2016 Results of OPG's Pickering and Darlington Environmental Monitoring Programs

ONTARIO POWER GENERATION

Presentation Outline

- EMP Objectives
- Non-Radiological Emissions
- Radiological Emissions
- EMP Sampling Locations
- Emissions and EMP Data
- EMP Results
- 2016 Public Dose
- Looking Ahead
- Summary

Environmental Monitoring Programs

Key Objectives of the EMPs (paraphrased from CSA N288.4-10):

- Demonstrate, independent of effluent monitoring, the effectiveness of containment and effluent control
- Demonstrate compliance with limits on the concentration/intensity of contaminants/physical stressors in the environment
- Provide data to assess the level of risk on human health and the environment and/or to confirm predictions made by environmental risk assessments

Results of Non-Radiological Emissions Monitoring

- 2016 emissions continue to be reported through 2017, therefore the 2016 EMP Report summarized the complete set of emissions for 2015
- No regulatory non-compliances for 2015 and met all ECA limits

Hazardous Material	DN	PN
	Mg	Mg
AIR		
SO_2 to Air[(a)(b)]	9.1E-01	3.4E+00
NO_2 to Air[(b)]	1.9E+01	7.3E+01
CO_2 to Air[(a)(b)]	7.3E-02	2.7E-01
Ammonia to Air	3.0E+00	6.7E+00
Hydrazine to Air[(c)]	6.4E-02	5.4E-03
Ozone Depleting Substances (ODS) Releases[(d)]	2.3E-02	4.5E-02
WATER		
Ammonia to Water	3.9E+00	6.5E-01
Hydrazine to Water[(c)]	7.0E-01	2.4E-01

NOTES:

Mg = Megagrams

(a) Reported in OPG Sustainable Development Report as an OPGN aggregate value.

(b) Based on annual fuel consumption.

(c) Based on annual consumption.

(d) Based on estimated quantity when a release occurs.

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2016 Results of Radioactive Emissions Monitoring

- All radioactive emissions to air and to water were below 2% of DRLs

Site Emissions[d]	DN		PNA (Units 1-4)		PNB (Units 5-8)	
	Bq	%DRL	Bq	%DRL	Bq	%DRL
AIR						
Tritium Oxide	1.8E+14	0.3	2.2E+14	0.2	4.6E+14	0.2
Elemental Tritium [a]	1.7E+13	<0.01	NA	NA	NA	NA
Noble Gas [b]	1.6E+13	0.04	1.1E+14	0.3	5.8E+12	0.01
I-131[c]	1.4E+08	0.01	9.9E+06	<0.01	4.1E+06	<0.01
Particulate	3.2E+07	<0.01	5.5E+06	<0.01	2.4E+07	<0.01
C-14	1.6E+12	0.5	1.2E+12	0.05	1.2E+12	0.1
WATER						
Tritium Oxide	3.5E+14	<0.01	1.1E+14	0.03	2.1E+14	0.03
Gross Beta/Gamma	4.9E+10	0.1	6.8E+09	0.4	5.1E+10	1.6
C-14[e]	2.2E+09	<0.01	NA	NA	4.7E+09	<0.01

NOTES: NA = Not Applicable, Bq = Bequerels

(a) Emissions from Darlington Tritium Removal Facility

(b) Units for noble gas emissions are γBq-MeV

(c) Weekly samples are usually < Method Detection Limit (MDL)

(d) Annual air emissions are the sum of continuous samples analysed weekly (daily for PN tritium).
Note that if interim Noble Gas sampling is in place, samples may not be continuous.
Annual water emissions are the sum of monthly composite samples for C-14, and weekly composite samples for tritium oxide and gross beta/gamma.

(e) While reported under PNB emissions in this table, the 2016 C-14 waterborne emission value is the total for all Pickering units.

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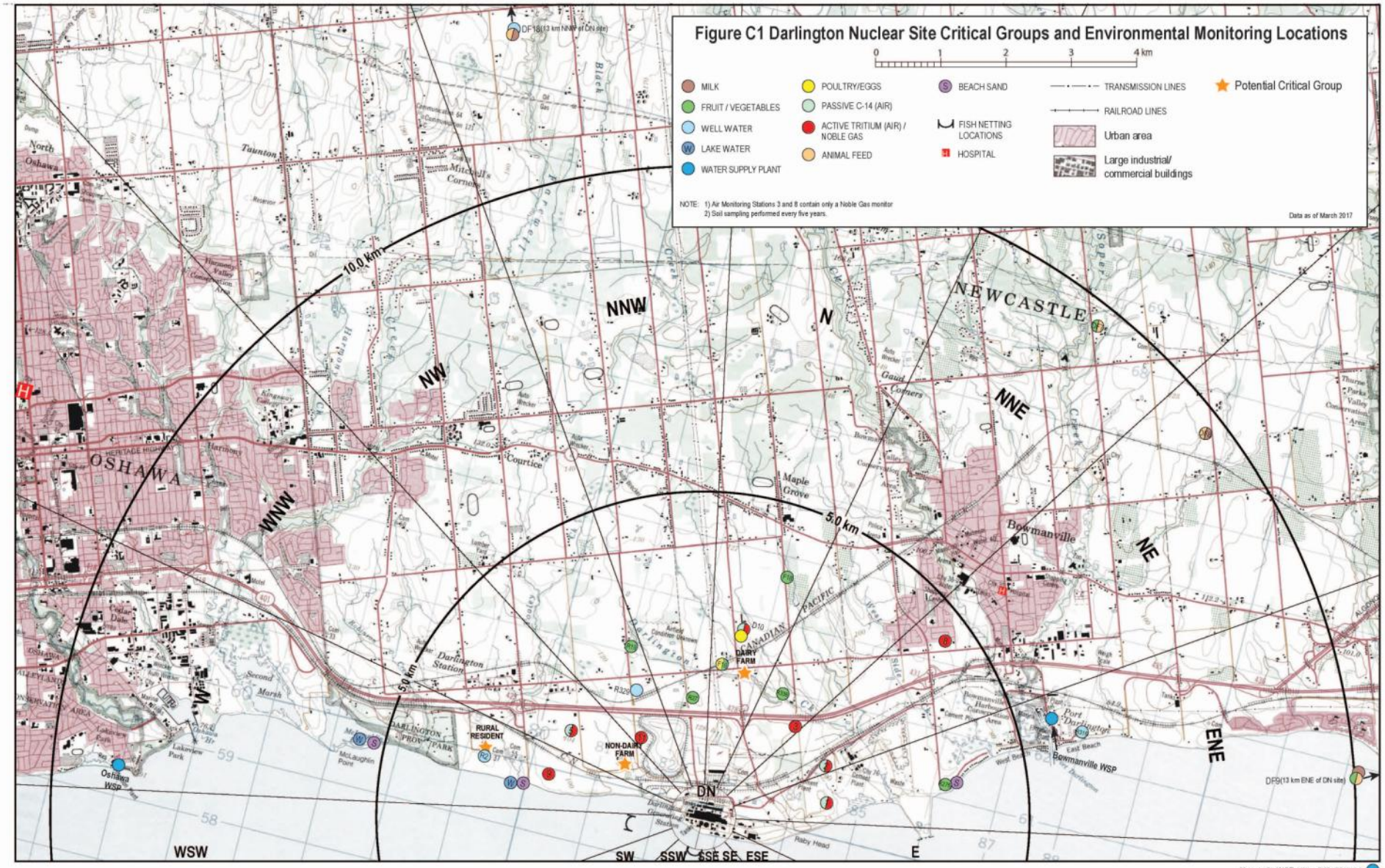
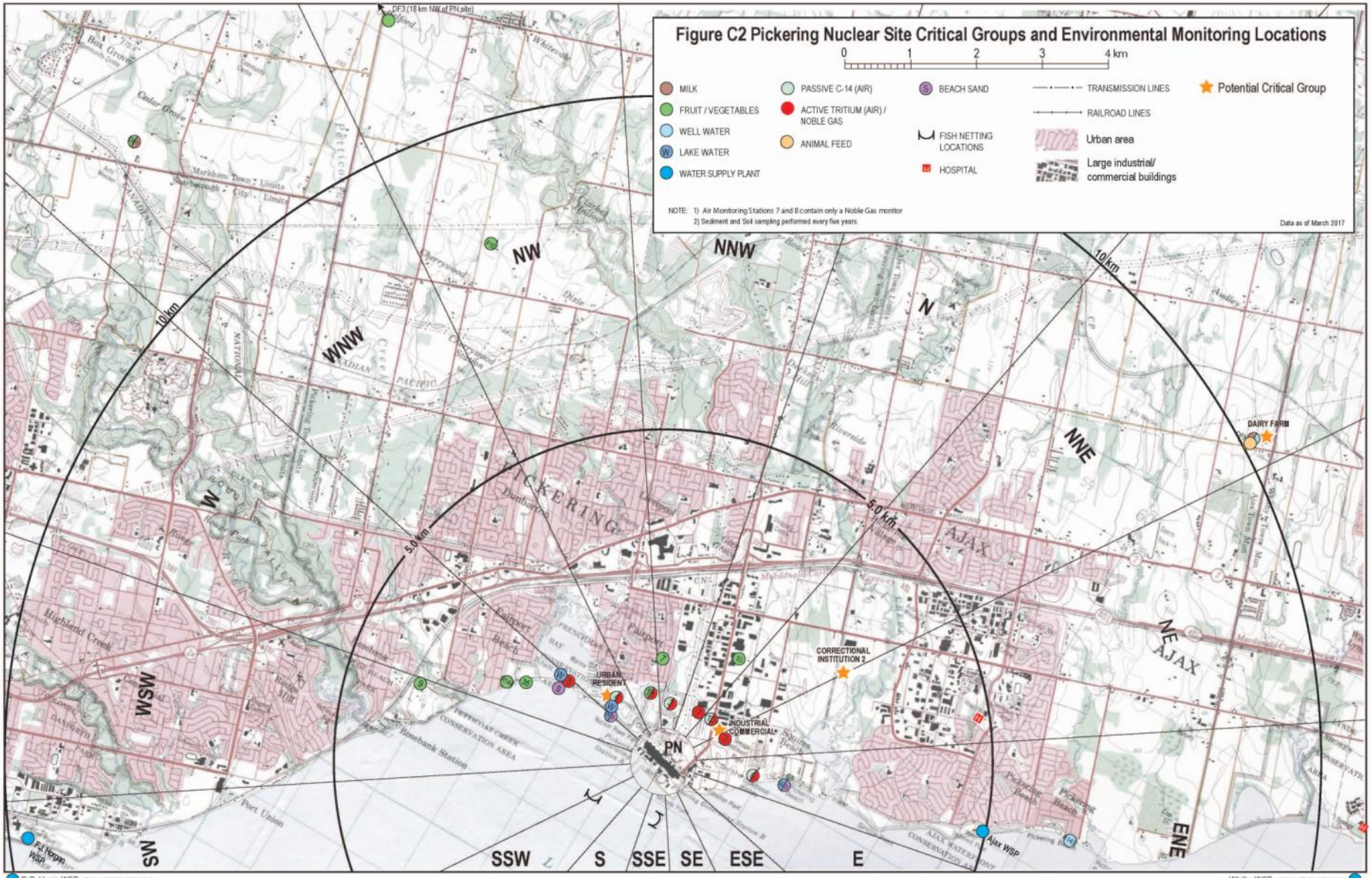
DN Critical Groups and Sampling Locations

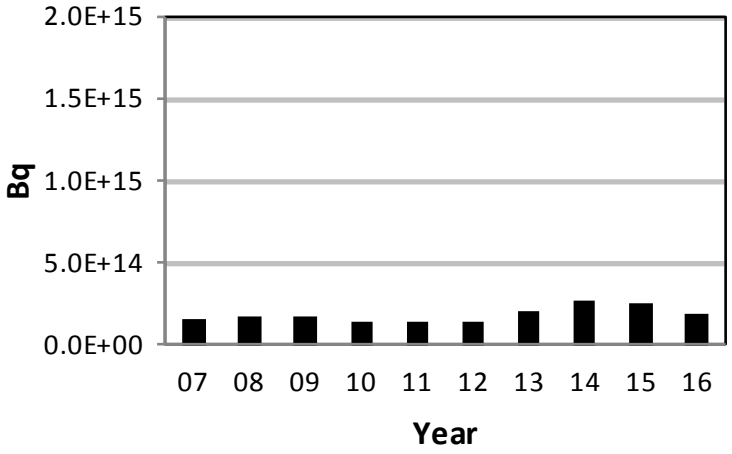


PN Critical Groups and Sampling Locations

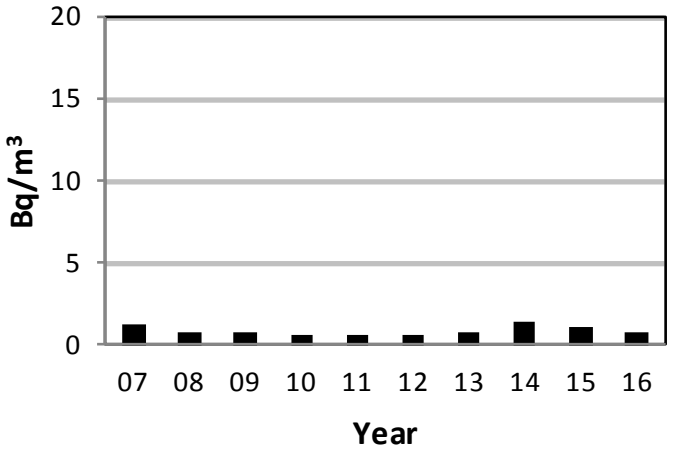


Emissions and EMP Data

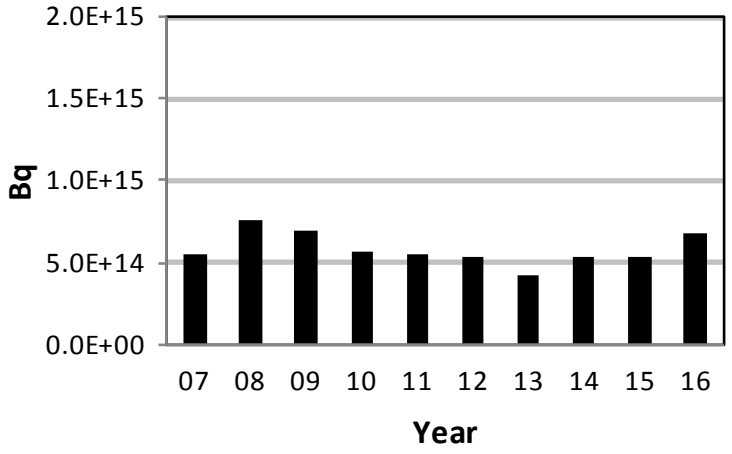
DN HTO to Air Emissions



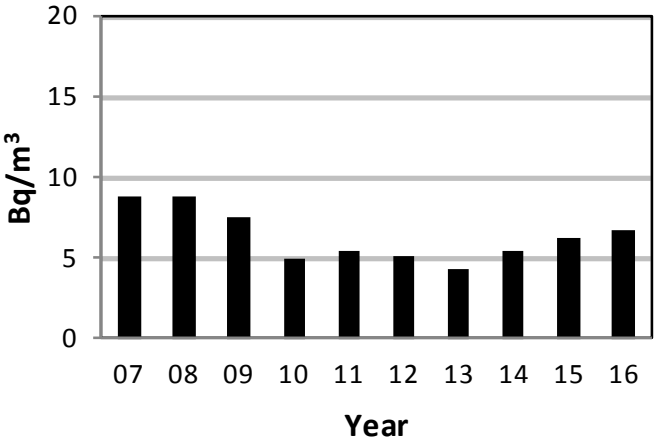
DN HTO in Air at Site Boundary



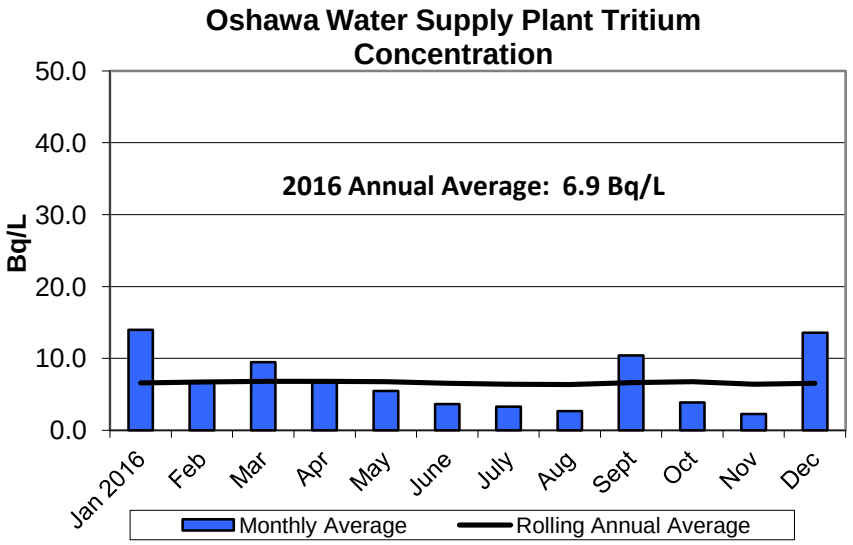
PN HTO to Air Emissions

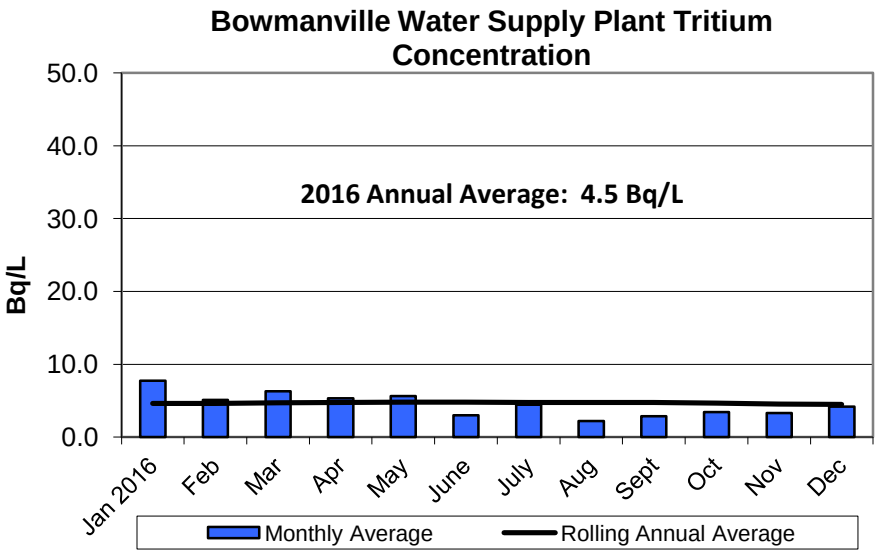


PN HTO in Air at Site Boundary



Tritium at Water Supply Plants Near DN





- Ontario Drinking Water Quality Standard is 7000 Bq/L
- WSP annual average concentrations far below OPG's commitment of < 100 Bq/L

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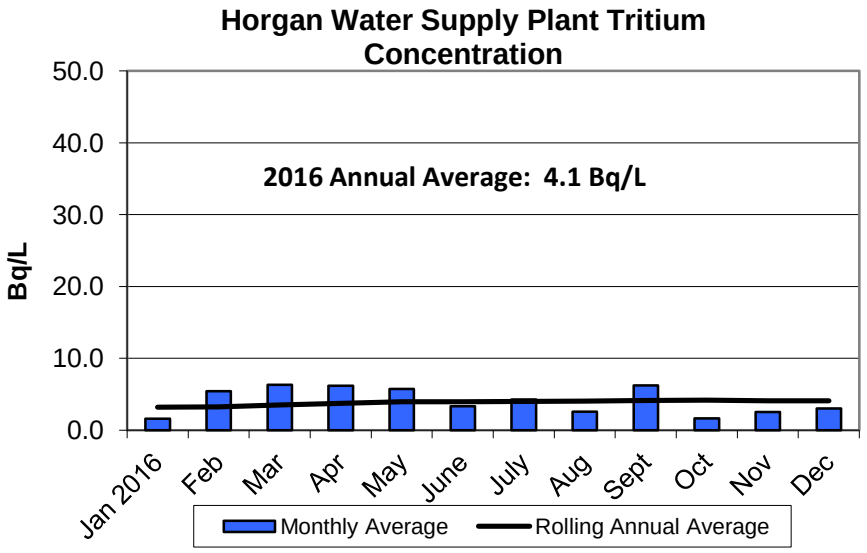
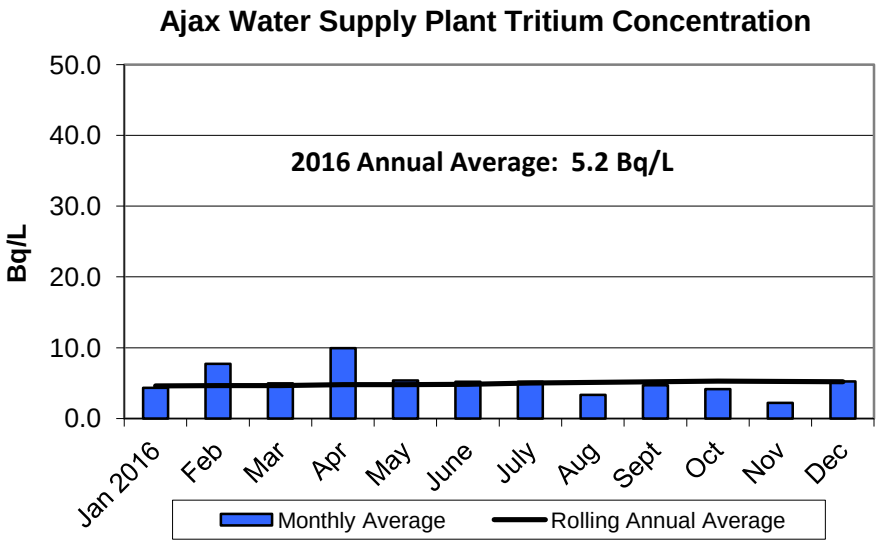
Tritium at Water Supply Plants Near PN





- Ontario Drinking Water Quality Standard is 7000 Bq/L
- WSP annual average concentrations far below OPG's commitment of < 100 Bq/L

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2016 Environmental Monitoring Results

- 979 laboratory analyses performed for the 2016 dose calculation
- Monitoring results in the environment reflect station emissions trends
- Tritium in drinking water measured at local water supply plants remained at a small fraction of the Ontario Drinking Water Quality Standard of 7000 Bq/L and OPG's voluntary commitment of 100 Bq/L
- In 2016 OPG conducted one supplementary study on tritium concentrations in Hydro Marsh water in support of the PN EMP. The study confirmed that tritium concentrations in Hydro Marsh are not statistically different from those in Frenchman's Bay. Therefore, for Environmental Risk Assessment purposes, it is not necessary to consider Hydro Marsh as a separate assessment location from Frenchman's Bay.

Other Monitoring Programs

- The overall EMPs encompass other programs that are reported separately, but summarized in the EMP report.
- Due to differences in reporting requirements/schedules, some 2016 information is based on preliminary data.

Thermal Monitoring

- Discharge of warm water through condenser cooling water system has potential to impact spawning success and larvae development of fish species.
- OPG has conducted/participated in studies (round whitefish meta-population, thermal modeling/monitoring) and is performing Thermal and Ambient Lake Water Temperature Monitoring to understand potential impacts from the Pickering and Darlington Stations.

Impingement and Entrainment Monitoring

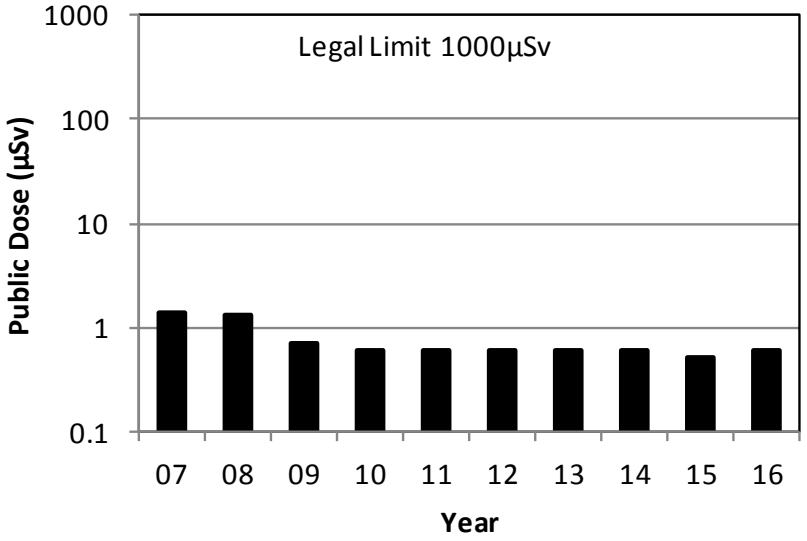
- Pickering deploys a Fish Diversion System annually to protect fish species from impingement during the taking of cooling water. Performance of this system is communicated to the CNSC annually. Work is underway to secure a Fisheries Act Authorization for any residual impact.
- A Fisheries Act Authorization is in effect for the Darlington operations.

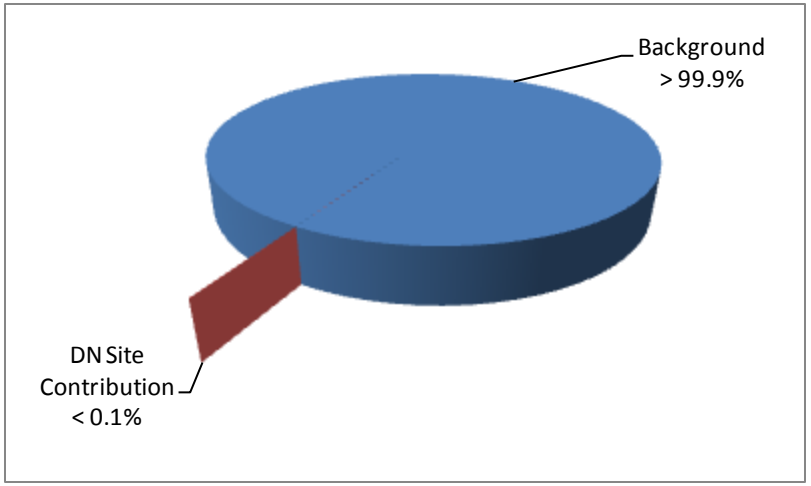
Groundwater Monitoring

- OPG will present the program results at the Sept 2017 DNHC meeting

Darlington Station 2016 Public Dose

- Darlington public dose continues to be very low and is consistent with the 2015 dose
- 2016 public dose was 0.6 µSv, represented by the Dairy Farm Infant
- C-14, HTO, and noble gases are the main dose contributors
- 0.1% of annual regulatory limit of 1000 µSv and <0.1% of annual natural background radiation of 1,400 µSv





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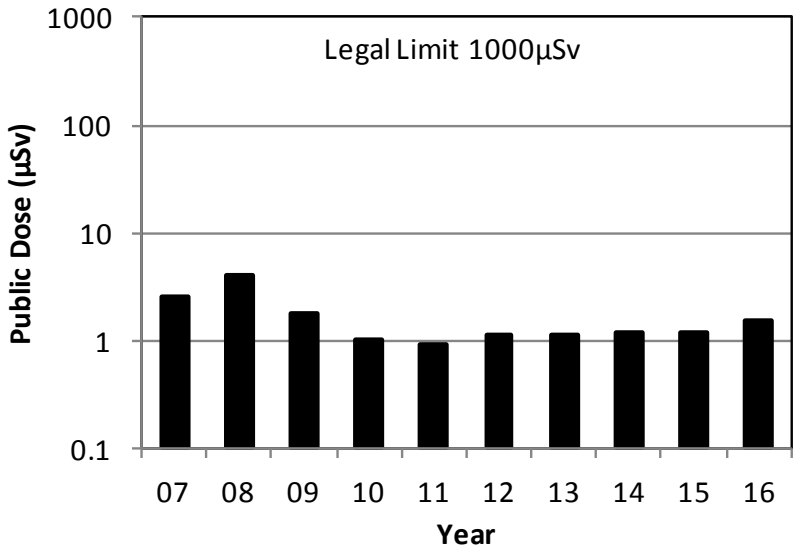
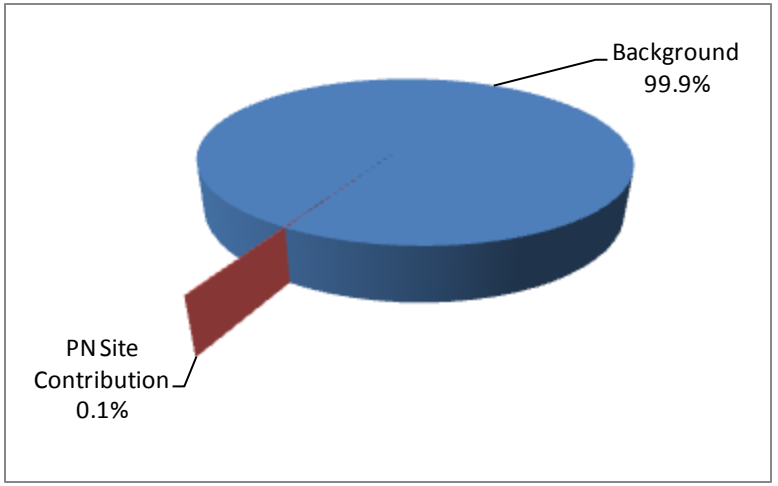
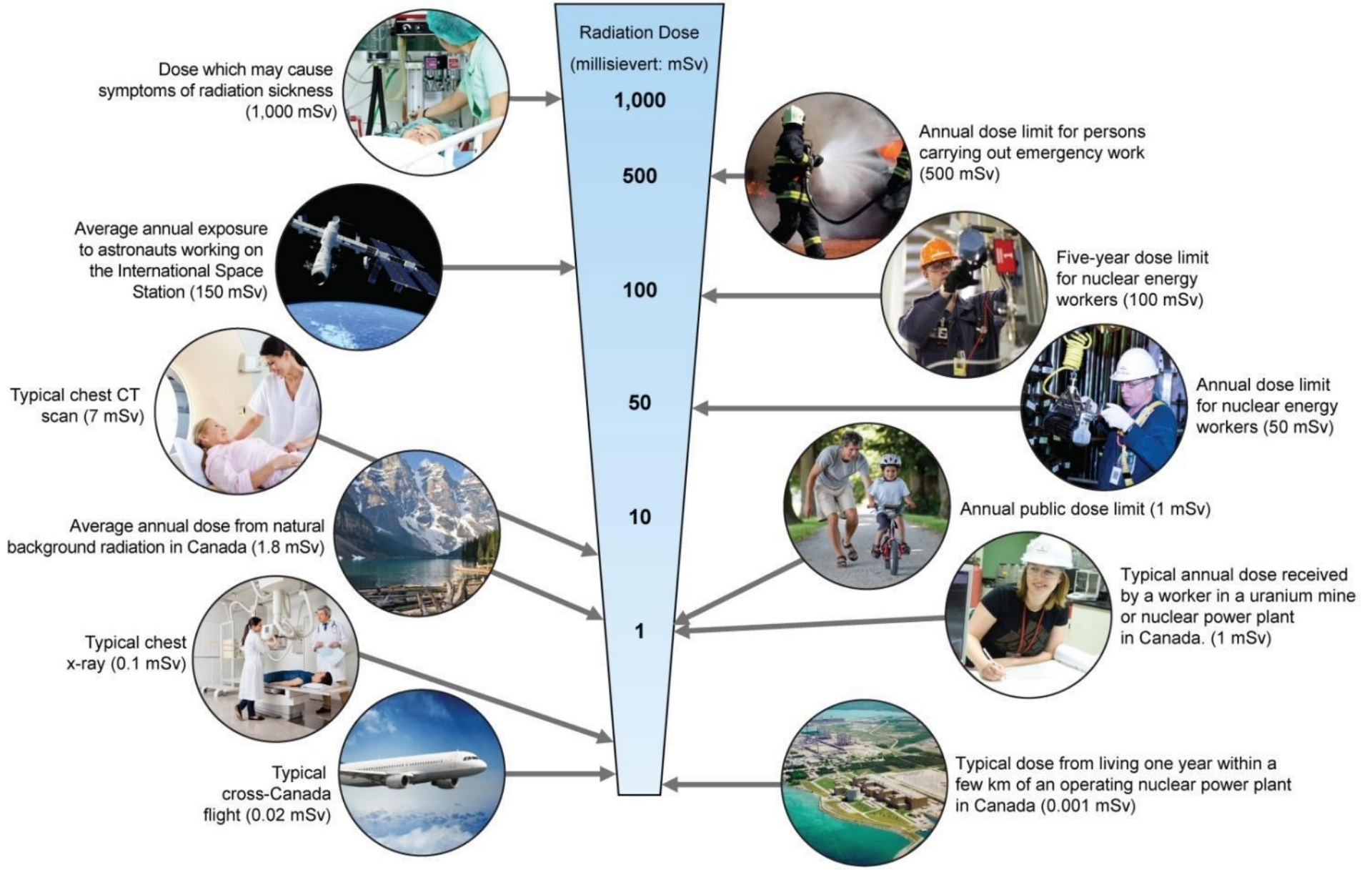
Pickering Station 2016 Public Dose

- Pickering public dose continues to be very low and is consistent with the 2015 dose
- 2016 public dose was 1.5 µSv, represented by Urban Residential Adult
- Noble gas and HTO are main dose contributors
- 0.2% of annual regulatory limit of 1000 µSv and 0.1% of annual natural background radiation of 1,400 µSv





Radiation Dose Examples



Taken from http://www.cnsc-ccsn.gc.ca/eng/resources/radiation/introduction-to-radiation/radiation-doses.cfm

Looking Ahead

- Supplementary studies conducted as part of the 2017 EMPs :
  - Direct gamma and skyshine dose from the Pickering Waste Management Facility will be measured on Lake Ontario. This study was last performed in 2000 and is being repeated to more accurately reflect the current dose to offsite receptors.
- Review/Updates to:
  - PN and DN DRLs (2016-2017)
  - DN Environmental Risk Assessment (2016-2017)
  - PN Environmental Risk Assessment (2017)

2016 Summary

- Station radiological emissions were all below 2% of their respective Derived Release Limits
- Annual public doses resulting from PN and DN operations were 1.5 µSv and 0.6 µSv respectively; 0.2% and 0.1% of the annual regulatory limit
- Dose calculations and annual report were reviewed and verified by an independent third party
- 2016 EMP report was submitted to CNSC by April, 30, 2017 and will be available on www.opg.com on June 20, 2017

Thank you!

Questions?

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