154-16 Tritium Data

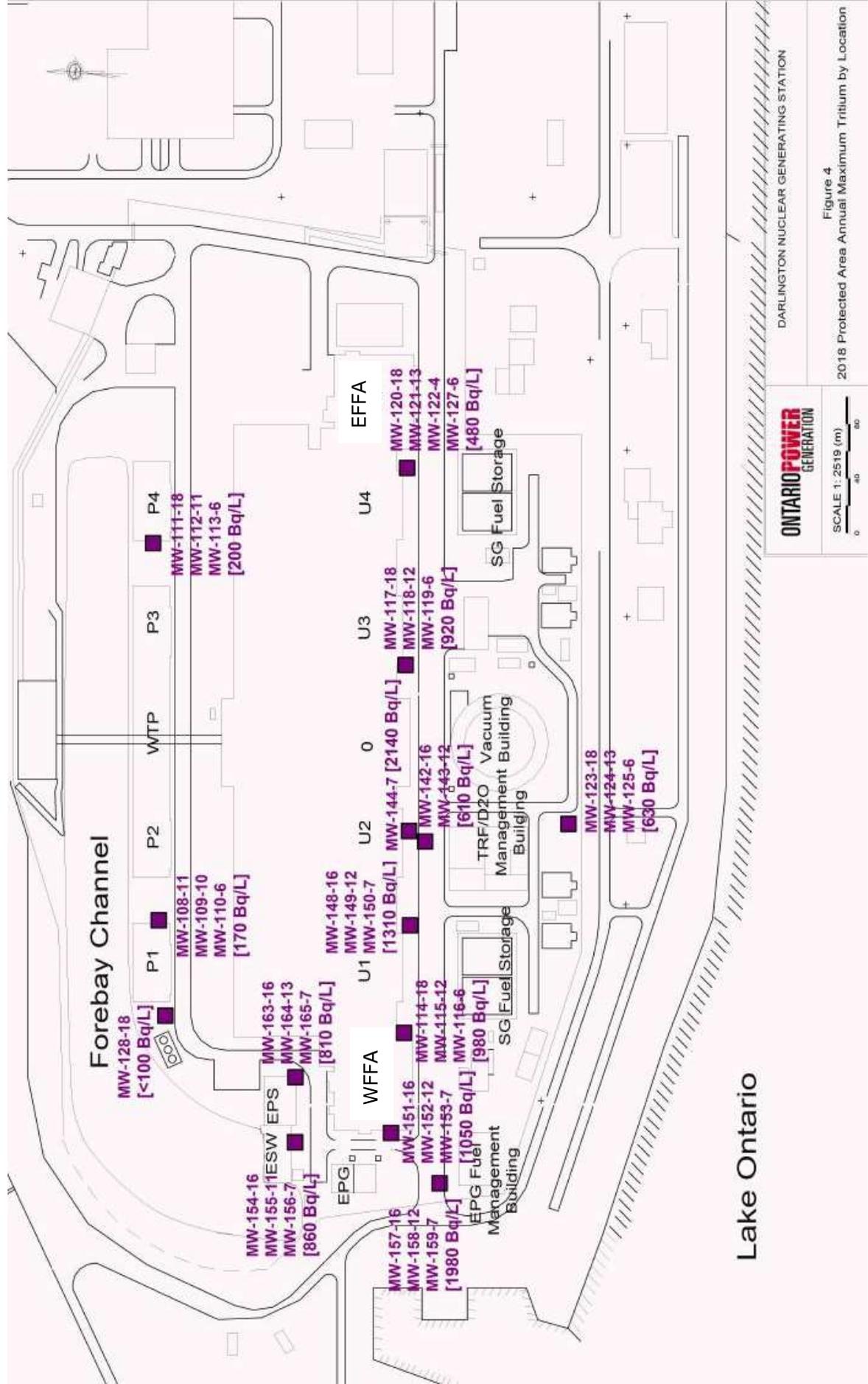
Northern Side of Powerhouse

On the northern side of the Powerhouse, tritium concentrations remained low, ranging from less than 100 Bq/L (0.0027 μ Ci/L) to 2.00×10^2 Bq/L (0.0054 μ Ci/L). These concentrations are within the expected tritium concentrations that may result from the infiltration of precipitation. A previous precipitation study indicated that the tritium in precipitation ranged from not detectable to a maximum of 1.92×10^3 Bq/L (0.052 μ Ci/L), with a maximum average of 5.14×10^2 Bq/L (0.014 μ Ci/L).

Internal Use Only	
Document Number:	Usage Classification:
NK38-REP-10140-10028	N/A
Sheet Number:	Revision Number:
N/A	R000
Page: 17 of 30	

Report

Title:
2018 DARLINGTON NUCLEAR GROUNDWATER MONITORING PROGRAM RESULTS



ONTARIO POWER GENERATION

DARLINGTON NUCLEAR GENERATING STATION

SCALE 1: 2519 (m)

Figure 4
 2018 Protected Area Annual Maximum Tritium by Location

Report

Internal Use Only		
Document Number:	Usage Classification:	
NK38-REP-10140-10028	N/A	
Sheet Number:	Revision Number:	Page:
N/A	R000	18 of 30

Title:

2018 DARLINGTON NUCLEAR GROUNDWATER MONITORING PROGRAM RESULTS

3.2.2 Controlled Area Groundwater Quality

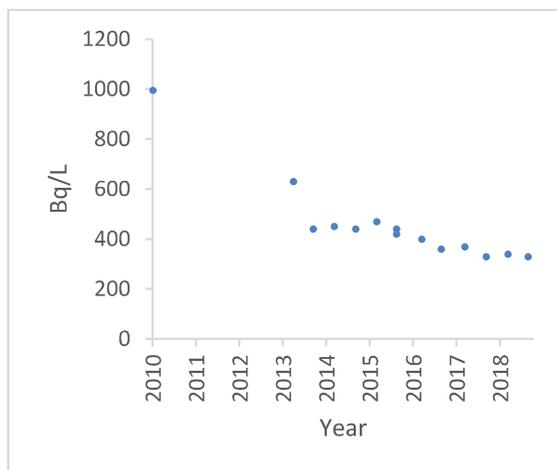
In 2018, 11 monitoring wells were sampled in the controlled area to assess tritium concentrations and trends.

Tritium concentrations in the controlled area wells remained low, ranging from less than the method detection limit of 100 Bq/L (0.0027 $\mu\text{Ci/L}$) to a maximum of 3.80×10^2 Bq/L (0.010 $\mu\text{Ci/L}$) at MW-025-8. Concentrations similar to MW-025-8 were also observed at MW-003-7.

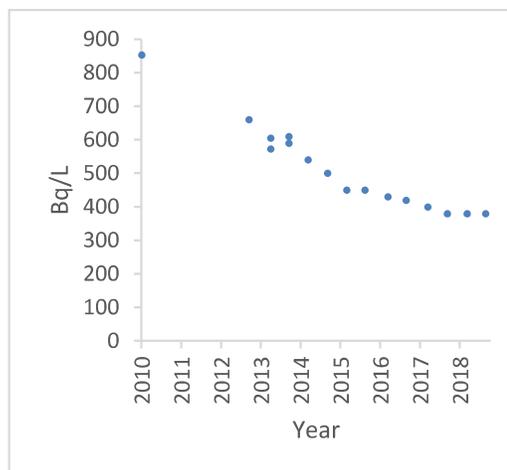
The presence of tritium at MW-003-7 and MW-025-8 is mainly attributed to a past spill from the building effluent lagoon in 2001. Corrective actions to address this spill were implemented. Groundwater monitoring results indicate that tritium concentrations have been declining (Graphs 11 and 12).

Monitoring of groundwater in the controlled area will continue. In particular, surveillance of the lagoon area will continue to ensure due diligence is applied.

The results are further presented on Figure 5 (Page 21) and Table A-2 (Appendix A). Again, for Figure 5, the annual maximum tritium concentration is presented for each monitoring well cluster.



Graph 11: MW-003-7 Tritium Data



Graph 12: MW-025-8 Tritium Data

3.2.3 Petroleum Hydrocarbons and BTEX in Groundwater

In 2018, groundwater monitoring was conducted in the vicinity or downgradient of the Emergency Power Generators, Standby Generators and the Construction Boilerhouse to detect underground fuel oil piping leaks.

Nine monitoring wells were sampled for PHCs and BTEX and their analytical results were compared to the Ontario Environmental Protection Act, Part XV.1 Soil, Ground

Report

Internal Use Only		
Document Number:	Usage Classification:	
NK38-REP-10140-10028	N/A	
Sheet Number:	Revision Number:	Page:
N/A	R000	19 of 30

Title:

2018 DARLINGTON NUCLEAR GROUNDWATER MONITORING PROGRAM RESULTS

Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act for 2011, Table 3: Non-Potable Site Condition Standards for groundwater for all types of property uses and coarse soils (Ministry of the Environment, Conservation and Parks [MECP] Table 3 Standard). This comparison was conducted for assessment purposes only, because the Standards are used as a best management practice in this case.

In 2018, there were no results that exceeded the MECP Table 3 standards for PHCs and BTEX. The majority of results were non-detectable.

At MW-143-12, the majority of results were non-detectable. In the cases where parameters were detected, the concentrations were well below the Standards. This monitoring well had shown some exceedances for PHC parameters in past years (2015 and 2016). This monitoring well was repaired in 2015 due to well integrity issues identified at that time (MW-143-12 did not appear to have an adequate seal at surface and may have been experiencing some surface water infiltration). The results indicate that concentrations have declined following the repairs.

The analytical results for PHCs and BTEX are presented in Table A-4 (Appendix A).

3.3 Objective 3 Results

In 2018, 30 monitoring wells located at the property boundary were sampled. Overall, low tritium concentrations at site-perimeter locations indicate that there are no adverse off-site impacts from DNGS groundwater.

With the exception of MW-016C-4, all samples from perimeter monitoring wells had tritium concentrations of less than 100 Bq/L (0.0027 $\mu\text{Ci/L}$).

MW-016C-4, located at the southern perimeter of the station, had a 2018 tritium concentration of 4.70×10^2 Bq/L (0.013 $\mu\text{Ci/L}$). An increasing tritium trend was observed at this well beginning in 2009 (Graph 13). The increase was attributed to a small portion of tritium migrating from the IWST spill area that occurred in December 2009. Concentrations have begun to decrease in the last few years and this decrease is expected to continue over time as the source term diminishes.

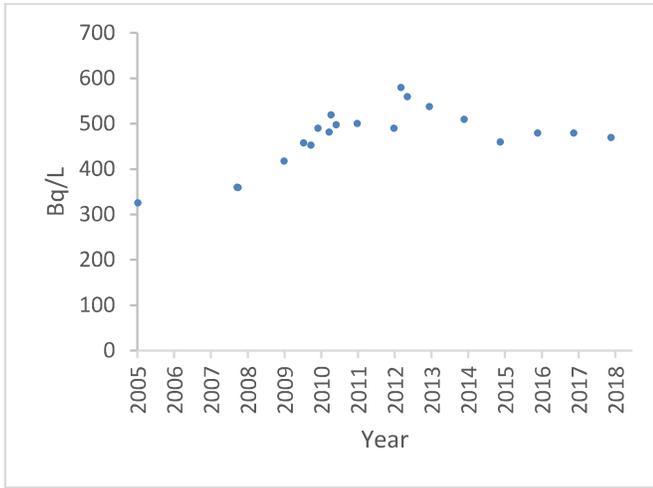
As part of the annual OPG DNGS Environmental Monitoring Program, municipal drinking water samples are collected from the downstream Water Supply Plants (WSPs). In 2018, the data from this sampling demonstrated that the annual average tritium concentration at each WSP was well below the Ontario Drinking Water Quality Standard (ODWQS) for tritium of 7,000 Bq/L. This further supports that there were no indications of adverse off-site impacts from DNGS groundwater.

The data for all of the perimeter groundwater monitoring locations are presented on Figure 5 (Page 21) and Table A-3 (Appendix A).

Report

Internal Use Only		
Document Number: NK38-REP-10140-10028	Usage Classification: N/A	
Sheet Number: N/A	Revision Number: R000	Page: 20 of 30

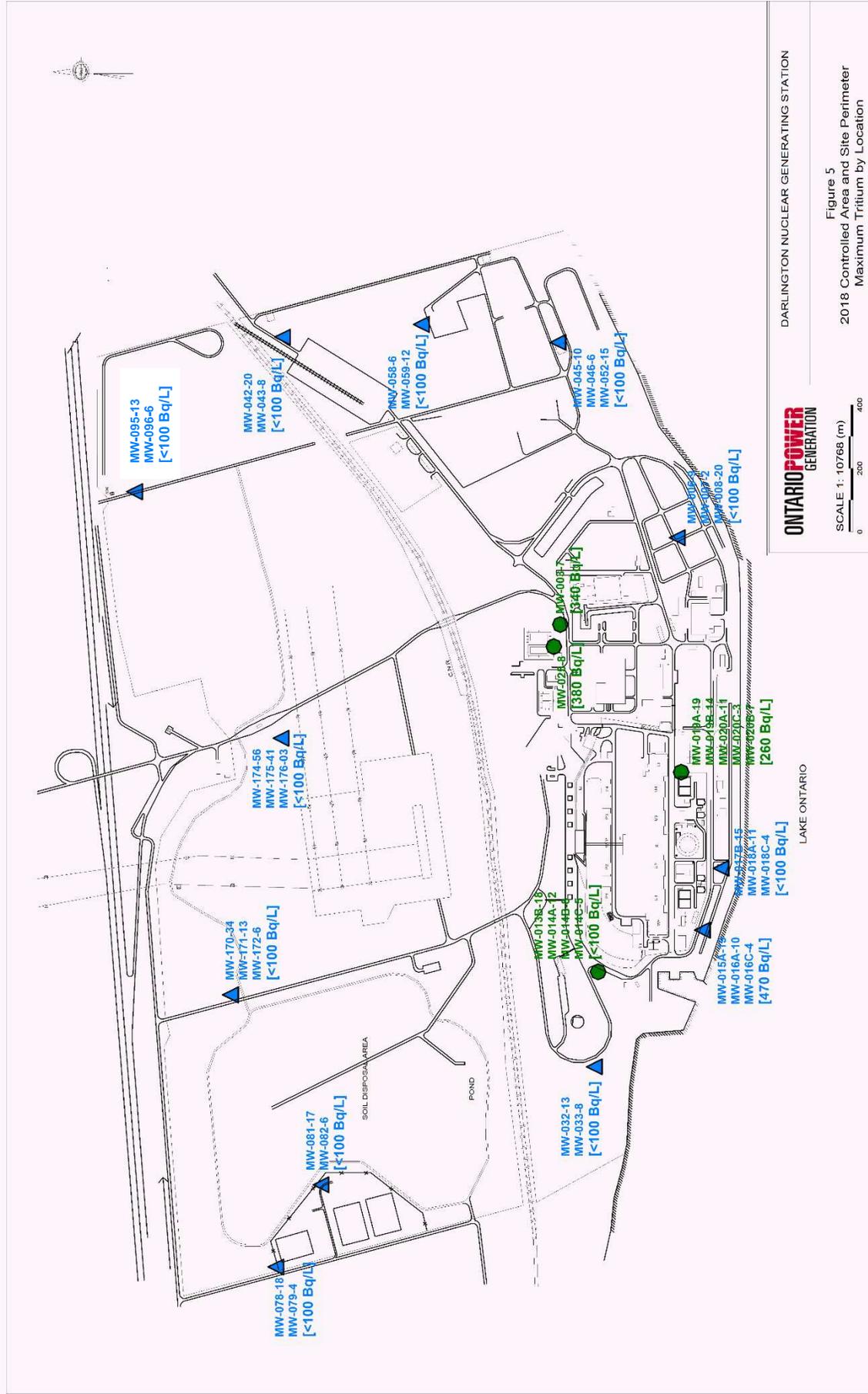
Title:
2018 DARLINGTON NUCLEAR GROUNDWATER MONITORING PROGRAM RESULTS



Graph 13: MW-016C-4 Tritium Data

Report

Internal Use Only	
Document Number:	Usage Classification:
NK38-REP-10140-10028	N/A
Sheet Number:	Revision Number:
N/A	R000
Page: 21 of 30	
Title:	
2018 DARLINGTON NUCLEAR GROUNDWATER MONITORING PROGRAM RESULTS	



Report

Internal Use Only		
Document Number:	NK38-REP-10140-10028	Usage Classification:
Sheet Number:	N/A	Page:
	R000	22 of 30

Title: 2018 DARLINGTON NUCLEAR GROUNDWATER MONITORING PROGRAM RESULTS
--

4.0 QUALITY ASSURANCE AND QUALITY CONTROL

The Quality Assurance and Quality Control for the groundwater monitoring program encompasses all activities in field sample collection, laboratory analysis and laboratory quality control. The objective is to provide confidence in the interpretation of the DNGS groundwater monitoring data through a systematic and documented process.

4.1 Quality Assurance Program for Laboratories

Maxxam is accredited to ISO 17025 by the Standards Council of Canada for environmental tests. Many of the conventional contaminants are governed by criteria established in MECP’s “Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act”. Maxxam has a Quality Assurance Department, which routinely monitors procedures and processes by way of compliance audits, quality system audits and method audits to ensure compliance with accreditation and regulatory requirements. Maxxam is also accredited by the Standards Council of Canada for radiological tests.

4.2 Quality Control Results

Duplicates, field blanks, and travel blanks were collected at a prescribed frequency to measure sampling and analytical performance.

In 2018, field duplicate samples were collected from 10 monitoring locations. The analytical results and calculated relative percentage differences (RPD) were evaluated to understand the sampling precision. The RPD values were less than 20 percent in all instances (ranging from zero to 13 percent), with the exception of one pair of samples where the difference was 40 percent. Given that the majority of sample pairs showed a RPD less than 20 percent, it can be concluded that the field technique and the laboratory’s analytical methods were reproducible and reliable.

All field blank results were non-detectable. Therefore, no significant contamination of those samples occurred during the sample collection process.

Similarly, all travel blank results were non-detectable as well, indicating that there was no contamination of the samples during handling and transportation.

The sample results discussed above are presented in Tables A-5 and A-6 (Appendix A).

5.0 SUPPLEMENTARY STUDIES AND AUDITS

There were no supplementary studies related to DNGS groundwater initiated in 2018. There were no audits completed on the DNGS groundwater program in 2018.

Report

Internal Use Only		
Document Number:	Usage Classification:	
NK38-REP-10140-10028	N/A	
Sheet Number:	Revision Number:	Page:
N/A	R000	23 of 30

Title: 2018 DARLINGTON NUCLEAR GROUNDWATER MONITORING PROGRAM RESULTS

6.0 CSA N288.7 UPDATE

OPG has committed to the Canadian Nuclear Safety Commission (CNSC) to be compliant with Canadian Standards Association (CSA) N288.7, “Groundwater Protection Programs at Class I Nuclear Facilities and Uranium Mines and Mills”, for the Darlington site by December 31, 2022. In 2018, OPG retained a vendor to assist with the implementation of the standard. In the previous year, a gap analysis was conducted between DNGS’s current groundwater monitoring program and the mandatory clauses of the CSA standard. The work is progressing as planned and an update will again be provided in the 2019 report.

7.0 ACRONYMS

µCi/L	<i>Micro-curie per Litre</i>
Bq/L	<i>Becquerel per Litre</i>
BTEX	<i>Benzene / Toluene / Ethylbenzene / Xylenes</i>
CSA	<i>Canadian Standards Association</i>
CNSC	<i>Canadian Nuclear Safety Commission</i>
DNGS	<i>Darlington Nuclear Generating Station</i>
EMP	<i>Environmental Monitoring Program</i>
EPG	<i>Emergency Power Generator</i>
EPS	<i>Emergency Power Service</i>
HU	<i>Hydrostratigraphic Unit</i>
IWST	<i>Injection Water Storage Tank</i>
MECP	<i>Ministry of the Environment, Conservation and Parks</i>
MW	<i>Monitoring Well</i>
ODWQS	<i>Ontario Drinking Water Quality Standard</i>
OPG	<i>Ontario Power Generation</i>
PHC	<i>Petroleum Hydrocarbon</i>
RPD	<i>Relative Percentage Difference</i>
SAP	<i>Sampling and Analysis Plan</i>
WFFA	<i>West Fueling Facility Auxiliary</i>
WSP	<i>Water Supply Plant</i>

Appendix A: Tables A-1 to A-6

**Table A-1
2018 DNGS Protected Area Tritium Results**

Sample Location Name	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4
0-10140-MW-108-11	Bq/L	--	150	--	170
0-10140-MW-109-10	Bq/L	--	130	--	170
0-10140-MW-110-6	Bq/L	--	< 100	--	170
0-10140-MW-111-18	Bq/L	--	108	--	150
0-10140-MW-112-11	Bq/L	--	200	--	200
0-10140-MW-113-6	Bq/L	--	180	--	200
0-10140-MW-114-18	Bq/L	790	900	910	920
0-10140-MW-115-12	Bq/L	800	920	890	910
0-10140-MW-116-6	Bq/L	890	980	980	890
0-10140-MW-117-18	Bq/L	390	640	610	440
0-10140-MW-118-12	Bq/L	650	920	890	900
0-10140-MW-119-6	Bq/L	840	830	800	520
0-10140-MW-120-18	Bq/L	--	370	--	350
0-10140-MW-121-13	Bq/L	--	410	--	480
0-10140-MW-122-4	Bq/L	--	350	--	300
0-10140-MW-123-18	Bq/L	310	290	270	290
0-10140-MW-124-13	Bq/L	141	129	121	101
0-10140-MW-125-6	Bq/L	630	500	200	380
0-10140-MW-127-6	Bq/L	--	360	--	300
0-10140-MW-128-18	Bq/L	--	< 100	--	< 100
0-10140-MW-142-16	Bq/L	550	610	590	580
0-10140-MW-143-12	Bq/L	520	530	570	580
0-10140-MW-144-7	Bq/L	2140	1880	1550	1640
0-10140-MW-148-16	Bq/L	1000	930	970	970
0-10140-MW-149-12	Bq/L	970	1100	1310	1310
0-10140-MW-150-7	Bq/L	890	950	990	930
0-10140-MW-151-16	Bq/L	850	880	900	1030
0-10140-MW-152-12	Bq/L	800	870	970	1050
0-10140-MW-153-7	Bq/L	500	590	920	640
0-10140-MW-154-16	Bq/L	460	710	510	500
0-10140-MW-155-11	Bq/L	390	380	450	430
0-10140-MW-156-7	Bq/L	550	600	660	860
0-10140-MW-157-16	Bq/L	550	560	640	670
0-10140-MW-158-12	Bq/L	190	130	160	150
0-10140-MW-159-7	Bq/L	630	1390	1980	1370
0-10140-MW-163-16	Bq/L	330	550	430	680
0-10140-MW-164-13	Bq/L	330	410	320	460
0-10140-MW-165-7	Bq/L	740	760	810	810

Notes:

NA denotes that sample could not be collected and result is not available

-- denotes that sample was not required

< denotes that result is below the laboratory method detection limit

**Table A-2
2018 DNGS Controlled Area Tritium Results**

Sample Location Name	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4
0-10140-MW-003-7	Bq/L	--	340	--	330
0-10140-MW-013B-18	Bq/L	--	< 100	--	< 100
0-10140-MW-014A-12	Bq/L	--	< 100	--	< 100
0-10140-MW-014B-8	Bq/L	--	< 100	--	< 100
0-10140-MW-014C-5	Bq/L	--	< 100	--	< 100
0-10140-MW-019A-19	Bq/L	--	< 100	--	< 100
0-10140-MW-019B-14	Bq/L	--	< 100	--	< 100
0-10140-MW-020A-11	Bq/L	--	< 100	--	< 100
0-10140-MW-020B-7	Bq/L	--	260	--	220
0-10140-MW-020C-3	Bq/L	--	230	--	260
0-10140-MW-025-8	Bq/L	--	380	--	380

Notes:

NA denotes that sample could not be collected and result is not available

-- denotes that sample was not required

< denotes that result is below the laboratory method detection limit

**Table A-3
2018 DNGS Perimeter Tritium Results**

Sample Location Name	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4
0-10140-MW-006-9	Bq/L	--	< 100	--	--
0-10140-MW-007-2	Bq/L	--	< 100	--	--
0-10140-MW-008-20	Bq/L	--	< 100	--	--
0-10140-MW-015A-19	Bq/L	--	< 100	--	--
0-10140-MW-016A-10	Bq/L	--	< 100	--	--
0-10140-MW-016C-4	Bq/L	--	470	--	--
0-10140-MW-017B-15	Bq/L	--	< 100	--	--
0-10140-MW-018A-11	Bq/L	--	< 100	--	--
0-10140-MW-018C-4	Bq/L	--	< 100	--	--
0-10140-MW-032-13	Bq/L	--	< 100	--	--
0-10140-MW-033-8	Bq/L	--	< 100	--	--
0-10140-MW-042-20	Bq/L	--	< 100	--	--
0-10140-MW-043-8	Bq/L	--	< 100	--	--
0-10140-MW-045-10	Bq/L	--	< 100	--	--
0-10140-MW-046-6	Bq/L	--	< 100	--	--
0-10140-MW-052-15	Bq/L	--	< 100	--	--
0-10140-MW-058-6	Bq/L	--	< 100	--	--
0-10140-MW-059-12	Bq/L	--	< 100	--	--
0-10140-MW-078-18	Bq/L	--	< 100	--	--
0-10140-MW-079-4	Bq/L	--	< 100	--	--
0-10140-MW-081-17	Bq/L	--	< 100	--	--
0-10140-MW-082-6	Bq/L	--	< 100	--	--
0-10140-MW-095-13	Bq/L	--	< 100	--	--
0-10140-MW-096-6	Bq/L	--	< 100	--	--
0-10140-MW-170-34	Bq/L	--	< 100	--	--
0-10140-MW-171-13	Bq/L	--	< 100	--	--
0-10140-MW-172-6	Bq/L	--	< 100	--	--
0-10140-MW-174-56	Bq/L	--	< 100	--	--
0-10140-MW-175-41	Bq/L	--	< 100	--	--
0-10140-MW-176-03	Bq/L	--	< 100	--	--

Notes:

NA denotes that sample could not be collected and result is not available

-- denotes that sample was not required

< denotes that result is below the laboratory method detection limit

**Table A-4
2018 DNGS BTEX and Petroleum Hydrocarbon Results**

Parameter	Units	MECP Table 3 Standard	0-10140-MW-020A-11	0-10140-MW-020B-7	0-10140-MW-020C-3	0-10140-MW-143-12
Benzene	ug/L	44	< 0.2	< 0.2	< 0.2	2
Toluene	ug/L	18000	< 0.2	< 0.2	< 0.2	0.4
Ethylbenzene	ug/L	2300	< 0.2	< 0.2	< 0.2	< 0.2
M&p-xylenes	ug/L	--	< 0.4	< 0.4	< 0.4	0.44
O-Xylene	ug/L	--	< 0.2	< 0.2	< 0.2	< 0.2
Total Xylenes	ug/L	4200	< 0.4	< 0.4	< 0.4	0.44
PHC F1 C06-C10	ug/L	750	< 25	< 25	< 25	110
PHC F2 C10-C16	ug/L	150	< 100	< 100	< 100	< 100
PHC F3 C16-C34	ug/L	500	< 200	< 200	< 200	< 200
PHC F4 C34-C50	ug/L	500	< 200	< 200	< 200	< 200

Parameter	Units	MECP Table 3 Standard	0-10140-MW-144-7	0-10140-MW-158-12	0-10140-MW-159-7	0-10140-MW-161-12	0-10140-MW-162-7
Benzene	ug/L	44	< 0.2	0.72	< 0.2	0.33	< 0.2
Toluene	ug/L	18000	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Ethylbenzene	ug/L	2300	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
M&p-xylenes	ug/L	--	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
O-Xylene	ug/L	--	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Total Xylenes	ug/L	4200	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
PHC F1 C06-C10	ug/L	750	< 25	< 25	< 25	< 25	< 25
PHC F2 C10-C16	ug/L	150	< 100	< 100	< 100	< 100	< 100
PHC F3 C16-C34	ug/L	500	< 200	< 200	< 200	< 200	< 200
PHC F4 C34-C50	ug/L	500	< 200	< 200	< 200	< 200	< 200

Notes:
< denotes that result is below the laboratory method detection limit

**Table A-5
2018 DNGS Quality Control Results - Blanks**

QA/QC Sample Type	Sample Date	Parameter	Units	Value
Field Blank	5/28/2018	Benzene	ug/L	< 0.2
Field Blank	5/28/2018	Toluene	ug/L	< 0.2
Field Blank	5/28/2018	Ethylbenzene	ug/L	< 0.2
Field Blank	5/28/2018	M&p-xylenes	ug/L	< 0.4
Field Blank	5/28/2018	O-Xylene	ug/L	< 0.2
Field Blank	5/28/2018	Total Xylenes	ug/L	< 0.4
Field Blank	5/30/2018	Benzene	ug/L	< 0.2
Field Blank	5/30/2018	Toluene	ug/L	< 0.2
Field Blank	5/30/2018	Ethylbenzene	ug/L	< 0.2
Field Blank	5/30/2018	M&p-xylenes	ug/L	< 0.4
Field Blank	5/30/2018	O-Xylene	ug/L	< 0.2
Field Blank	5/30/2018	Total Xylenes	ug/L	< 0.4
Trip Blank	5/31/2018	Benzene	ug/L	< 0.2
Trip Blank	5/31/2018	Toluene	ug/L	< 0.2
Trip Blank	5/31/2018	Ethylbenzene	ug/L	< 0.2
Trip Blank	5/31/2018	M&p-xylenes	ug/L	< 0.4
Trip Blank	5/31/2018	O-Xylene	ug/L	< 0.2
Trip Blank	5/31/2018	Total Xylenes	ug/L	< 0.4

Notes:

< denotes that result is below the laboratory method detection limit

Table A-6
2018 DNGS Quality Control Results - Duplicates

Sample Location Name and Type	Sample Date	Parameter	Units	Qualifier	Value	Relative Percentage Difference
0-10140-MW-052-15 Field Duplicate	5/30/2018	H3	Bq/L	<	100	0%
0-10140-MW-052-15 Regular Sample	5/30/2018	H3	Bq/L	<	100	
0-10140-MW-079-4 Field Duplicate	5/29/2018	H3	Bq/L	<	100	0%
0-10140-MW-079-4 Regular Sample	5/29/2018	H3	Bq/L	<	100	
0-10140-MW-111-18 Field Duplicate	5/30/2018	H3	Bq/L		111	3%
0-10140-MW-111-18 Regular Sample	5/30/2018	H3	Bq/L		108	
0-10140-MW-111-18 Field Duplicate	11/13/2018	H3	Bq/L	<	100	40%
0-10140-MW-111-18 Regular Sample	11/13/2018	H3	Bq/L		150	
0-10140-MW-118-12 Field Duplicate	3/15/2018	H3	Bq/L		650	0%
0-10140-MW-118-12 Regular Sample	3/15/2018	H3	Bq/L		650	
0-10140-MW-118-12 Field Duplicate	5/30/2018	H3	Bq/L		860	7%
0-10140-MW-118-12 Regular Sample	5/30/2018	H3	Bq/L		920	
0-10140-MW-118-12 Field Duplicate	9/14/2018	H3	Bq/L		900	1%
0-10140-MW-118-12 Regular Sample	9/14/2018	H3	Bq/L		890	
0-10140-MW-118-12 Field Duplicate	11/14/2018	H3	Bq/L		910	1%
0-10140-MW-118-12 Regular Sample	11/14/2018	H3	Bq/L		900	
0-10140-MW-121-13 Field Duplicate	5/30/2018	H3	Bq/L		360	13%
0-10140-MW-121-13 Regular Sample	5/30/2018	H3	Bq/L		410	
0-10140-MW-121-13 Field Duplicate	11/12/2018	H3	Bq/L		460	4%
0-10140-MW-121-13 Regular Sample	11/12/2018	H3	Bq/L		480	
0-10140-MW-149-12 Field Duplicate	3/14/2018	H3	Bq/L		960	1%
0-10140-MW-149-12 Regular Sample	3/14/2018	H3	Bq/L		970	
0-10140-MW-149-12 Field Duplicate	6/4/2018	H3	Bq/L		1080	2%
0-10140-MW-149-12 Regular Sample	6/4/2018	H3	Bq/L		1100	
0-10140-MW-149-12 Field Duplicate	9/13/2018	H3	Bq/L		1380	5%
0-10140-MW-149-12 Regular Sample	9/13/2018	H3	Bq/L		1310	
0-10140-MW-149-12 Field Duplicate	11/27/2018	H3	Bq/L		1380	5%
0-10140-MW-149-12 Regular Sample	11/27/2018	H3	Bq/L		1310	
0-10140-MW-151-16 Field Duplicate	3/14/2018	H3	Bq/L		860	1%
0-10140-MW-151-16 Regular Sample	3/14/2018	H3	Bq/L		850	
0-10140-MW-151-16 Field Duplicate	6/4/2018	H3	Bq/L		890	1%
0-10140-MW-151-16 Regular Sample	6/4/2018	H3	Bq/L		880	
0-10140-MW-151-16 Field Duplicate	9/13/2018	H3	Bq/L		920	2%
0-10140-MW-151-16 Regular Sample	9/13/2018	H3	Bq/L		900	
0-10140-MW-151-16 Field Duplicate	11/27/2018	H3	Bq/L		1050	2%
0-10140-MW-151-16 Regular Sample	11/27/2018	H3	Bq/L		1030	
0-10140-MW-162-7 Field Duplicate	5/28/2018	Benzene	ug/L	<	0.2	0%
0-10140-MW-162-7 Regular Sample	5/28/2018	Benzene	ug/L	<	0.2	
0-10140-MW-162-7 Field Duplicate	5/28/2018	Toluene	ug/L	<	0.2	0%
0-10140-MW-162-7 Regular Sample	5/28/2018	Toluene	ug/L	<	0.2	
0-10140-MW-162-7 Field Duplicate	5/28/2018	Ethylbenzene	ug/L	<	0.2	0%
0-10140-MW-162-7 Regular Sample	5/28/2018	Ethylbenzene	ug/L	<	0.2	
0-10140-MW-162-7 Field Duplicate	5/28/2018	M&p-xylenes	ug/L	<	0.4	0%
0-10140-MW-162-7 Regular Sample	5/28/2018	M&p-xylenes	ug/L	<	0.4	
0-10140-MW-162-7 Field Duplicate	5/28/2018	O-Xylene	ug/L	<	0.2	0%
0-10140-MW-162-7 Regular Sample	5/28/2018	O-Xylene	ug/L	<	0.2	
0-10140-MW-162-7 Field Duplicate	5/28/2018	Total Xylenes	ug/L	<	0.4	0%
0-10140-MW-162-7 Regular Sample	5/28/2018	Total Xylenes	ug/L	<	0.4	
0-10140-MW-162-7 Field Duplicate	5/28/2018	PHC F1 C06-C10	ug/L	<	25	0%
0-10140-MW-162-7 Regular Sample	5/28/2018	PHC F1 C06-C10	ug/L	<	25	
0-10140-MW-162-7 Field Duplicate	5/28/2018	PHC F2 C10-C16	ug/L	<	100	0%
0-10140-MW-162-7 Regular Sample	5/28/2018	PHC F2 C10-C16	ug/L	<	100	
0-10140-MW-162-7 Field Duplicate	5/28/2018	PHC F3 C16-C34	ug/L	<	200	0%
0-10140-MW-162-7 Regular Sample	5/28/2018	PHC F3 C16-C34	ug/L	<	200	
0-10140-MW-162-7 Field Duplicate	5/28/2018	PHC F4 C34-C50	ug/L	<	200	0%
0-10140-MW-162-7 Regular Sample	5/28/2018	PHC F4 C34-C50	ug/L	<	200	
0-10140-MW-171-13 Field Duplicate	6/5/2018	H3	Bq/L	<	100	0%
0-10140-MW-171-13 Regular Sample	6/5/2018	H3	Bq/L	<	100	
0-10140-MW-175-41 Field Duplicate	6/5/2018	H3	Bq/L	<	100	0%
0-10140-MW-175-41 Regular Sample	6/5/2018	H3	Bq/L	<	100	

Notes:

< denotes that result is below the laboratory method detection limit