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2017 Results of OPG's Pickering and Darlington Environmental Monitoring Programs

Presentation Outline

- EMP Key Objectives
- EMP Sampling Locations
- 2017 EMP Program Summary
- 2017 Public Dose
- Radiological Emissions
- Emissions and EMP Data
- Non-Radiological Emissions
- 2017 EMP Results
- Supplementary Studies
- Other Monitoring Programs
- Looking Ahead

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Environmental Monitoring Programs

Key Objectives

- 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

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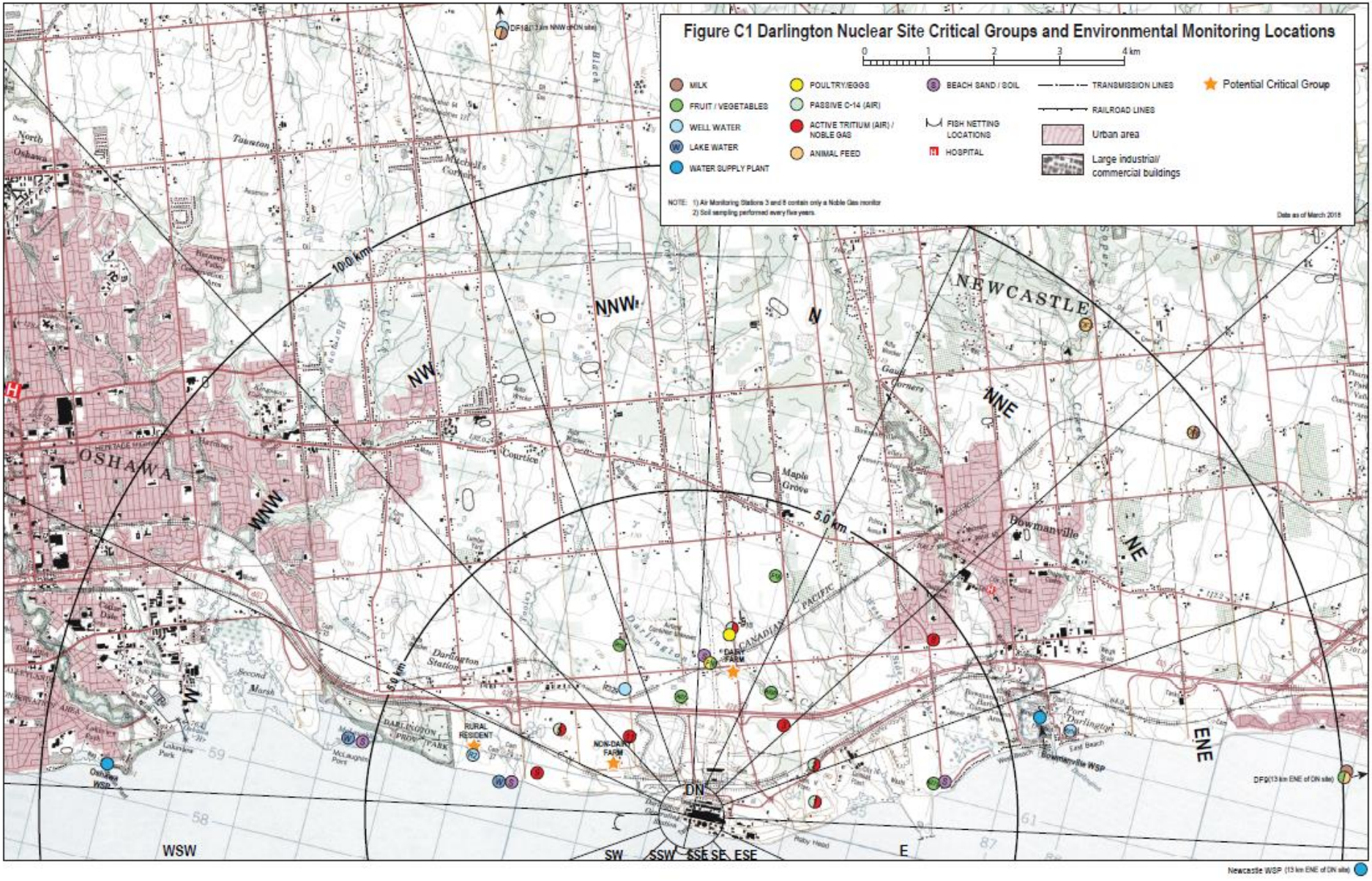
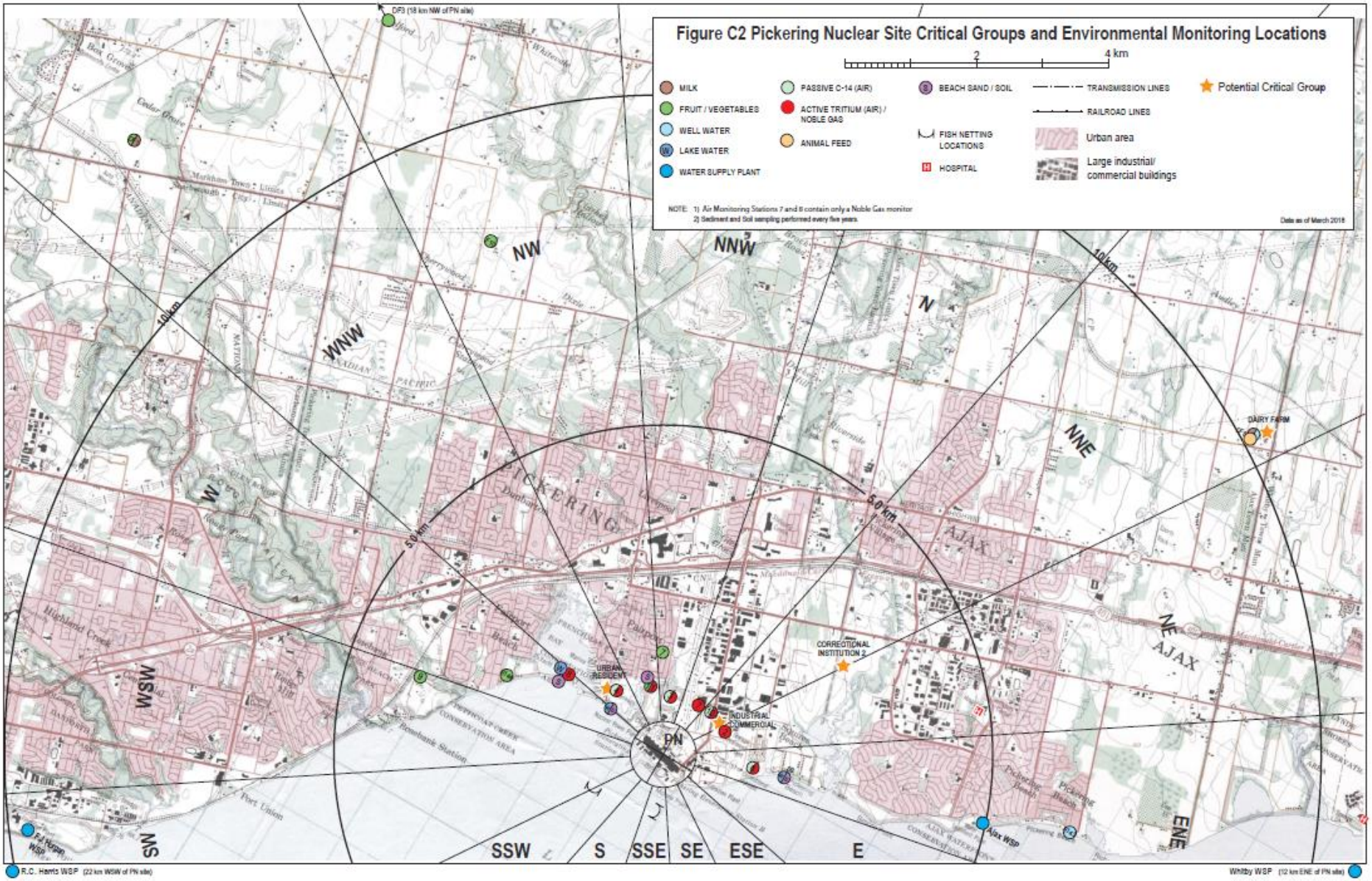
DN Critical Groups and Sampling Locations

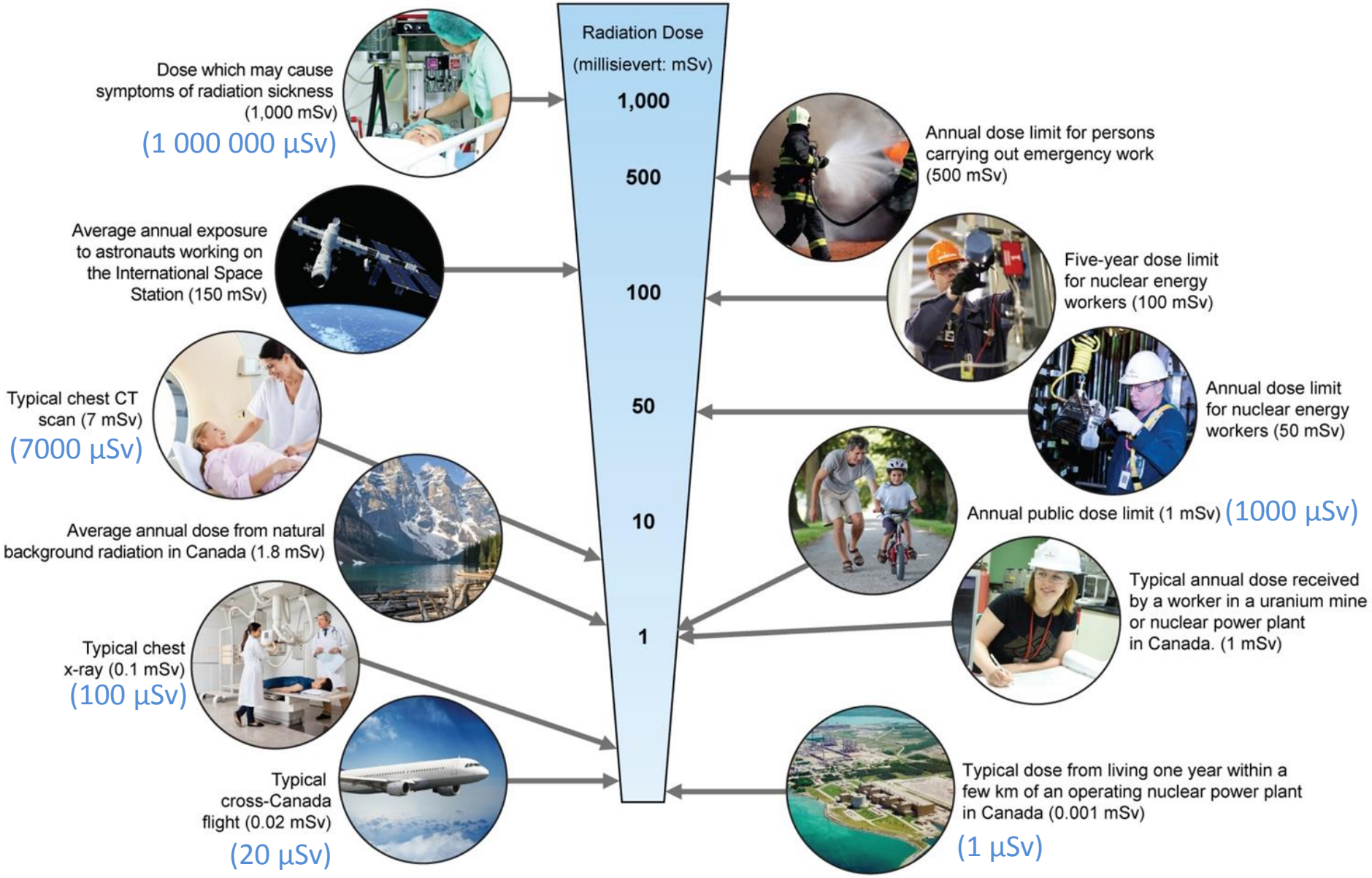


PN Critical Groups and Sampling Locations

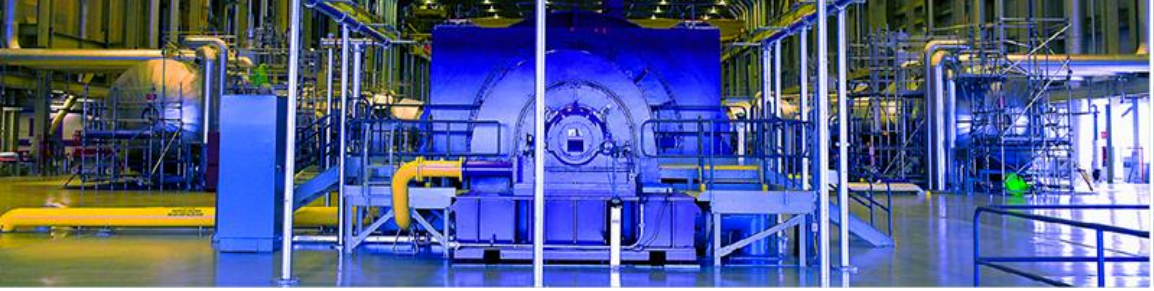


Radiation Dose Examples

Note: 1 mSv = 1000 µSv



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



2017 EMP Program Summary

- Annual public doses resulting from PN and DN operations were 1.8 µSv and 0.7 µSv respectively; 0.2% and 0.1% of the annual regulatory limit
- Station radiological emissions were all below 1% of their respective Derived Release Limits
- Dose calculations and annual report were reviewed and verified by an independent third party
- 2017 EMP report was submitted to CNSC on April 20, 2018 and will be available on www.opg.com on June 19, 2018

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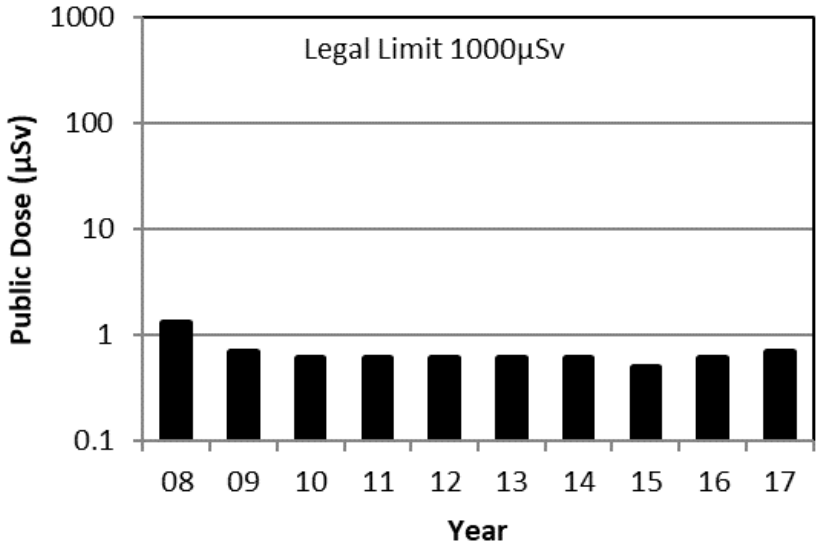
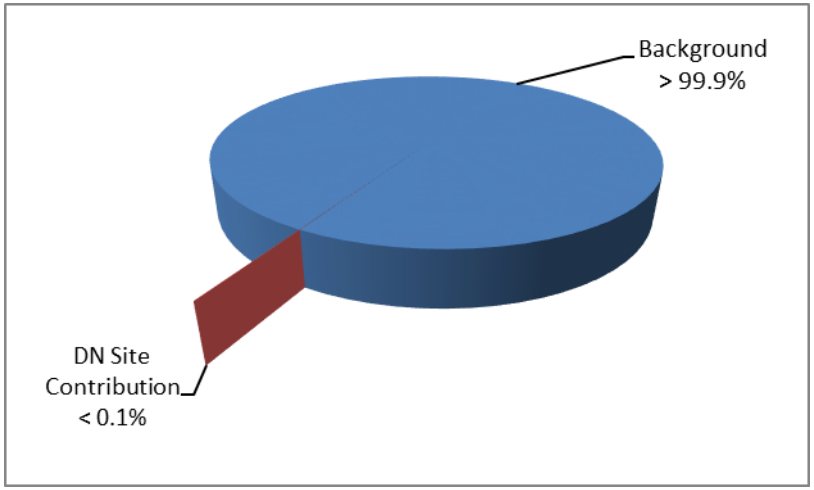
Darlington Station 2017 Public Dose

- 2017 public dose was 0.7 µSv, represented by the Dairy Farm Infant
- Darlington public dose continues to be very low and is consistent with the 2016 dose
- 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

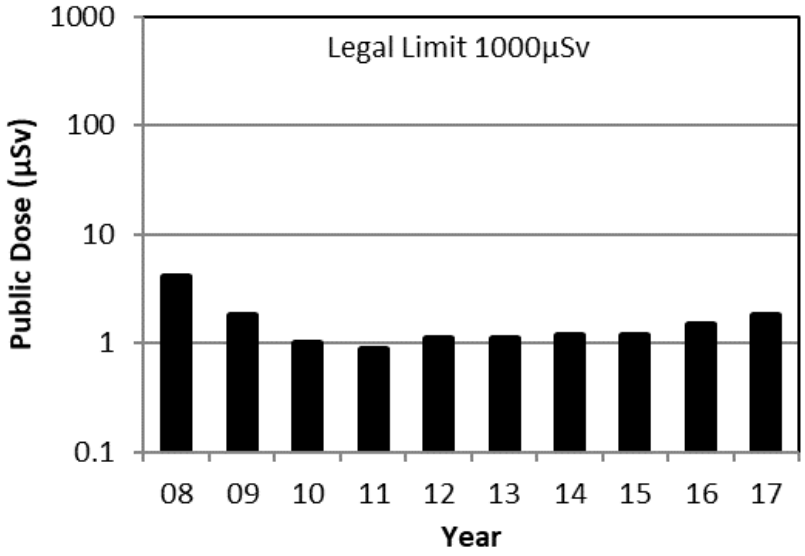


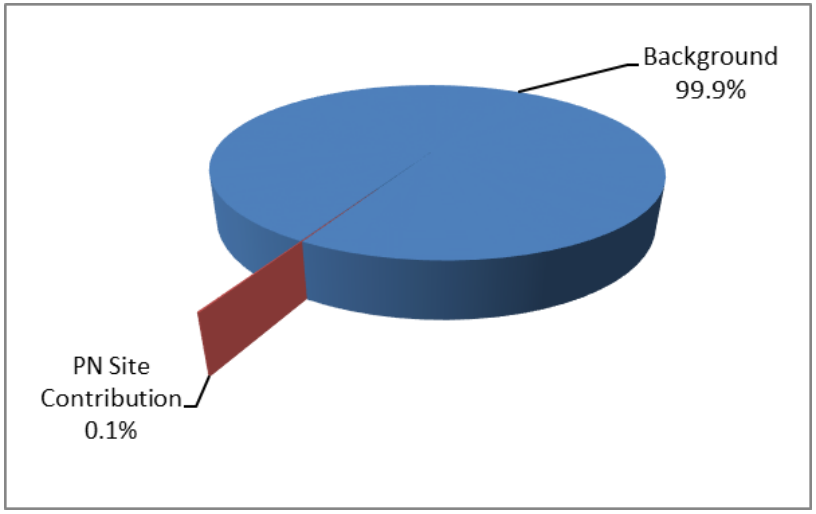




Pickering Station 2017 Public Dose

- 2017 public dose was 1.8 µSv, represented by Urban Residential Adult
- Pickering public dose continues to be very low and is consistent with the 2016 dose
- 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





2017 Results of Radioactive Emissions Monitoring

- All radioactive emissions to air and to water were below 1% of DRLs

Site Emissions[d]	DN		PNA (Units 1-4)		PNB (Units 5-8)	
	Bq	%DRL	Bq	%DRL	Bq	%DRL
AIR						
Tritium Oxide	2.4E+14	0.41	3.1E+14	0.26	3.8E+14	0.20
Elemental Tritium [a]	1.4E+14	1.6E-02	NA	NA	NA	NA
Noble Gas [b]	1.5E+13	0.03	1.5E+14	0.47	3.5E+12	<0.01
I-131[c]	1.5E+08	<0.01	9.6E+06	<0.01	4.3E+06	<0.01
Particulate	2.6E+07	<0.01	6.9E+06	<0.01	2.0E+08	2.8E-02
C-14	1.4E+12	0.40	1.3E+12	0.06	1.3E+12	0.07
WATER						
Tritium Oxide	5.6E+14	1.1E-02	1.1E+14	0.03	2.7E+14	0.04
Gross Beta/Gamma	2.6E+10	3.7E-02	6.5E+09	0.38	2.0E+10	0.63
C-14[e]	1.7E+09	<0.01	NA	NA	1.9E+09	<0.01

NOTES: NA = Not Applicable, Bq = Bequerels

(a) Emissions from Darlington Tritium Removal Facility

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

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

(d) Annual air emissions are the sum of continuous samples analysed weekly.
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 2017 C-14 waterborne emission value is the total for all Pickering units.

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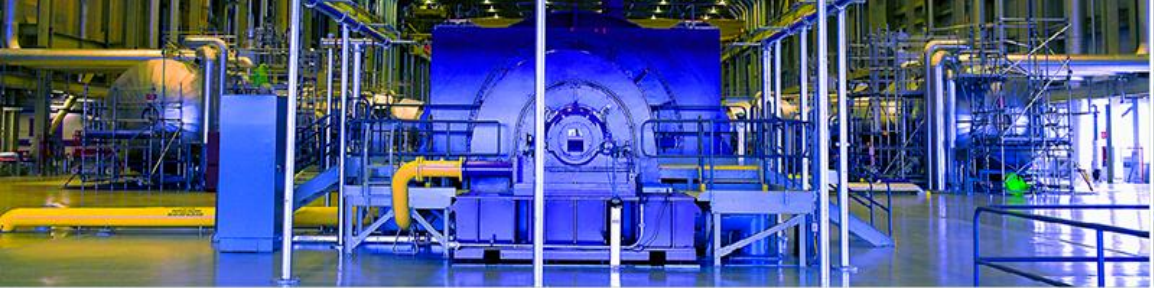
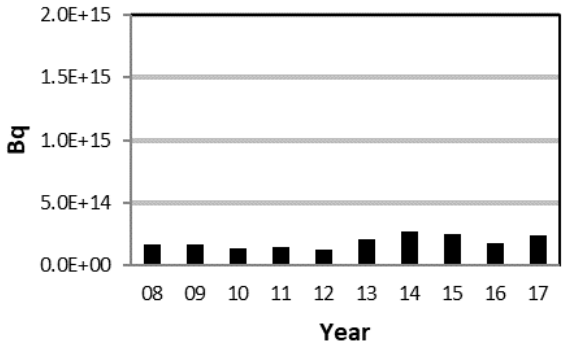


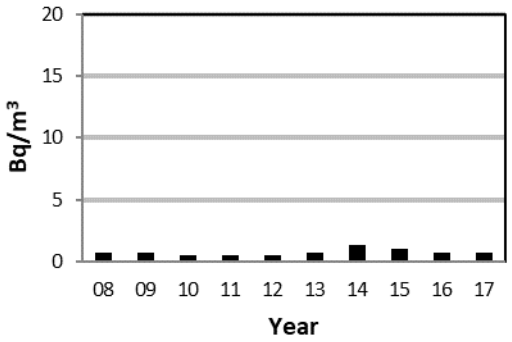
Emissions and EMP Data

DN HTO to Air Emissions



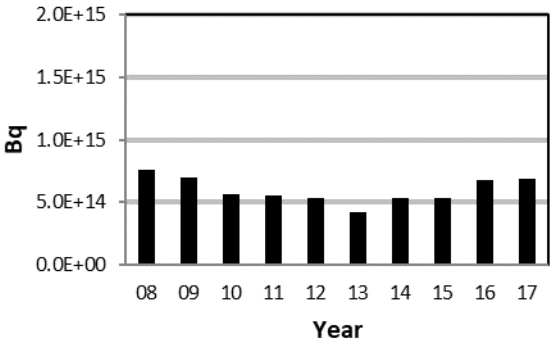
2017 = 2.40×10^{14} Bq

DN HTO in Air at Site Boundary



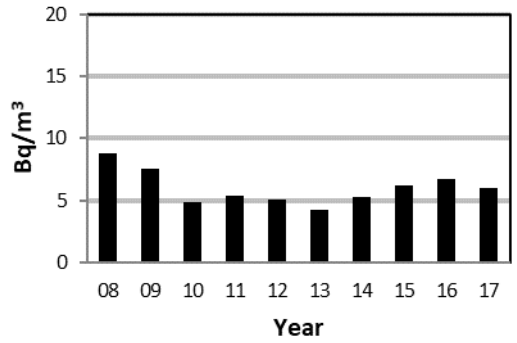
2017 = 0.80 Bq/m^3

PN HTO to Air Emissions



2017 = 6.90×10^{14} Bq

PN HTO in Air at Site Boundary



2017 = 6.02 Bq/m^3

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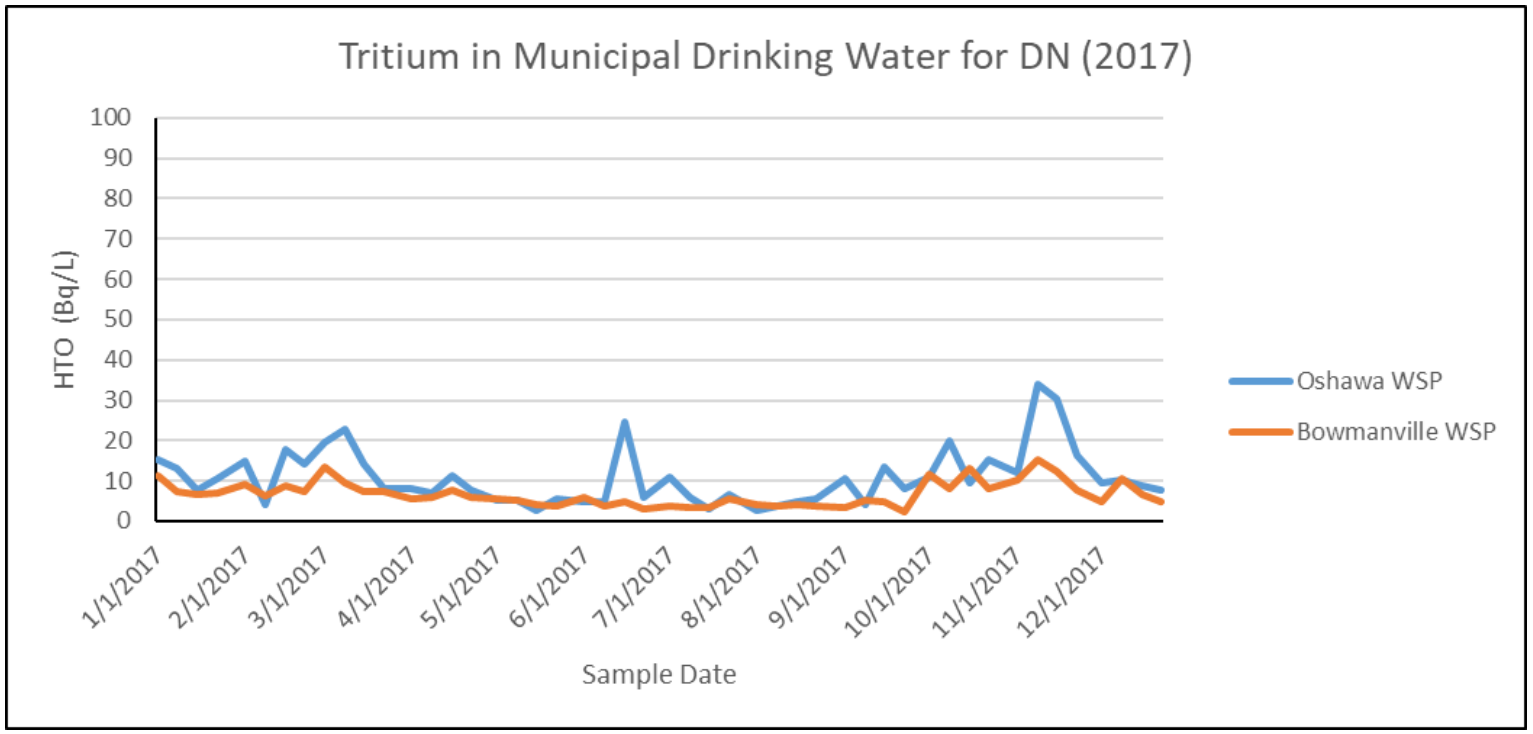
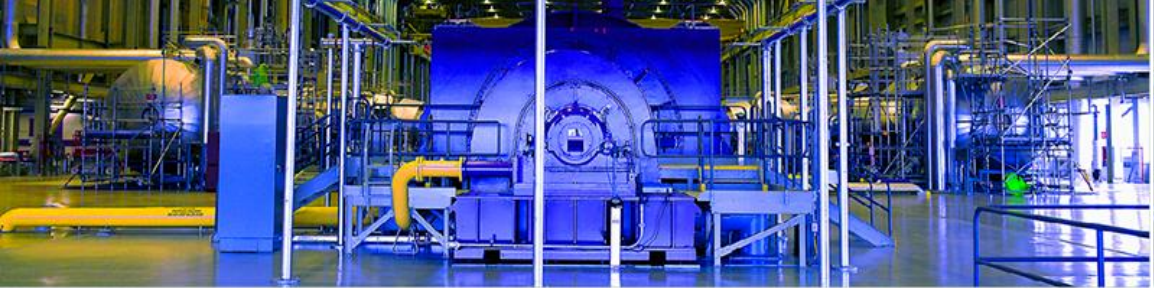
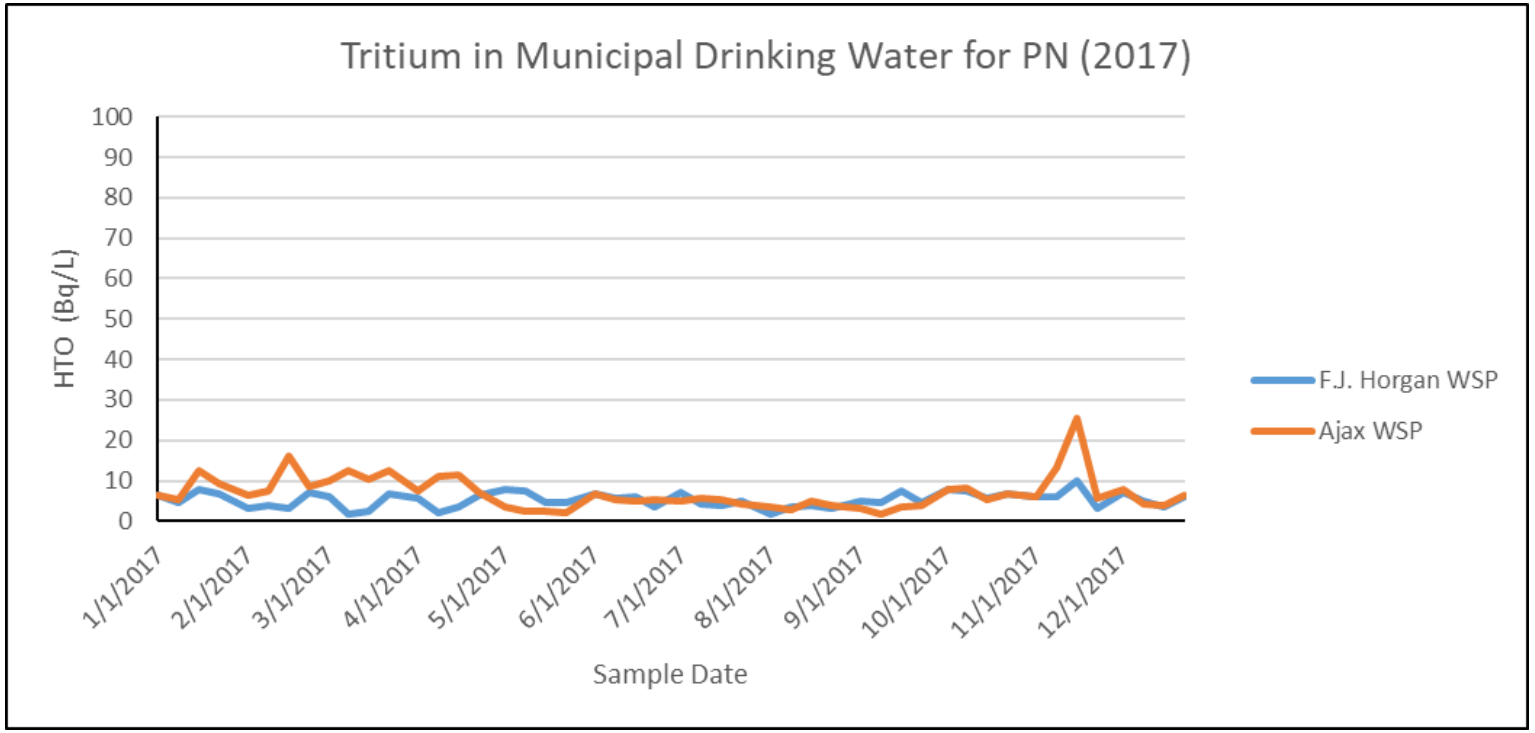
Tritium at Water Supply Plants Near DN



- Average HTO Concentrations: Oshawa = 10.8 Bq/L , Bowmanville = 6.8 Bq/L
- Ontario Drinking Water Quality Standard is 7000 Bq/L
- Water Supply Plant annual average concentrations far below OPG's commitment of < 100 Bq/L



Tritium at Water Supply Plants Near PN



- Average HTO Concentrations: F.J. Horgan = 5.3 Bq/L, Ajax = 7.0 Bq/L
- Ontario Drinking Water Quality Standard is 7000 Bq/L
- Water Supply Plant annual average concentrations far below OPG's commitment of < 100 Bq/L

Results of Non-Radiological Emissions Monitoring

- 2017 emissions continue to be reported through 2018, therefore the 2017 EMP Report summarized the complete set of emissions for 2016
- No regulatory non-compliances for 2016 and met all ECA limits

Hazardous Material	DN	PN
	Mg	Mg
AIR		
SO_2 to Air[(a)(b)]	1.0E+00	2.1E+00
NO_2 to Air[(b)]	2.2E+01	4.5E+01
CO_2 to Air[(a)(b)]	8.4E-02	4.0E-01
Ammonia to Air	4.6E+00	4.5E+00
Hydrazine to Air[(c)]	2.1E-02	5.1E-03
Ozone Depleting Substances (ODS) Releases[(d)]	2.5E-02	4.0E-02
WATER		
Ammonia to Water	2.0E+00	5.9E-01
Hydrazine to Water[(c)]	4.1E-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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2017 Environmental Monitoring Program Results

- 979 laboratory analyses performed for the 2017 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 2017, OPG conducted a supplementary study which confirmed that the air kerma rate due to the waste storage facilities cannot be detected at distances greater than 400m from the facilities. Skyshine dose from this source is not significant for potential critical groups outside the 1 km boundary.

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PN Supplementary Studies

Contaminants of Potential Concern (COPCs) in Soil at PN		
Recommended by	**Objective**	**Results**
Recommended in the PN 2014 ERA. Sampling took place in 2015 and the full results are summarized in the most recent PN ERA, completed in 2016/17.	Soil data on site was updated to reduce uncertainty regarding concentrations of COPCs used in dose calculations for non-human biota.	Average concentrations in soil did not exceed acceptable risk levels for mammals or birds. There were no exceedances of the radiation dose benchmark for terrestrial biota on the PN site.

Sediment and Water Sampling of Non-radiological Contaminants at PN		
Recommended by	**Objective**	**Results**
Recommended in the PN 2014 ERA. Sampling took place in 2015 and the full results are summarized in the most recent PN ERA, completed in 2016/17.	Sediment and water samples were collected from the northern section of the Frenchman's Bay wetland to reduce uncertainty regarding the assessment of biota in the bay. Previously, biota were assessed at the mouth of the bay where sediment data were available, south of the wetland.	In general, the study showed that the exposure levels for non-radiological contaminants are below benchmark values.

DN Supplementary Studies

2015/16 Entrainment Study for DN		
Recommended by	**Objective**	**Results**
Follow-up monitoring program identified in the DN refurbishment and continued operations EA. Committed in the DN Fisheries Act authorization	To characterize the station's entrainment of ichthyoplankton (i.e., fish eggs and larvae) and benthic invertebrates and to confirm no significant residual adverse effects to aquatic biota as a result of Condenser Cooling Water (CCW) operations.	An estimated 589 kg of biomass was entrained during the study. The equivalent Age 1 biomass lost was estimated at 48 kg. Additionally, it is concluded that entrainment at DN does not negatively impacting local benthic invertebrate populations.

2016 Benthic Study for DN		
Recommended by	**Objective**	**Results**
Follow-up monitoring program identified in the DN refurbishment and continued operations EA.	To determine the baseline abundance and species diversity of benthic invertebrates in the area of the DN intake structure and to compare the results to nearshore studies completed in 2008 in the vicinity of the proposed New Nuclear at Darlington (NND) project infill area.	Results demonstrate that the composition of the benthic invertebrate community at DN was within the range of variability observed in invertebrate community composition at the reference locations. Therefore, there is no effect on the benthic community related to CCW operations.

DN Supplementary Studies

Effluent Characterization Study at DN		
Recommended by	**Objective**	**Results**
As identified in the DN refurbishment and continued operations EA. Results from this study informed the most recent DN ERA.	To confirm EA findings of non-significant impact from non-radiological effluent constituents on human and non-human biota.	The chemical concentration data from the effluent characterization study was used in the most recent DN ERA to determine if any new COPCs warranted further assessment. Analytical results were found to be acceptable and adequate for statistical characterization of effluent at DN.

Other Monitoring Programs

- The overall EMPs encompass other programs that are reported separately.
- Note: some 2017 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 is performing Thermal and Ambient Lake Water Temperature Monitoring to understand potential impacts from the Pickering and Darlington Stations.
- The average lake temperature at the Darlington Lake Current Monitor between December 1st 2016 and March 31st 2017 was 3.0°C, compared to a threshold of 6.0° C.
- There is no indication of a warming trend which would approach the threshold in the near term.

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Other Monitoring Programs

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.
- The biomass impinged in 2016 was estimated to be 1,035 kg, or 0.22 kg/million m^3 of station flow.
- The total biomass impinged in 2017 was 25,217 kg, or 4.99 kg/million m^3 of station flow.
- Results were heavily influenced by a single event in November, during which a preliminary estimate of 24,000 kg of Alewife were impinged.
- In the absence of this event, impingement was 1,217 kg, the second lowest on record since assessment commenced in 2010.

- In 2017, per Section 35 of the Federal Fisheries Act, OPG obtained a Fisheries Act Authorization for the residual impingement from the operation of PN.
- A Fisheries Act Authorization is in effect for DN operations.

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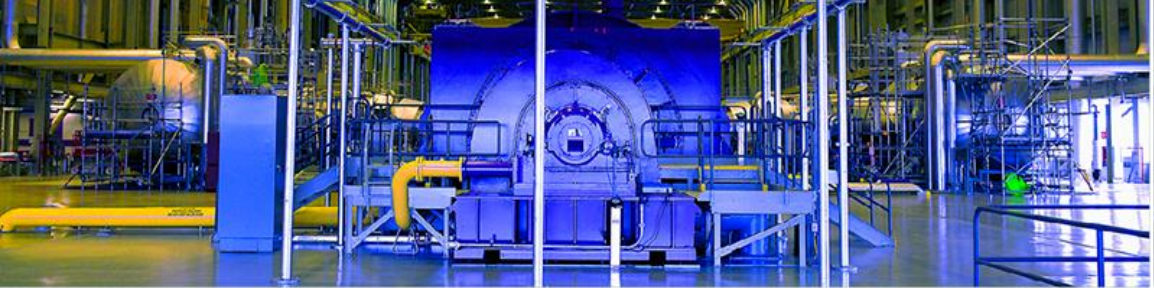

Looking Ahead

Review/Updates to:

- Site Specific Survey Review (2018)
- Program Design Reviews (2018-2019)
- Implementation of PN and DN DRLs (2019)

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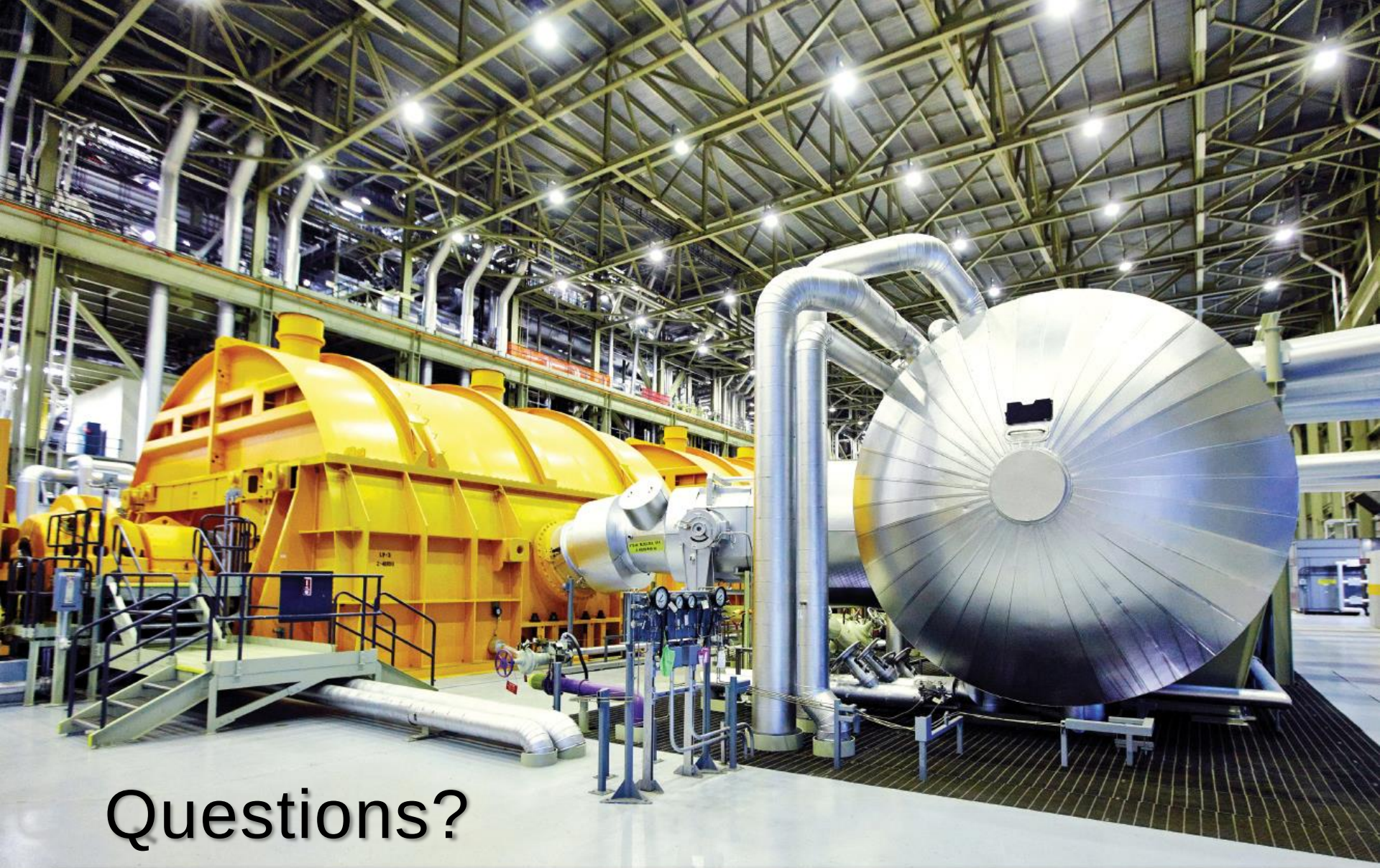

Questions?

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