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The Regional Municipality of Durham Report

To:	Works Committee
From:	Commissioner of Works
Report:	#2024-WR-5
Date:	May 8, 2024

Subject:

Durham York Energy Centre – Analysis of Ambient Air and Emissions Monitoring to Identify Local Airshed Impacts

Recommendation:

That the Works Committee recommends to Regional Council:

That Report #2024-WR-5 of the Commissioner of Works be received for information.

Report:

1. Purpose

1.1 The purpose of this report is to update the Works Committee and Regional Council members regarding the summary of the Durham York Energy Centre (DYEC) ambient and emission monitoring study (Study) conducted by Matthew Adams, Ph.D., an Associate Professor within the University of Toronto's department of Geography, Geomatics, and the Environment.

2. Background

2.1 Dr. Matthew Adams was retained by the Regions (Regional Municipality of Durham and York Region) to conduct a Study of the local airshed in the vicinity of the Durham York Energy Centre (DYEC). The Study included an analysis of ambient air monitoring data, wind direction, air pollution, and National Pollution Release Inventory (NPRI) data in an effort to improve the community understanding of how the DYEC contributes to the local ambient air conditions.

2.2 As a requirement of the DYEC's environmental approval, conditions within the facility are monitored, as are conditions within the general area of the facility, which is referred to as the ambient environment. While measurements within the facility are directly attributed to the operations, measurements within the ambient environment can be influenced by a number of sources. The Region recognizes the importance of understanding and communicating information surrounding the DYEC to the community.

2.3 This report aligns with the following strategic goals and priorities in the Durham Region Strategic Plan:

a. Goal 1: Environmental Sustainability

- 1.4 Demonstrate leadership in sustainability and addressing climate change

b. Goal 5: Service Excellence

- 5.3 Demonstrate commitment to continuous quality improvement and communicating results.

3. Study Conclusion

3.1 The results from the study concluded that the Durham York Energy Centre's Air Emissions Monitoring Plan effectively measures emissions, and the emissions from the Durham York Energy Centre are below the Ministry of Environment, Conservation and Parks' Ontario Ambient Air Quality Criteria. The study compared the emissions reported by the DYEC to the National Pollutant Release Inventory(NPRI) with all reported emission sources in Durham and York Regions.

3.2 The analysis determined that none of the pollutants analyzed indicate any notable contribution from the Durham York Energy Centre to ambient air pollution concentrations. Overall, the Durham York Energy Centre does not significantly impact the local airshed.

3.3 Dr. Matthew Adams will be presenting the highlights of the Study and conclusions to the Works Committee on May 8, 2024.

3.4 This report has been reviewed by Legal Services – Office of the CAO.

3.5 For additional information, contact Andrew Evans, Director, Waste Management Services, at 905-668-7711, extension 4102.

4. Attachments

4.1 Attachment #1: Analysis of Ambient and Emissions Monitoring Report to Identify Local Airshed Impacts

4.2 Attachment #2: Summary of Analysis of Ambient and Emissions Monitoring to Identify Local Airshed Impacts

4.3 Attachment #3: Examining Air Pollution Sources in the Proximity of Durham York Energy Centre

4.4 Attachment #4: Analysis of Ambient Air Exceedances in the Proximity of Durham York Energy Centre

Respectfully submitted,

Original signed by:

Ramesh Jagannathan, M.B.A., M.Eng., P.Eng., P.T.O.E.
Commissioner of Works

Recommended for Presentation to Committee

Original signed by:

Elaine C. Baxter-Trahair
Chief Administrative Officer

Attachment #1 to Report #2024-WR-5

DURHAM YORK ENERGY CENTRE

ANALYSIS OF AMBIENT AND EMISSION MONITORING TO IDENTIFY LOCAL AIRSHED IMPACTS

Prepared for:

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Prepared by:

Matthew Adams, Ph.D.

Executive Summary

An analysis was conducted to identify if the Durham York Energy Centre (DYEC) impacts local air quality by contributing emissions that elevate ambient air pollution concentrations. The evaluation included ambient air monitoring data from two air monitoring stations, one located upwind and one downwind of the DYEC, and emission monitoring data from the DYEC.

The air pollutants included fine particulate matter ($PM_{2.5}$), nitrogen oxides (NO_X), sulphur dioxide (SO_2), total suspended particulate (TSP) including metals, polycyclic aromatic hydrocarbons (PAHs), and polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDDs/PCDFs). Additionally, the relative contribution of emissions reported to the National Pollutant Release Inventory for the DYEC were compared with all reported emission sources in Durham and York Regions. All the pollutants analyzed in this report have additional local and regional sources that contribute to air pollution measurements in Durham and York Regions.

The hypothesis in the research assumed that if the DYEC contributed emissions that impacted local air quality, it would be observed in the change in air pollution concentrations between the upwind ambient air monitoring data and the downwind ambient air monitoring data. The increases would occur if the DYEC were adding to the background concentrations of air pollutants. The analysis leverages the long-term ambient air monitoring from the Courtice and Rundle Road ambient air monitoring sites and includes continuous emission monitoring concentrations from the DYEC. The monitoring is conducted as part of the DYEC's Ambient Air Quality Monitoring Plan and Air Emissions Monitoring Plan.

Differences in concentrations were observed between upwind and downwind ambient air pollution; however, these differences varied in the response, at times, with the downwind concentrations demonstrating lower air pollution concentration. No difference was observed for PCDDs/PCDFs. Some PAHs demonstrated higher downwind concentrations but were higher at the downwind station when the wind blew from other directions, suggesting a different local source. In some cases, PAHs were lower downwind than upwind. TSP concentrations were high at the downwind ambient air monitor (Rundle Road) during all wind conditions, which suggests emissions from another local source. NO_X concentrations did not vary between upwind and downwind locations. SO_2 concentrations are higher upwind than downwind. $PM_{2.5}$ concentrations were the same at the upwind and downwind locations.

It can be concluded that the DYEC's Air Emissions Monitoring Plan effectively controls emissions so that it does not make any significant contributions to air pollution in the local airshed.

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1 STUDY OBJECTIVE

This study aims to determine if the Durham York Energy Centre (DYEC) emissions impact air quality in the local airshed. An impact is defined in this study as a statistically significant increase in any air pollutant measured relative to the background concentrations. Statistically significant increases would occur when concentration changes are outside of the natural variation in the monitoring data, i.e. it is due to an outside factor and not measurement error. Ambient air quality measurements, such as those utilized in this work, quantify the sum of local, regional, and transboundary sources of natural and anthropogenic pollution. In this report, we overcome regional and transboundary source influences because of the short distance between the upwind and downwind monitoring locations; however, we have applied different approaches to control for other local emission effects.

2 INTRODUCTION

This report analyzes the DYEC's impact on local air quality. The analysis is completed with ambient air monitoring data from two air monitoring stations located upwind and downwind of the DYEC and emission monitoring at the DYEC. The objective of the analysis is to determine if monitoring data indicates an impact from the DYEC on the local airshed, primarily defined by changes in ambient air measurements at two air pollution monitoring stations.

The DYEC is a 12-hectare facility that produces energy from municipal waste combustion and processes 140,000 tonnes of municipal waste from Durham and York Regions. The facility is about two kilometres west of the Darlington Nuclear Generating Station, one-half kilometre south of the 401 and one-half kilometre north of Lake Ontario. The site is surrounded by industrial and commercial lands, which transition into agricultural lands. The energy generated is sold to the Ontario provincial power grid under a Power Purchase Agreement through the Ontario Power Authority; the 17.5 megawatts (14 MW net output) is sufficient to power about 10,000 homes annually. The DYEC is publicly owned by Durham and York Regions and is operated by Covanta.

The DYEC facility includes two boilers using thermal mass burn with Martin GmbH stoker grate combustion technology. A minimum boiler temperature of 1,000°C is maintained to control emissions of volatile organic compounds (VOCs), dioxins and furans. The mass burn process generates electricity with a steam-powered turbine where the steam is generated from waste burning. The stoker grate is responsible for transporting waste through the furnace and agitating the debris to ensure proper airflow and complete combustion. In addition, the stoker grate moves the bottom ash to the ash management system. Each boiler is capable of processing over 200 tonnes of material per day. Emissions from the facility are emitted through a central stack with a height of 87.6 metres.

Each of the boilers has an air pollution control system that includes six primary components to limit the emissions of nitrogen oxides (NO_X), acid gas (gas mixtures that form acidic compounds when mixed with water), mercury, dioxin and furans, and particulate matter. A selective non-catalytic reduction system is included to reduce NO_X emissions, which converts NO_X into elemental nitrogen (outdoor air is 78 percent nitrogen) and water by injecting ammonia into the flue gas. In addition to the selective non-catalytic reduction system, the very low NO_X (VLN^{TM}) system developed by Covanta and Martin GmbH is included, where flue gas composition is maintained to minimize NO_X emissions. Flue gas is cooled and increased in humidity in an evaporative cooling tower that improves conditions for the dry lime reactor, which neutralizes acidic chemical compounds with lime. Activated carbon is injected into the flue gas for mercury and dioxin control, which adsorb to the carbon and are captured in the bag house as the pollutants are adsorbed onto particles. Particulate matter emissions are controlled with a fabric filter baghouse, a series of filters that the flue gases pass through before being emitted into the atmosphere.

Air pollution dispersion modelling was conducted for the environmental assessment of the DYEC and examined emissions from the on-site stack. The results from the modelling were utilized along with air monitor citing criteria to identify the locations for long-term air pollution monitoring. Three sites were identified, upwind, downwind, and property line. Property line monitoring was required for only one year in the Ambient Air Quality Monitoring Plan but operated until June 2018. The downwind monitoring location was selected because its location aligned with the wind direction that could result in pollution being directed toward nearby residents and that long-term dispersion models highlighted maximum concentrations to occur within 1 to 2 km from the stack. In addition, the then Ministry of the Environment, currently the Ministry of Environment, Conservation and Parks, requested that the upwind site be south or southwest of the DYEC to capture background air pollution concentrations (Stantec Consulting Ltd., 2012). Data measured at these two ambient air sampling locations are the basis for this analysis and report, representing real-world air pollution measurements.

3 METHODOLOGY

3.1 AIR POLLUTION DATA

The DYEC Ambient Air Quality Monitoring and Reporting Plan includes continuous and non-continuous ambient air (outdoor air) monitoring to comply with Condition 11 of the EA Notice of Approval and Condition 7(4) Environmental Compliance Approval (ECA). Continuous monitoring instruments measure air pollution in real-time as outdoor air is drawn through the device. Non-continuous approaches (discrete samplers) sample air for a specific period; the air is either contained in a specialized canister or passes through a filter where pollutants are retained. These discrete sampling approaches require the sample to be processed in a laboratory where the amount of pollutant retained is measured and divided by the amount of air sampled to determine the ambient concentration.

Three ambient air monitoring stations were established based on the Ambient Air Quality Monitoring Plan (Stantec Consulting Ltd., 2012), with one upwind, one downwind and one property line (required operation for one year, operated until June 2018). This analysis considers the upwind and downwind sites, which are currently operational. The two monitoring locations were identified based on general wind patterns: upwind (Courtice Station) and downwind (Rundle Road Station) relative to the DYEC. The upwind monitoring location, Courtice Station, is currently located at the west end of the Courtice Water Pollution Control Plant (Latitude: 43.87128; Longitude: -78.75913); previously (before this analysis period), it was located about 140 metres west of its current location (Latitude: 43.8716; Longitude: -78.7609). The upwind monitoring location was identified based on feedback from the then Ontario Ministry of the Environment (currently Ministry of Environment, Conservation and Parks [MECP]) to select a site in the predominantly upwind direction from the DYEC (Stantec Consulting Ltd., 2012). The downwind location, known as the Rundle Road station (Latitude: 43.88743; Longitude: -78.73477), is located east of Rundle Road and south of Baseline Road West. Highway 401 lies between the DYEC and Rundle Road air monitor. The Ambient Air Quality Monitoring Plan identified characteristics at Rundle Road's location that made it suitable to measure conditions downwind. In particular, two of those characteristics are very important: (1) relative to the DYEC, it is in the dominant downwind direction that aligns with winds that would pass by the DYEC towards the residential areas, and (2) it is located within the 1-2 km range of the facility where previous dispersion models identified the highest potential air pollution impact would occur (Stantec Consulting Ltd., 2012).

The Air Emissions Monitoring Plan (Golder Associates, 2013) specifies continuous emissions monitoring. Selected air pollutants are monitored at the DYEC for the two boilers, providing real-time air emissions data posted to the DYEC website.

3.2 Wind Direction Analysis

Both Rundle Road and Courtice monitoring stations include measurements for wind direction and speed on an hourly basis. Data between January 2016 and June 2022 were analyzed to identify the frequency of upwind and downwind conditions for each monitor and crosswind conditions. Hourly measurements were averaged to daily wind direction and speed measurements by converting speed (m/s) and direction (degrees) into the component vector winds, which were then averaged (mean value) for each day and back-transformed to wind direction and wind speed. Wind calculations were conducted with the rWind package version 1.1.7 (Fernández-López and Schliep, 2019). Wind information was calculated daily to align with the 24-hour air sampling period.

Figure 3.1 presents a map of the ambient air monitoring locations and their relative positions to the DYEC. The pink line connecting the Courtice monitor to the Rundle Road Monitor is 46°, with north being 0°, which means the Rundle Road Monitor is directly downwind from the Courtice monitor when the wind direction is 224° (southwest wind); the Courtice Monitor is downwind from the Rundle Road monitor when the wind is blowing from the north east (46°). Therefore, measuring from the stack to each monitor in their downwind configuration would result in the

Courtice monitor being directly downwind during 43° winds and the Rundle Road being directly downwind during winds from 236°. For each wind observation, it was identified when the Courtice monitor was downwind from the stack (43°) and when the Rundle Road monitor was downwind from the stack (236°). We included +/- 22.5 degrees in the downwind direction to ensure sufficient data. Observations that did not fall within either downwind classification were identified as crosswind conditions.

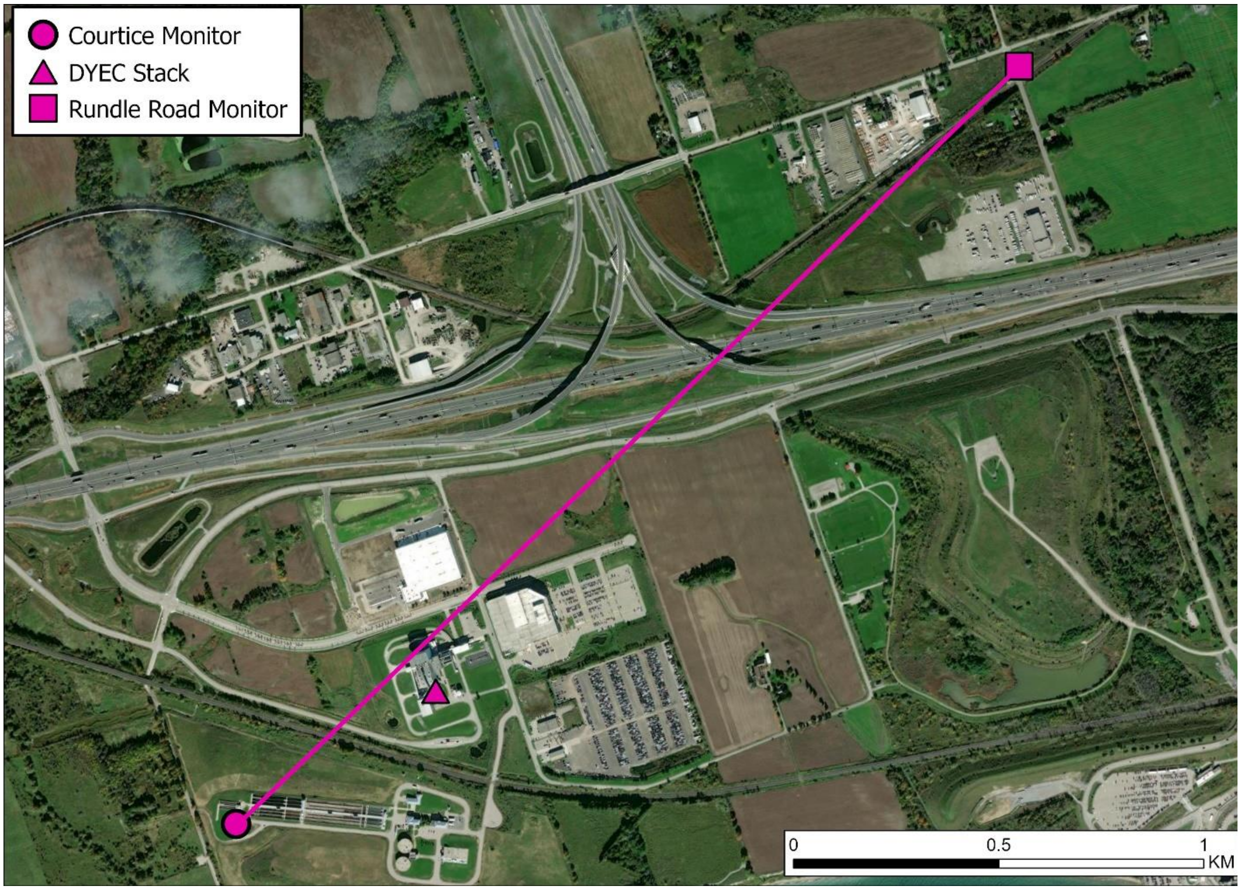

Figure 3.1 Map of Ambient Air Monitoring Locations Relative to the DYEC

3.3 Upwind Downwind Air Pollution Analysis

Three approaches have been implemented to analyze the ambient air pollution data determined by the data availability and air monitoring approach: 1) pollutants measured by discrete 24-hour sampling, 2) pollutants monitored by ambient monitoring (Courtice and Rundle Road) with continuous emissions monitoring available, and 3) pollutants monitored by ambient monitoring without continuous emissions monitoring. Discrete air pollution monitoring included three pollutant groups: 1) polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDD/PCDF), often referred to as dioxins and furans, 2) polycyclic aromatic hydrocarbons (PAHs), and 3) total suspended particulate (TSP) including the concentrations of metals. Furthermore, ambient air and emission monitoring are conducted for nitrogen oxides (NO_X) and sulphur dioxide (SO_2). In addition, ambient monitoring is undertaken for particulate matter 2.5 microns or smaller in aerodynamic diameter ($PM_{2.5}$).

3.3.1 Discrete Monitoring Ambient Data Analysis

The pollutants measured with discrete monitoring were quantified into multiple chemical species in the laboratory, which allows for analysis of the specific components and the sum of their parts. The species analyzed for each pollutant class (PCDD/PCDF, PAH & TSP) are listed in Table 3.1. Each sample was a 24-hour integrated measurement, and the concentrations were determined by laboratory processing following sample collection.

Daily wind direction data were assigned to each 24-hour air pollution observation to identify upwind-downwind relationships between the air monitors and the DYEC stack. Downwind alignments are based on the relative position of the monitor to the emission stack. Concentration data for each pollutant were separated into the following three conditions: (1) Rundle Road monitor downwind (Courtice monitor upwind), (2) Courtice monitor downwind (Rundle Road monitor upwind), or (3) Crosswind conditions neither monitor downwind.

Hypothesis: if air pollution emissions from the DYEC affect the local air, downwind concentrations will be statistically significantly higher than the upwind air monitor due to the additional pollution. However, if higher concentrations occurred during non-downwind conditions, it would suggest potential local sources other than the DYEC.

During each wind condition (Rundle Downwind, Courtice Downwind & Crosswind), a *t-test* was applied to determine if the measured concentrations during those conditions were statistically significantly different ($p < 0.05$) between the Courtice and Rundle Road concentrations.

3.3.2 Ambient Air Monitoring Analysis with Emissions Monitoring

Nitrogen oxides and SO_2 were measured by ambient air and continuous emissions monitoring at the DYEC. With the addition of continuous emissions monitoring, the analysis can be extended beyond comparing differences only and explore relationships between the upwind and downwind differences with respect to changes in measured emissions.

Hypothesis: if air pollution emissions from the DYEC affect the local air, measured emissions will statistically significantly explain the differences in downwind concentrations. For example, when emissions are high, it would be expected that downwind concentrations are higher than background (upwind) due to the additional pollution.

The statistical analysis included a linear regression model with the difference between the Rundle Road monitor and the Courtice monitor as the dependent variable, regressed against the sum of NO_X emissions from the CEMS during Rundle Road downwind conditions. Concentrations were averaged daily to align with the discrete air pollution analysis and reduce the number of temporally correlated values.

Table 3.1 Discrete Monitoring Classes and Chemical Species

PCDD/PCDF	**Total Suspended Particulate**	**Polycyclic Aromatic Hydrocarbons**
1,2,3,4,6,7,8-HeptaCDD	Particulate (TSP)	1-methylnaphthalene
1,2,3,4,6,7,8-HeptaCDF	Aluminum (Al)	2-methylnaphthalene
1,2,3,4,7,8-HexaCDD	Antimony (Sb)	Acenaphthene
1,2,3,4,7,8-HexaCDF	Arsenic (As)	Acenaphthylene
1,2,3,4,7,8,9-HeptaCDF	Barium (Ba)	Anthracene
1,2,3,6,7,8-HexaCDD	Beryllium (Be)	Benzo(a)anthracene
1,2,3,6,7,8-HexaCDF	Bismuth (Bi)	Benzo(a)fluorene
1,2,3,7,8-PentaCDD	Boron (B)	Benzo(a)pyrene
1,2,3,7,8-PentaCDF	Cadmium (Cd)	Benzo(b)fluoranthene
1,2,3,7,8,9-HexaCDD	Chromium (Cr)	Benzo(b)fluorene
1,2,3,7,8,9-HexaCDF	Cobalt (Co)	Benzo(e)pyrene
2,3,4,6,7,8-HexaCDF	Copper (Cu)	Benzo(g,h,i)perylene
2,3,4,7,8-PentaCDF	Iron (Fe)	Benzo(k)fluoranthene
2,3,7,8-TetraCDD	Lead (Pb)	Biphenyl
2,3,7,8-TetraCDF	Magnesium (Mg)	Chrysene
OctaCDD	Manganese (Mn)	Dibenz(a,h)anthracene
OctaCDF	Mercury (Hg)	Dibenzo(a,c) anthracene + Picene
Total Toxic Equivalency	Molybdenum (Mo)	Fluoranthene
	Nickel (Ni)	Fluorene
	Phosphorus (P)	Indeno(1,2,3-cd)pyrene
	Selenium (Se)	Naphthalene
	Silver (Ag)	O-terphenyl
	Strontium (Sr)	Perylene
	Thallium (Tl)	Phenanthrene
	Thorium (Th)	Pyrene
	Tin (Sn)	Tetralin
	Titanium (Ti)	Total PAH*
	Uranium (Ur)	
	Vanadium (V)	
	Zinc (Zn)	
	Zirconium (Zr)	

*Total PAH excludes Dibenzo(a,c) anthracene + Picene, and Fluorene as they were not monitored during the entire study period.

3.3.2.2 Ambient Monitoring Analysis without CEMS

The analysis of $PM_{2.5}$ aligned with the approach for the discrete air sampling. The goal was to identify significant downwind air pollution differences to identify any local impact on air quality from the DYEC.

Hypothesis: if air pollution emissions from the DYEC affect the local air, downwind concentrations will be statistically significantly higher than the upwind air monitor due to the additional pollution. However, if higher concentrations occurred during non-downwind conditions, it would suggest potential local sources other than the DYEC.

During each wind condition (Rundle Downwind, Courtice Downwind & Crosswind), a *t-test* was applied to determine if the measured concentrations during those conditions were statistically significantly different ($p < 0.05$) between the Courtice and Rundle Road concentrations.

3.4 Regional Emissions

Reported industrial emissions data were obtained from the Canadian National Pollutant Release Inventory, including emissions reporting data required for facilities that meet published reporting requirements under the Canadian Environmental Protection Act. The DYEC is required to report air releases of 15 compounds since 2015. The data examined included 2015 to 2021 emissions data for Ammonia, Arsenic, Cadmium, Cobalt, Copper, Dioxins and Furans - Total, Hexachlorobenzene, Lead, Manganese, Mercury, Nitrogen Oxides, Phosphorus, PM_{10}, $PM_{2.5}$, and Zinc. All emitters that were in Durham and York regions were selected for analysis. In addition, emissions by facility were mapped for Durham and York regions.

3.5 Ambient Measurements During Non-Operation Periods

Each year the two boilers are turned off for maintenance at the DYEC, which has occurred independently or concurrently. During concurrent shutdowns, it allows analyzing the air pollution concentration data to identify background differences between the Courtice and Rundle Road without emissions from the DYEC. The shutdown periods are provided in Table 3.2. In addition, mean concentrations for NO_X, SO_2 and $PM_{2.5}$ during the seven overlapping periods were calculated and compared to explore the baseline variation between the Rundle Road and Courtice air monitoring locations when the DYEC is not operational.

Table 3.2 Offline periods for DYEC boilers.

Year	Boiler 1	Boiler 2	Overlapping Shutdowns
2016	Feb 21 – Mar 7	Mar 12 – Mar 28 Sept 30 – Oct 6	
2017	Feb 6 – Mar 20 Aug 13 – Aug 20	Jan 28 – Mar 16 Aug 21 – Aug 28	Feb 6 – Mar 16
2018	Mar 11 – Mar 29 Sept 24 – Sept 29	Feb 11 – Mar 1 Oct 9 – Oct 19	
2019	Mar 17 – Apr 2 Sept 20 – Sept 30	Mar 18 – Apr 3 Sept 21 – Oct 1	Mar 18 – Apr 2 Sept 21 – Sept 30
2020	Mar 1 – Mar 14 Sept 26 – Oct 5	Feb 29 – Mar 13 Sept 27 – Oct 10	Mar 1 – Mar 13 Sept 27 – Oct 5
2021	Feb 28 – Mar 14 Sept 25 – Oct 7	Mar 2 – Mar 15 Sept 26 – Oct 6	Mar 2 – Mar 14 Sept 26 – Oct 6

4 RESULTS

4.1 WIND DIRECTION ANALYSIS RESULTS

Wind roses for the Courtice and Rundle Road monitors with data from January 1, 2016, until June 30, 2022, are presented in Figure 4.1. The wind data were hourly averages for wind speed and direction, totalling 56,952 hourly records. The Courtice data included 395 missing wind speed observations and 659 missing wind direction observations; in all cases, when wind speed data were missing, so were wind direction. The Rundle Road data included 1,408 missing wind speed observations and 3,773 missing wind direction observations; in all cases, when wind speed data were missing, so were wind direction. The data are audited by the Ministry of the Environment, Conservation and Parks and comply with data availability requirements.

In Figure 4.1, we observe for both stations that the dominant wind direction is from the west (northwest to the southwest), with Rundle Road showing a more dominant wind pattern from the west and southwest, which aligns with the data used in dispersion modelling to identify upwind and downwind air monitor locations. East winds dominate a secondary wind direction at both stations. The average wind speed was 3.3 m/s at Courtice and 2.6 m/s at Rundle Road, with maximum wind speeds of 19.2 m/s at Courtice and 14.0 m/s at Rundle. The higher wind speeds at Courtice are expected as the wind passes over Lake Ontario, which has a low surface roughness; as the wind reaches land, the surface roughness increases (e.g. due to vegetation and buildings), creating more mechanical turbulence and decreasing wind speed.

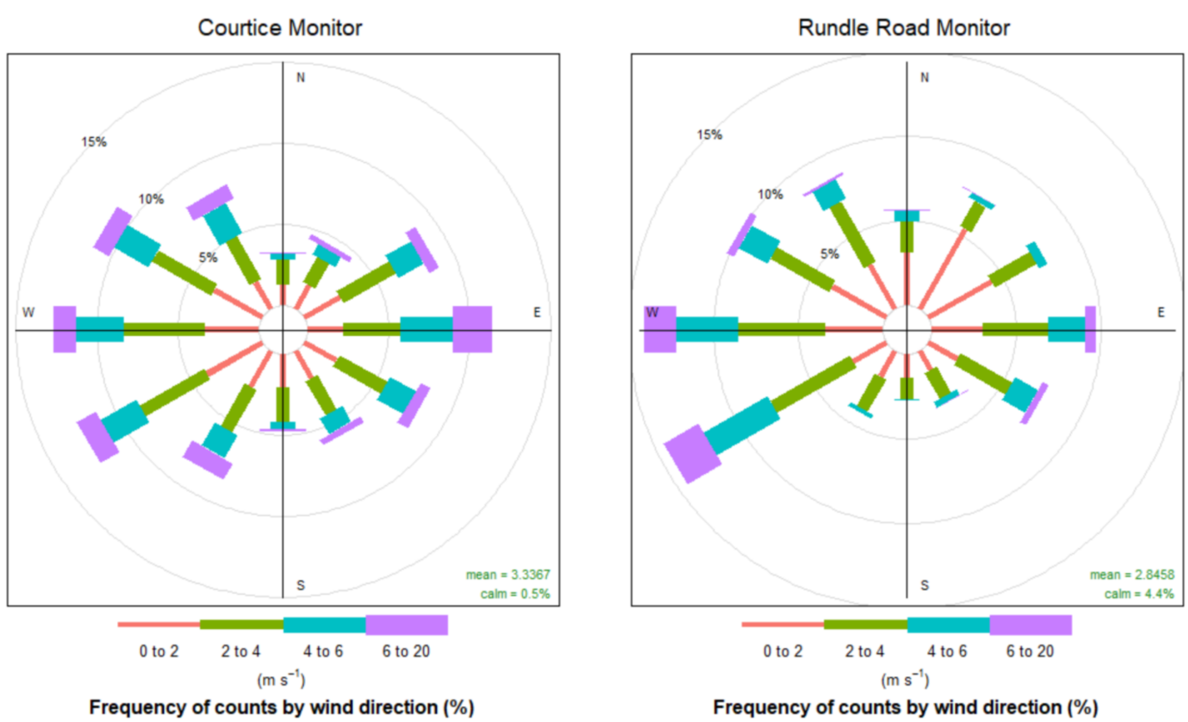

Figure 4.1 Wind roses for Courtice and Rundle Road Monitor for January 1, 2016, to June 30, 2022.

4.2 DISCRETE MONITORING AMBIENT DATA ANALYSIS

The number of monitored days varied for the three pollutant classes because of different sampling schedules. Valid data were available at both ambient air monitoring locations for TSP for 330 days, PAHs for 173 days and dioxins and furans for 94 days. Two PAH species were not measured during all sampling dates, which included Fluorene (67 days), and the combined total of Dibenzo(a,c) anthracene + Picene (68 days) and were excluded from the Total PAH value (sum of all other PAHs). Thorium (Th) speciation of the TSP was only included in 70 samples and excluded from the analysis. The mean concentrations of each pollutant by air monitor are presented in Appendix A.

Average concentrations separated by wind conditions are in Appendix B, which include when the Rundle Road downwind, Rundle Road upwind, and crosswind condition. The table includes the count of the number of sample days by wind condition, *t*-statistic and *p-value* for each *t-test*. No pollutants were significantly higher when the Courtice monitor was downwind. However, eighteen pollutants were significantly higher at the Rundle Road monitor when it was downwind compared to the Courtice monitor, which are included in Table 4.1.

Table 4.1 Cases when Rundle Road (Downwind) was significantly higher than Courtice

Class	Pollutant	Courtice (Upwind)	Rundle (Downwind)	*N*	*t*	*p*
PAH	1-methylnaphthalene	5.6745	9.3537	38	-2.26	0.03
PAH	2-methylnaphthalene	9.7107	17.1487	38	-2.35	0.02
PAH	Acenaphthene	3.4952	8.9259	38	-2.65	0.01
PAH	Anthracene	0.1532	0.5164	38	-3.12	<0.01
PAH	Biphenyl	2.8577	5.011	38	-2.42	0.02
PAH	fluoranthene	0.794	2.3357	38	-3.47	<0.01
PAH	Phenanthrene	4.1318	11.7618	38	-3.27	<0.01
PAH	Pyrene	0.3472	1.0432	38	-3.7	<0.01
PAH	Total PAH	58.789	93.572	38	-2.31	0.02
TSP	Aluminum (Al)	0.1389	0.2144	76	-2.52	0.01
TSP	Copper (Cu)	0.028	0.0436	76	-2.9	<0.01
TSP	Iron (Fe)	0.403	0.5466	76	-2.3	0.02
TSP	Magnesium (Mg)	0.2318	0.3153	76	-2.09	0.04
TSP	Manganese (Mn)	0.0131	0.0177	76	-2.15	0.03
TSP	Molybdenum (Mo)	0.0012	0.0024	76	-2.28	0.03
TSP	Particulate (TSP)	26.8154	37.9709	76	-2.78	0.01
TSP	Strontium (Sr)	0.0048	0.008	76	-3.1	<0.01
TSP	Titanium (Ti)	0.0068	0.0103	76	-2.65	0.01

Units: PAH (ng/m^3); TSP (µg/m^3)

Examining the 18 statistically significant Rundle Road downwind elevated pollutants; ten were also significantly increased at Rundle Road relative to Courtice during crosswind conditions, which are included in Table 4.2.

Table 4.2 Pollutants significantly higher at Rundle Road during crosswind conditions for pollutants, which were significantly higher during Rundle downwind conditions.

Class	Pollutant	Courtice	Rundle	*N*	*t*	*p*
PAH	Anthracene	0.1755	0.4912	120	-3.43	<0.01
PAH	Fluoranthene	0.744	1.7009	120	-4.09	<0.01
PAH	Phenanthrene	4.2106	9.635	120	-2.55	0.01
PAH	Pyrene	0.3488	0.7867	120	-4.33	<0.01
TSP	Aluminum (Al)	0.1375	0.1742	216	-2.41	0.02
TSP	Copper (Cu)	0.026	0.0311	216	-2.33	0.02
TSP	Magnesium (Mg)	0.1925	0.2345	216	-2.32	0.02
TSP	Molybdenum (Mo)	0.001	0.0013	216	-2.95	<0.01
TSP	Particulate (TSP)	24.803	30.762	216	-2.85	<0.01
TSP	Strontium (Sr)	0.0049	0.007	216	-3.22	<0.01

Units: PAH (ng/m^3); TSP (µg/m^3)

Though not statistically significantly higher, the remaining eight pollutants demonstrated higher concentrations at Rundle Road during crosswind conditions; those values are presented in Table 4.3. Given the non-statistical significance, these pollutants should be relied upon less in any interpretations as it may be due to natural variability in the data.

Table 4.3 Pollutants higher at Rundle Road during crosswind conditions for pollutants, which were significantly higher during Rundle downwind conditions.

Class	Pollutant	Courtice	Rundle	*N*	*t*	*p*
PAH	1-methylnaphthalene	5.4272	8.5793	120	-1.48	0.14
PAH	2-methylnaphthalene	9.5086	16.1301	120	-1.47	0.14
PAH	Acenaphthene	3.8539	8.7218	120	-1.74	0.08
PAH	Biphenyl	2.6843	4.1689	120	-1.32	0.19
PAH	Total PAH	65.4708	92.5924	120	-1.17	0.24
TSP	Iron (Fe)	0.4003	0.4176	216	-0.49	0.63
TSP	Manganese (Mn)	0.0114	0.012	216	-0.63	0.53
TSP	Titanium (Ti)	0.0071	0.0084	216	-1.76	0.08

Units: PAH (ng/m^3); TSP (µg/m^3)

4.3 Ambient Air Monitoring with Emissions Monitoring

The ambient concentrations during Rundle Road downwind conditions for NO_X were 7.5 ppb at Rundle Road and 7.1 ppb at the Courtice monitor, which indicates a slight increase in NO_X ambient conditions during Rundle Road downwind conditions. The linear regression model indicated a non-statistically significant relationship between the downwind difference and the DYEC CEMS data: coefficient of 0.1401 (t = 1.899, p = 0.06). The model's adjusted R^2 was insignificant at 0.01 (p = 0.06, F: 3.604, degrees of freedom: 399). The NO_X model demonstrates no relationship between emission and downwind pollution concentration intensification.

Sulphur dioxide ambient concentrations during Rundle Road downwind conditions demonstrated higher concentrations at the Courtice monitor (1.80 ppb) compared to the downwind Rundle Road monitor (0.65 ppb). The statistical modelling indicated no statistically significant relationship between DYEC emissions and the difference in ambient concentrations with a negative coefficient of -0.074 (p = 0.08). The model's adjusted R^2 was insignificant at <0.01 (p = 0.08, F: 2.987, degrees of freedom: 398). The SO_2 model demonstrates no relationships between emission and downwind concentration intensification.

4.4 Ambient Air Monitoring Data Without Emissions Monitoring

Particulate matter 2.5 microns or smaller in aerodynamic diameter concentrations did not demonstrate a significant difference during the three wind conditions, presented in Table 4.4.

Table 4.4 $PM_{2.5}$ concentrations separated by wind conditions with *t-test values*.

	Mean Concentration (µg/m³)				
Wind Condition	**Courtice**	**Rundle Road**	**t**	**df**	**p**
Rundle Downwind	8.0	8.0	-0.18	1005	0.86
Courtice Downwind	6.6	7.0	-0.77	330	0.44
Crosswind	5.8	5.9	-0.09	3165	0.93

4.5 Regional Emissions

Regional emissions will impact Durham and York Regions' airshed. Comparing the emission quantities from the DYEC with NPRI-reported regional emissions (NPRI Emissions in Durham and York Regions) contextualizes the scale of emissions. The emissions for each pollutant reported by the DYEC are compared against the regional outputs between 2015 and 2021, provided in Table 4.5. The DYEC emits 3.6 percent or less of total regional emissions for each pollutant reported to the NPRI. Ten reported pollutants represent less than one percent of regional emissions from the DYEC. Maps highlighting the percentage of regional emissions by location for each pollutant listed in Table 4.5 are available in Appendix C.

4.6 Ambient Concentrations During Dual Boiler Shutdowns

When both boilers are offline, the DYEC does not generate combustion-related emissions. During the boiler shutdowns, $PM_{2.5}$ concentrations were similar, 5.5 µg/m³ at Courtice and 5.9 µg/m³ at Rundle Road. NO_X and SO_2 concentrations were higher at the Courtice air monitor (NO_X = 7.4 ppb; SO_2 = 2.0) compared to the Rundle Road air monitor (NO_X = 4.8 ppb; SO_2 = 0.3). We observe a 7% difference for $PM_{2.5}$, a 43% difference for NO_X and a 148% difference for SO_2. In terms of the air pollution units, we observe differences of < 1 µg/m³ for $PM_{2.5}$, 2.6 ppb for NO_X and 1.7 ppb for SO_2.

Table 4.5 Regional Emissions of DYEC Reported Pollutants between 2015 and 2021

Pollutant	Units	Emissions DYEC	Emissions Regional	DYEC Contribution (%)
Ammonia	tonnes	39.187	3777.381	1.037
Arsenic	kg	0.27	42.43	0.64
Cadmium	kg	0.67	195.83	0.34
Cobalt	kg	0.43	31.83	1.35
Copper	tonnes	0.0131	0.9686	1.35
Dioxins and furans - Total	g TEQ	0.1904	8.8316	2.16
Hexachlorobenzene	grams	Zero	3451.24	Zero
Lead	kg	2.96	3558.90	0.08
Manganese	tonnes	0.0095	115.0316	0.0082
Mercury	kg	2.24	1192.57	0.19
Nitrogen oxides	tonnes	975.70	27346.03	3.57
Phosphorus	tonnes	Zero	0.57	Zero
PM_{10}	tonnes	2.0990	3644.5190	0.058
$PM_{2.5}$	tonnes	1.5960	1530.6871	0.104
Zinc	tonnes	0.0311	54.6885	0.057

5 DISCUSSION

Evaluating a single source's impact on an airshed is challenging due to the multiple natural and anthropogenic sources within the airshed. In addition, ambient air pollution is affected by regional and transboundary air pollution and unravelling those nuances is not always possible. This report has assessed the DYECs impact on local air quality by analyzing ambient air pollution measurements from two monitoring stations implemented to monitor air pollution from the DYEC. The ambient air monitoring design for the DYEC leveraged the Rundle Road air monitor as predominately downwind from the DYEC and the Courtice location to serve as an upwind location to provide background air pollution concentrations.

Examining the wind direction and speed data measured at both Courtice and Rundle Road between Jan 1, 2016, and June 30, 2022, confirmed that the anticipated primary wind pattern was from the west. The average wind speed was lower at the Rundle Road Monitor, likely due to friction from increased surface roughness as the air masses transition from passing over water (low friction) to increased turbulence from the natural and anthropogenic features on land. The reduced wind speed would indicate a lower ability for pollutants to disperse at the Rundle Road monitor. Our analysis considered three wind patterns in most of the analysis that included periods when each monitor was in a relative downwind position to the other and then crosswinds. A 45-degree window was selected to define downwind conditions, which was selected to find the smallest window possible while ensuring enough samples for our analysis. The primary limiting factor was the discrete samples for dioxins and furans, which are the least frequently sampled.

5.1 Dioxins and Furans

Polychlorinated dibenzo-p-dioxins (PCDDs) and dibenzo-furans (PCDFs) exposure has been associated with health effects that include skin disorders, liver problems, impacts to developing nervous systems, certain types of cancers, and impairment of the endocrine system, immune system and reproductive functions. The risk of the health effects is dose and exposure dependent; however, minimizing exposure to PCDD/PCDFs is clear. Dioxins and furans are generated during combustion (Mukherjee et al., 2016; Peng et al., 2020).

Dioxin and furan sampling occurred with discrete sampling for 94 days. Seventeen compounds are analyzed in each sample, which can be analyzed individually, or toxic equivalency (TEQ) values can be calculated. To determine the TEQ, toxic equivalency factors (TEF) are applied that provide a relative factor for each chemical with the most toxic form of dioxin (2,3,7,8-TCDD; TEF = 1). Then, each compound's concentration is multiplied by its TEF, and the sum of the 17 compounds can be compared with the MECP Ambient Air Quality Criteria, which is 0.1 pg TEQ/m^3. The dioxins and furans AAQC was established based on human health (Ontario Ministry of the Environment, Conservation and Parks, 2020).

The mean TEQ/m^3 values across all samples for both Rundle Road (0.0157) and Courtice (0.0127) are below the MECP Ambient Air Quality Criteria (AAQC), which indicates that ambient air is between 12.7% and 15.7% of the MECP AAQC. In addition, during downwind conditions for both air monitors, no statistically significant increase occurred between the upwind and downwind air monitors. This suggests that the DYEC was not emitting concentrations to cause a notable change in air pollution concentrations from the background conditions.

The DYEC is a minor contributor to Durham and York Regions' dioxin and furan industrial emissions. Data from the NPRI between 2015 (the start of DYEC reporting) and 2021 (most recent data available), the DYEC contributed only 2.2% of the total emissions in the region. However, to the west of the DYEC, five other locations emit these compounds, with two sites releasing between 25-50% of total regional emissions. These sites are likely why Courtice and Rundle Road during westerly winds (Rundle Road downwind) demonstrate their highest concentrations compared to concentrations during the other two wind patterns.

The data analysis in this report does not suggest that DYEC emissions likely impact local concentrations of dioxins and furans. The concentrations are below the Ontario AAQCs, which is also a positive given the additional sources in the airshed.

5.2 PAHs

Polycyclic aromatic hydrocarbons (PAHs) are formed during incomplete combustion, including burning coal, oil, gas, wood, and garbage (Abdel-Shafy and Mansour, 2016). PAH effects include toxicity, mutagenic properties (causing a mutation in DNA), and they are known carcinogens. In the atmosphere, PAHs may occur as a gas (smaller compounds) or bound to particulate matter (larger compounds). Many PAH compounds exist, but most regulations and reporting focus on between 14 and 20 compounds (Abdel-Shafy and Mansour, 2016). The Ambient Air Quality Monitoring Plan for the DYEC includes monitoring 25 PAHs and then summing those to obtain a total PAH concentration. Unlike dioxins and furans, no toxic equivalency factors or similar adjustments are applied, and the values are summed across all concentrations evenly. Six of the PAHs have MECP criteria to compare measured concentrations against, which include 1-Methylnaphthalene (12,000 ng/m^3), 2-Methylnaphthalene (10,000 ng/m^3), acenaphthylene (3,500 ng/m^3), anthracene (200 ng/m^3), benzo(a)pyrene (Ambient Air Quality Criteria: 0.05 ng/m^3; O. Reg. 419/05 Schedule Upper Risk Thresholds: 5 ng/m^3) and naphthalene (22,500 ng/m^3). Within Ontario, benzo(a)pyrene has been selected as a surrogate for all PAHs during monitoring, and the AAQC was determined based on the carcinogenicity of PAH exposure (Standards Development Branch Ontario Ministry of the Environment, 2011). The benzo(a)pyrene AAQC was developed to be protective of human health (Ontario Ministry of the Environment, Conservation and Parks, 2020).

The mean concentrations for all monitoring at both Courtice and Rundle Road are far below the MECP criteria applied to the DYEC monitoring program for 1-Methylnaphthalene (Courtice: 5.5 ng/m^3 and Rundle Road: 8.5 ng/m^3), 2-Methylnaphthalene (Courtice: 9.7 ng/m^3 and Rundle Road: 15.9 ng/m^3), Acenaphthylene (Courtice: 0.2 ng/m^3 and Rundle Road: 0.3 ng/m^3), Anthracene (Courtice: 0.2 ng/m^3 and Rundle Road: 0.5 ng/m^3), and Naphthalene (Courtice: 24 ng/m^3 and Rundle Road: 28 ng/m^3). Benzo(a)pyrene concentrations are below the AAQC with concentrations of 0.03 ng/m^3 at Courtice and 0.04 ng/m^3 measured at Rundle Road.

Benzo(a)pyrene was not statistically significantly higher at the downwind air monitor compared to upwind concentrations when either Courtice or Rundle Road monitors were downwind. However, concentrations were consistently higher at the Rundle Road air monitor regardless of the wind direction. The difference between the monitoring stations was the highest during crosswind conditions (Rundle Road +0.0177 ng/m^3), followed by Rundle Road being upwind (+0.0144 ng/m^3), and Rundle Road showed the smallest increase when it was downwind of the DYEC (+0.0092 ng/m^3). Examining concentrations during upwind conditions indicate that the area's background conditions range from 0.0315 ng/m^3 (Courtice Upwind) to 0.0521 ng/m^3 (Rundle Downwind).

The analyzed ambient air monitoring data does not suggest that the DYEC impacts PAH ambient air quality.

5.3 TOTAL SUSPENDED PARTICULATE

Total suspended particulate measures all particles in the air, including particulate matter size fractions of PM_{10} and $PM_{2.5}$. Total suspended particulate is measured as a mass per volume of air, where most of the mass is made up of larger particles, which would deposit out of the atmosphere quicker than smaller particles. This rapid deposition means TSP is a good indicator of local effects. The body typically filters the larger particles in the upper respiratory tract, whereas smaller particles, such as $PM_{2.5}$, can travel deeper into the body. The MECP Ambient Air Quality Criteria for TSP is 120 $\mu g/m^3$ for 24-hour samples and 60 $\mu g/m^3$ for annual concentrations. Because TSP is composed of many types of particles, chemical species are often identified within the sample (speciation). Ambient air monitoring for the DYEC quantifies 29 metals in TSP.

Average concentrations measured at both the Courtice (25 $\mu g/m^3$) and Rundle Road (32 $\mu g/m^3$) air monitors are below the MECP 24-hour and Annual Air Quality Criteria, as well all metals species analyzed with MECP Criteria demonstrate concentrations below the criteria at both Courtice and Rundle Road.

Downwind TSP concentrations at the Rundle Road air monitor are statistically significantly higher than at Courtice; however, like PAHs, TSP is higher at Rundle Road during all wind conditions (statistically significant during crosswinds). Eight metals species were higher (statistically significant) at the Rundle Road monitor when it was downwind compared to the Courtice monitor; however, only three were not significantly higher at Rundle Road during crosswind conditions (Iron, Manganese and Titanium). The DYEC reports manganese emissions to Canada's National Pollutant Release Inventory; within Durham and York regions, the DYEC emitted <0.001% of emissions between 2015 and 2021.

Overall, measured TSP concentrations are well below the Ontario AAQC. The data and analysis do not suggest any significant patterns of increased concentrations in TSP or subsets of metal species due to emissions from the DYEC. However, the consistently higher concentrations at the Rundle Road air monitor suggest a local source impacting TSP air pollution concentrations may be present.

5.4 NITROGEN OXIDES

Two measures were available for NO_X: ambient air monitoring and continuous emission monitoring. Long-term concentrations at Rundle Road (7.5 ppb) are similar to those at Courtice (7.1 ppb), which is a smaller difference than the difference in concentrations observed between the two monitors when the DYEC boilers were offline (2.6 ppb difference). In addition, the analysis explored the relationship between emission concentrations and the difference between upwind and downwind concentrations at Rundle Road relative to Courtice. No relationship existed between emissions and the difference in ambient air downwind concentrations.

The analysis does not indicate an impact from the DYEC on ambient air pollution concentrations within the airshed. Additionally, mapping the NPRI emission sources identifies the presence of additional local point sources of NO_X.

5.5 SULPHUR DIOXIDE

The same measurement data were available for SO_2 as NO_X. As with NO_X, our modelling of measured emissions compared with differences in ambient measurements did not demonstrate any relationship. However, SO_2 concentrations are much higher at the Courtice monitor when it is upwind of the Rundle Road air monitor, which suggests there may be a nearby emission source. Additionally, Courtice concentrations were higher than Rundle Road when the DYEC boilers were offline. If a local SO_2 air pollution source is present, the concentrations are diluted by dispersion in the short distance to the Rundle Road air monitor.

None of the SO_2 analyses indicated an impact from the DYEC emissions on local SO_2 concentrations. However, the evidence suggests a local source exists near the Courtice air monitor.

5.6 PARTICULATE MATTER

The DYEC reports 0.1% of industrial emissions for $PM_{2.5}$ in Durham and York Regions from the NPRI. The concentrations measured at the two monitoring stations did not differ meaningfully. Both monitoring locations reported the same 8.0 µg/m3 concentration during Rundle Road downwind conditions. NPRI emission mapping of industrial sources demonstrates many sources, with no single source representing more than 25% of emissions. The analysis does not suggest any impact from the DYEC.

6 CONCLUSIONS

The analysis of ambient air pollution data for PCDD/PCDFs, PAHs, TSP, NO_X, SO_2 and $PM_{2.5}$ indicates that the DYEC is not impacting the local airshed. The region has multiple known stressors, such as those high emitters identified in the NPRI data. After reviewing the ambient monitoring data, one primary concern arose, which included elevated concentrations of benzo(a)pyrene that have included individual samples exceeding Ontario AAQC during the period evaluated. These elevated concentrations do not seem influenced by DYEC emission, and while they may be elevated at Rundle Road, it is not possible to infer the expected concentrations at residential locations within the region. Future exceedances should be individually evaluated to examine the relative wind directions during the exceedance and identify baseline conditions using the upwind monitor; however, the analysis indicates that local and regional sources influence the ambient air monitors, both Courtice and Rundle Road.

Overall, it is concluded that the DYEC's Air Emissions Monitoring Plan effectively controls emissions so that it does not significantly contribute to air pollution in the local airshed.

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Appendix A: Long-term Mean Concentration of Air Pollutants

Pollutant (WHO2005 TEFs)	Courtice Monitor	Rundle Monitor	MECP Criteria
Dioxins and Furans (pg/m^3)			
1,2,3,4,6,7,8-HeptaCDD (EF = 0.01)	0.047947	0.060058	-
1,2,3,4,6,7,8-HeptaCDF (EF = 0.01)	0.013002	0.010458	-
1,2,3,4,7,8-HexaCDD (EF = 0.1)	0.002864	0.003478	-
1,2,3,4,7,8-HexaCDF (EF = 0.1)	0.004946	0.004445	-
1,2,3,4,7,8,9-HeptaCDF (EF = 0.01)	0.003752	0.003403	-
1,2,3,6,7,8-HexaCDD (EF = 0.1)	0.004179	0.004727	-
1,2,3,6,7,8-HexaCDF (EF = 0.1)	0.003228	0.003188	-
1,2,3,7,8-PentaCDD (EF = 1)	0.003295	0.004075	-
1,2,3,7,8-PentaCDF (EF = 0.03)	0.002948	0.002922	-
1,2,3,7,8,9-HexaCDD (EF = 0.1)	0.005281	0.006545	-
1,2,3,7,8,9-HexaCDF (EF = 0.1)	0.002773	0.002978	-
2,3,4,6,7,8-HexaCDF (EF = 0.1)	0.003525	0.003544	-
2,3,4,7,8-PentaCDF (EF = 0.3)	0.003792	0.004108	-
2,3,7,8-TetraCDD (EF = 1)	0.003008	0.003083	-
2,3,7,8-TetraCDF (EF = 0.1)	0.005146	0.004919	-
OctaCDD (EF = 0.0003)	0.160438	0.223894	-
OctaCDF (EF = 0.0003)	0.013056	0.011172	-
Total Toxic Equivalency	0.0127	0.0157	0.1
Polycyclic Aromatic Hydrocarbons (ng/m^3)			
1-methylnaphthalene	5.513639	8.51748	12000
2-methylnaphthalene	9.690533	15.89989	10000
Acenaphthene	3.77011	8.348541	-
Acenaphthylene	0.177239	0.243071	3500
Anthracene	0.17102	0.477141	200
Benzo(a)anthracene	0.04945	0.058863	-
Benzo(a)fluorene	0.097637	0.118325	-
Benzo(a)pyrene	0.028554	0.043789	0.05
Benzo(b)fluoranthene	0.070012	0.086179	-
Benzo(b)fluorene	8.36149	8.373876	-
Benzo(e)pyrene	0.097021	0.109319	-
Benzo(g,h,i)perylene	0.059328	0.071442	-
Benzo(k)fluoranthene	0.063267	0.0769	-
Biphenyl	2.734306	4.223189	-
Chrysene	0.084293	0.105784	-
Dibenz(a,h)anthracene	0.042405	0.045388	-
Fluoranthene	0.74818	1.800712	-
Indeno(1,2,3-cd)pyrene	0.058402	0.071871	-
Naphthalene	24.44774	27.66692	22500

O-terphenyl	0.083036	0.086836	-
Perylene	0.078419	0.084692	-
Phenanthrene	4.135605	9.767028	-
Pyrene	0.349923	0.828773	-
Tetralin	3.08E+00	3.40E+00	-
Total PAH	63.99649	90.50697	-
Total Suspended Particulate (μg/m^3)			
Aluminum (Al)	0.133826	0.1798	4.8
Antimony (Sb)	0.001836	0.001742	25
Arsenic (As)	0.001453	0.001927	0.3
Barium (Ba)	0.00748	0.007885	10
Beryllium (Be)	0.000162	0.000161	0.01
Bismuth (Bi)	0.00115	0.00114	-
Boron (B)	0.00687	0.006901	120
Cadmium (Cd)	0.000575	0.00056	0.025
Chromium (Cr)	0.002666	0.002683	0.5
Cobalt (Co)	0.000558	0.000562	0.1
Copper (Cu)	0.026417	0.033667	50
Iron (Fe)	0.389	0.437037	4
Lead (Pb)	0.002349	0.002259	0.5
Magnesium (Mg)	1.96E-01	2.48E-01	-
Manganese (Mn)	0.011413	0.013066	0.4
Mercury (Hg)	1.16E-05	1.12E-05	2
Molybdenum (Mo)	1.03E-03	1.50E-03	120
Nickel (Ni)	1.15E-03	1.22E-03	0.2
Particulate (TSP)	24.70522	31.8486	120
Phosphorus (P)	0.229783	0.237141	-
Selenium (Se)	0.002758	0.002733	10
Silver (Ag)	0.000823	0.000815	1
Strontium (Sr)	0.004752	0.007102	120
Thallium (Tl)	0.001391	0.001373	-
Tin (Sn)	0.00186	0.002086	10
Titanium (Ti)	0.006859	0.008669	120
Uranium (Ur)	7.80E-05	7.76E-05	1.5
Vanadium (V)	0.00166	0.00181	2
Zinc (Zn)	0.033215	0.02916	120
Zirconium (Zr)	0.00106	0.001036	20

Appendix B: Statistical test values comparing upwind, downwind and crosswind air pollution concentrations.

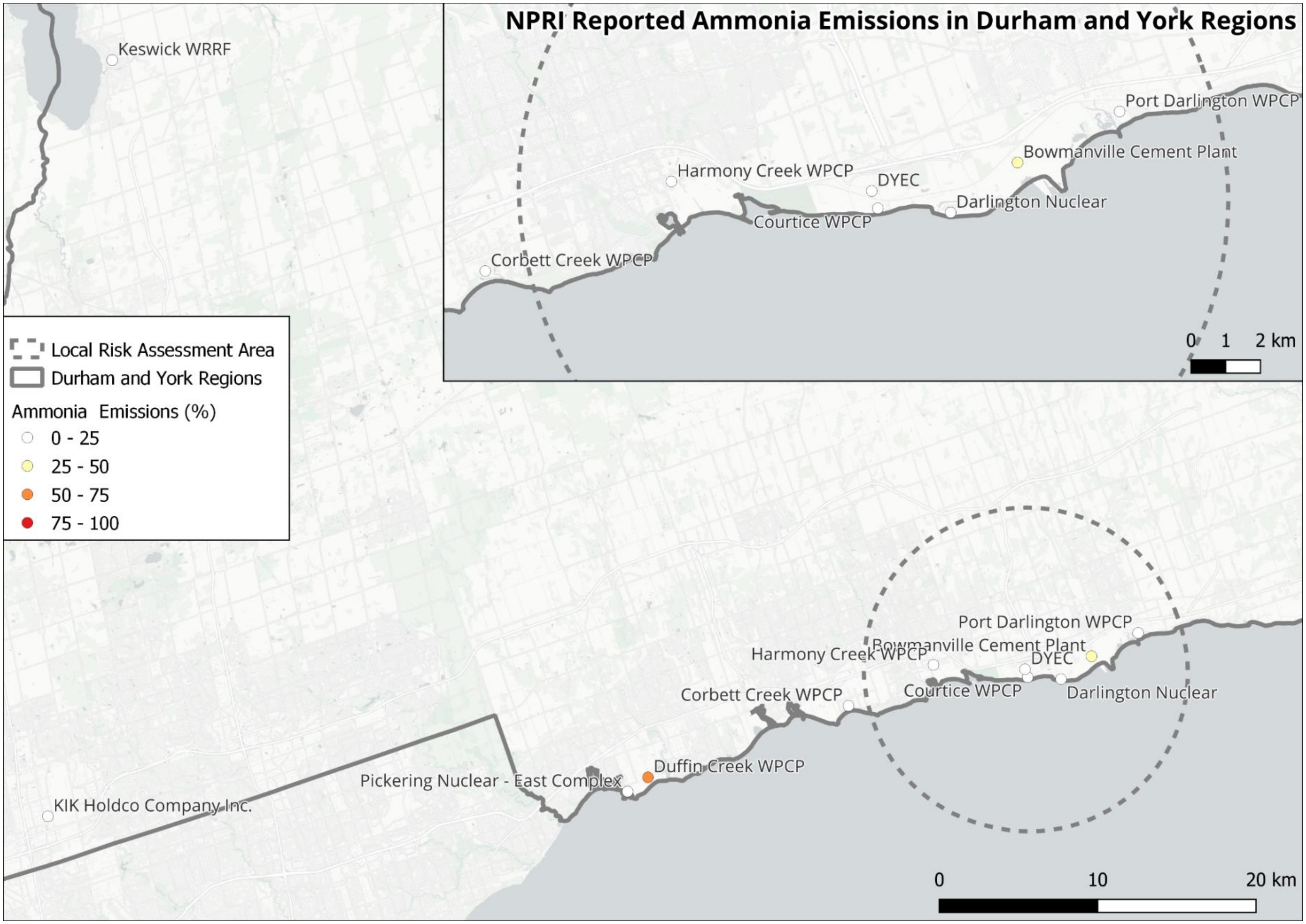
Red cells indicate statistically significant values.

	Rundle Road Downwind					Courtice Downwind					Crosswind				
Pollutant	Courtice	Rundle	*N*	*t*	*p*	Courtice	Rundle	*N*	*t*	*p*	Courtice	Rundle	*N*	*t*	*p*
Dioxins and Furans (pg/m^3)															
1,2,3,4,6,7,8-HeptaCDD	0.0973	0.129	22	-0.33	0.75	0.0335	0.0306	6	0.13	0.9	0.0339	0.0412	63	-0.76	0.45
1,2,3,4,6,7,8-HeptaCDF	0.027	0.0226	22	0.2	0.85	0.0075	0.0035	6	1.31	0.23	0.0092	0.0073	63	0.58	0.56
1,2,3,4,7,8-HexaCDD	0.0042	0.006	22	-0.8	0.43	0.0037	0.0026	6	0.71	0.5	0.0024	0.0028	63	-0.81	0.42
1,2,3,4,7,8-HexaCDF	0.0104	0.0099	22	0.05	0.96	0.0029	0.0027	6	0.17	0.87	0.0035	0.0029	63	0.46	0.65
1,2,3,4,7,8,9-HeptaCDF	0.0071	0.0068	22	0.05	0.96	0.0042	0.0025	6	0.9	0.39	0.0027	0.0025	63	0.44	0.66
1,2,3,6,7,8-HexaCDD	0.007	0.0081	22	-0.23	0.82	0.0042	0.0028	6	0.75	0.47	0.0034	0.0039	63	-0.75	0.45
1,2,3,6,7,8-HexaCDF	0.006	0.0063	22	-0.05	0.96	0.0028	0.0023	6	0.42	0.69	0.0024	0.0023	63	0.2	0.84
1,2,3,7,8-PentaCDD	0.0039	0.0056	22	-1.17	0.25	0.004	0.0034	6	0.4	0.7	0.0031	0.0036	63	-0.94	0.35
1,2,3,7,8-PentaCDF	0.0048	0.0045	22	0.11	0.91	0.0048	0.0033	6	0.72	0.49	0.0023	0.0024	63	-0.38	0.7
1,2,3,7,8,9-HexaCDD	0.0096	0.0131	22	-0.41	0.68	0.0054	0.0026	6	1.17	0.28	0.004	0.0049	63	-0.82	0.42
1,2,3,7,8,9-HexaCDF	0.0037	0.0044	22	-0.57	0.57	0.0042	0.0032	6	0.54	0.6	0.0024	0.0026	63	-0.34	0.74
2,3,4,6,7,8-HexaCDF	0.0057	0.007	22	-0.29	0.77	0.0038	0.0029	6	0.59	0.57	0.0029	0.0025	63	0.48	0.64
2,3,4,7,8-PentaCDF	0.0068	0.008	22	-0.22	0.82	0.0048	0.0035	6	0.73	0.49	0.0028	0.003	63	-0.33	0.74
2,3,7,8-TetraCDD	0.0041	0.004	22	0.07	0.95	0.0032	0.0029	6	0.23	0.83	0.0027	0.0028	63	-0.46	0.65
2,3,7,8-TetraCDF	0.012	0.0112	22	0.07	0.94	0.0032	0.0028	6	0.34	0.74	0.0032	0.0031	63	0.07	0.94
OctaCDD	0.3387	0.4984	22	-0.39	0.7	0.1447	0.102	6	0.61	0.56	0.1062	0.149	63	-1.25	0.21
OctaCDF	0.0261	0.0247	22	0.07	0.94	0.0104	0.0038	6	1.56	0.16	0.0093	0.0076	63	0.5	0.62
Total Toxic Equivalency	0.0183	0.0252	22	-0.78	0.44	0.0134	0.0114	6	0.56	0.59	0.0111	0.0131	63	-1.19	0.24
Polycyclic Aromatic Hydrocarbons (ng/m^3)															
1-methylnaphthalene	5.6745	9.3537	38	-2.26	*0.03*	6.2659	8.9751	11	-0.81	0.43	5.4272	8.5793	120	-1.48	0.14
2-methylnaphthalene	9.7107	17.1487	38	-2.35	*0.02*	11.3871	17.0566	11	-0.85	0.41	9.5086	16.1301	120	-1.47	0.14
Acenaphthene	3.4952	8.9259	38	-2.65	*0.01*	4.119	9.2643	11	-1.13	0.28	3.8539	8.7218	120	-1.74	0.08
Acenaphthylene	0.1602	0.2369	38	-1.42	0.16	0.2876	0.3098	11	-0.21	0.83	0.1684	0.2413	120	-1.33	0.18
Anthracene	0.1532	0.5164	38	-3.12	*<0.01*	0.2383	0.6179	11	-1.42	0.18	0.1755	0.4912	120	-3.43	*<0.01*
Benzo(a)anthracene	0.0563	0.0635	38	-0.73	0.47	0.0648	0.0829	11	-0.85	0.41	0.0478	0.0575	120	-1.37	0.17

Benzo(a)fluorene	0.1131	0.129	38	-0.8	0.43	0.13	0.155	11	-0.84	0.41	0.0939	0.1163	120	-1.88	0.06
Benzo(a)pyrene	0.0315	0.0407	38	-1.19	0.24	0.0377	0.0521	11	-0.73	0.48	0.0272	0.0449	120	-1.67	0.1
Benzo(b)fluoranthene	0.0695	0.0911	38	-1.63	0.11	0.1164	0.1199	11	-0.07	0.94	0.0679	0.0841	120	-1.38	0.17
Benzo(b)fluorene	0.1066	0.118	38	-0.54	0.59	0.1222	0.1336	11	-0.34	0.74	12.011	12.0245	120	0	1
Benzo(e)pyrene	0.1102	0.1232	38	-0.64	0.52	0.1283	0.1328	11	-0.13	0.9	0.094	0.1075	120	-1.06	0.29
Benzo(g,h,i)perylene	0.0611	0.0708	38	-1.06	0.29	0.0713	0.0726	11	-0.08	0.94	0.0591	0.0733	120	-1.22	0.22
Benzo(k)fluoranthene	0.0646	0.0766	38	-1.33	0.19	0.0902	0.0753	11	0.49	0.63	0.0623	0.0797	120	-1.69	0.09
Biphenyl	2.8577	5.011	38	-2.42	*0.02*	3.3462	4.1444	11	-0.51	0.62	2.6843	4.1689	120	-1.32	0.19
Chrysene	0.0826	0.1004	38	-1.67	0.1	0.1019	0.1263	11	-0.66	0.52	0.0839	0.1068	120	-1.76	0.08
Dibenz(a,h)anthracene	0.0497	0.0533	38	-0.32	0.75	0.0586	0.0618	11	-0.17	0.87	0.0409	0.0441	120	-0.53	0.6
Fluoranthene	0.794	2.3357	38	-3.47	*<0.01*	0.9704	2.8397	11	-1.5	0.16	0.744	1.7009	120	-4.09	*<0.01*
Indeno(1,2,3-cd)pyrene	0.0628	0.0729	38	-1.08	0.29	0.0698	0.0887	11	-0.96	0.35	0.0573	0.0717	120	-1.4	0.16
Naphthalene	27.8317	33.2584	38	-1.03	0.3	32.0028	34.3206	11	-0.21	0.83	22.7916	26.0021	120	-1.01	0.31
O-terphenyl	0.0992	0.1054	38	-0.27	0.78	0.117	0.1228	11	-0.16	0.88	0.0789	0.0822	120	-0.28	0.78
Perylene	0.0945	0.1015	38	-0.3	0.77	0.1126	0.1215	11	-0.23	0.82	0.0753	0.0816	120	-0.53	0.6
Phenanthrene	4.1318	11.7618	38	-3.27	*<0.01*	4.971	12.8784	11	-1.37	0.2	4.2106	9.635	120	-2.55	*0.01*
Pyrene	0.3472	1.0432	38	-3.7	*<0.01*	0.5005	1.3031	11	-1.65	0.13	0.3488	0.7867	120	-4.33	*<0.01*
Tetralin	2.6309	2.8337	38	-0.23	0.82	8.3494	6.681	11	0.21	0.83	2.7584	3.1609	120	-0.38	0.71
Total PAH	58.789	93.572	38	-2.31	*0.02*	73.6591	99.7363	11	-0.76	0.46	65.4708	92.5924	120	-1.17	0.24
Total Suspended Particulate ($\mu g/m^3$)															
Aluminum (Al)	0.1389	0.2144	76	-2.52	*0.01*	0.1041	0.1463	27	-1.52	0.13	0.1375	0.1742	216	-2.41	*0.02*
Antimony (Sb)	0.0022	0.0021	76	0.49	0.62	0.0022	0.0021	27	0.15	0.88	0.0018	0.0017	216	0.62	0.54
Arsenic (As)	0.0015	0.0015	76	0.03	0.97	0.0016	0.0062	27	-0.98	0.34	0.0014	0.0016	216	-0.88	0.38
Barium (Ba)	0.0084	0.0098	76	-1.78	0.08	0.007	0.0076	27	-0.44	0.66	0.0074	0.0075	216	-0.21	0.84
Beryllium (Be)	2.00E-04	2.00E-04	76	0.04	0.97	2.00E-04	2.00E-04	27	0.01	0.99	2.00E-04	2.00E-04	216	0.07	0.94
Bismuth (Bi)	0.0013	0.0013	76	0.07	0.94	0.0013	0.0013	27	0.06	0.95	0.0011	0.0011	216	0.18	0.85
Boron (B)	0.0058	0.0059	76	-0.14	0.89	0.0056	0.0055	27	0.12	0.91	0.0072	0.0072	216	0.02	0.98
Cadmium (Cd)	6.00E-04	6.00E-04	76	0.52	0.61	6.00E-04	6.00E-04	27	0.22	0.83	6.00E-04	6.00E-04	216	0.34	0.74
Chromium (Cr)	0.0026	0.0029	76	-1.02	0.31	0.0031	0.0028	27	0.5	0.62	0.0027	0.0026	216	0.61	0.54

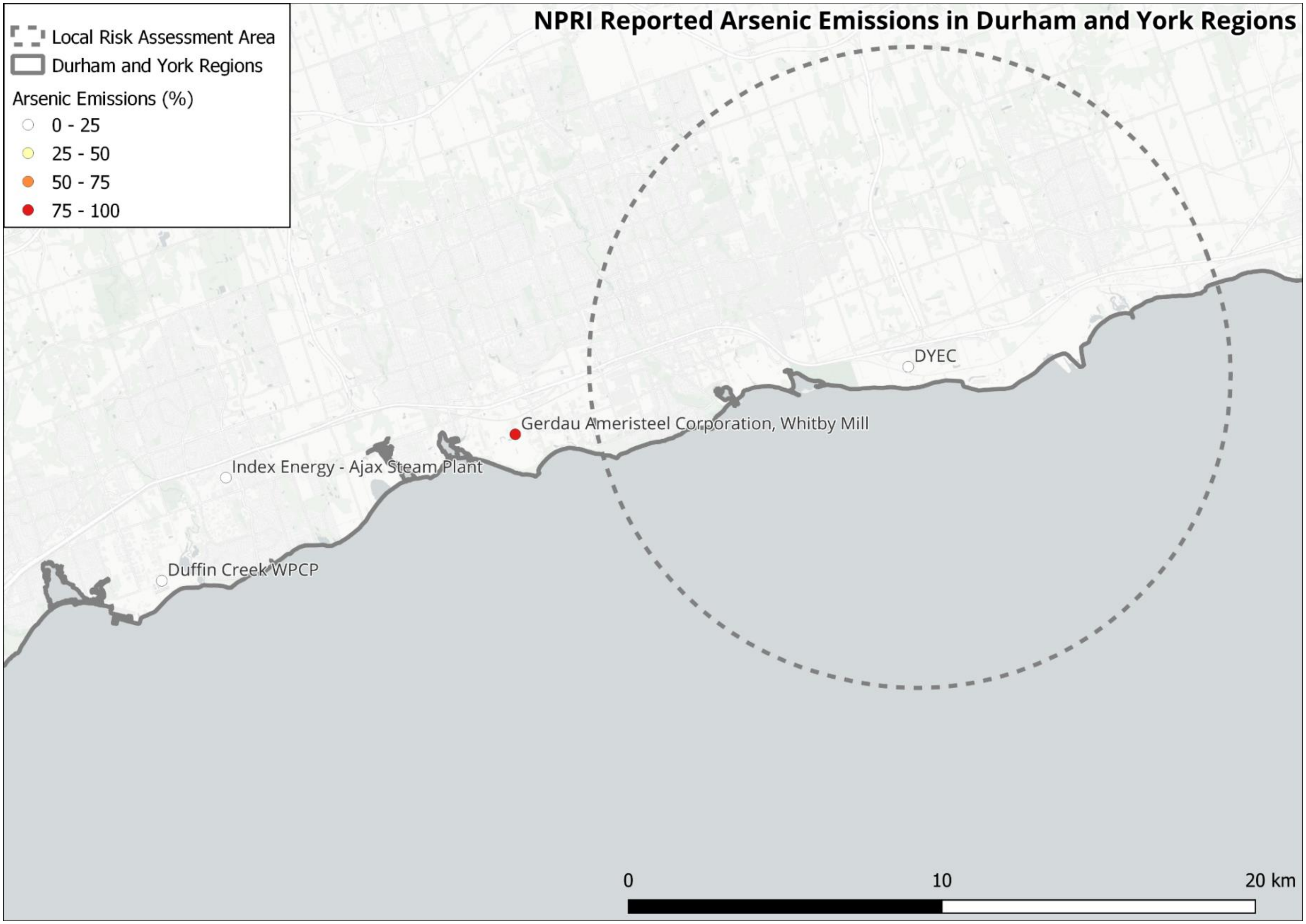
Cobalt (Co)	5.00E-04	5.00E-04	76	0.12	0.9	6.00E-04	5.00E-04	27	0.12	0.9	6.00E-04	6.00E-04	216	-0.26	0.8
Copper (Cu)	0.028	0.0436	76	-2.9	*<0.01*	0.0296	0.0292	27	0.06	0.95	0.026	0.0311	216	-2.33	*0.02*
Iron (Fe)	0.403	0.5466	76	-2.3	*0.02*	0.3322	0.3658	27	-0.51	0.61	0.4003	0.4176	216	-0.49	0.63
Lead (Pb)	0.0029	0.003	76	-0.31	0.76	0.0025	0.0023	27	0.37	0.71	0.0022	0.002	216	1.02	0.31
Magnesium (Mg)	0.2318	0.3153	76	-2.09	*0.04*	0.1594	0.2171	27	-1.47	0.15	0.1925	0.2345	216	-2.32	*0.02*
Manganese (Mn)	0.0131	0.0177	76	-2.15	*0.03*	0.0096	0.0113	27	-0.77	0.44	0.0114	0.012	216	-0.63	0.53
Mercury (Hg)	0	0	76	0.52	0.61	0	0	27	-0.43	0.67	0	0	216	0.58	0.56
Molybdenum (Mo)	0.0012	0.0024	76	-2.28	*0.03*	0.0011	0.0013	27	-0.67	0.51	0.001	0.0013	216	-2.95	*<0.01*
Nickel (Ni)	0.0012	0.0013	76	-0.85	0.4	0.0011	0.001	27	1.1	0.28	0.0012	0.0012	216	-0.8	0.42
Particulate (TSP)	26.8154	37.9709	76	-2.78	*0.01*	23.029	31.2536	27	-1.4	0.17	24.803	30.762	216	-2.85	*<0.01*
Phosphorus (P)	0.1762	0.159	76	0.4	0.69	0.1762	0.1789	27	-0.03	0.97	0.2564	0.2717	216	-0.4	0.69
Selenium (Se)	0.0027	0.0026	76	0.2	0.84	0.0028	0.0028	27	0.1	0.92	0.0028	0.0028	216	0.31	0.75
Silver (Ag)	9.00E-04	9.00E-04	76	0.05	0.96	0.001	0.001	27	0.04	0.96	8.00E-04	8.00E-04	216	0.16	0.88
Strontium (Sr)	0.0048	0.008	76	-3.1	*<0.01*	0.0045	0.0072	27	-1.78	0.08	0.0049	0.007	216	-3.22	*<0.01*
Thallium (Tl)	0.0017	0.0017	76	0.05	0.96	0.0018	0.0018	27	0.04	0.97	0.0013	0.0013	216	0.13	0.9
Tin (Sn)	0.0022	0.0026	76	-1.01	0.32	0.0022	0.0033	27	-0.97	0.34	0.0018	0.002	216	-0.86	0.39
Titanium (Ti)	0.0068	0.0103	76	-2.65	*0.01*	0.0056	0.0072	27	-1	0.32	0.0071	0.0084	216	-1.76	0.08
Uranium (Ur)	1.00E-04	1.00E-04	76	0.11	0.91	1.00E-04	1.00E-04	27	0.06	0.95	1.00E-04	1.00E-04	216	0.02	0.98
Vanadium (V)	0.0016	0.0016	76	-0.63	0.53	0.0017	0.0017	27	-0.01	0.99	0.0017	0.0019	216	-0.97	0.33
Zinc (Zn)	0.0382	0.0396	76	-0.39	0.7	0.0341	0.0286	27	0.9	0.37	0.0319	0.0262	216	2.37	*0.02*
Zirconium (Zr)	0.0011	0.0011	76	0.08	0.94	0.0012	0.0012	27	0.23	0.82	0.001	0.001	216	0.54	0.59

Appendix C.1: NPRI Ammonia Emissions Map

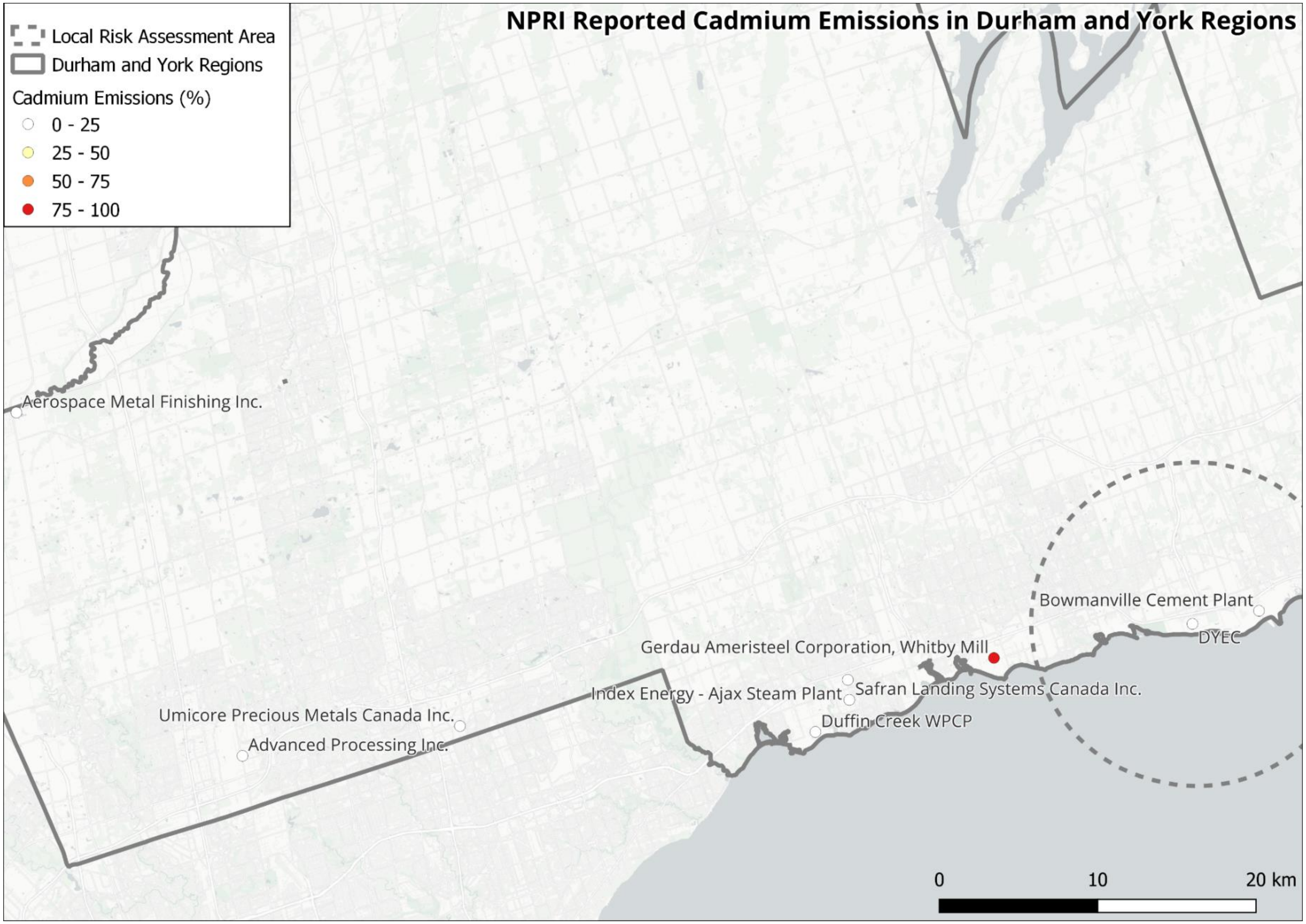


Attachment #1 to Report #2024-WR-5

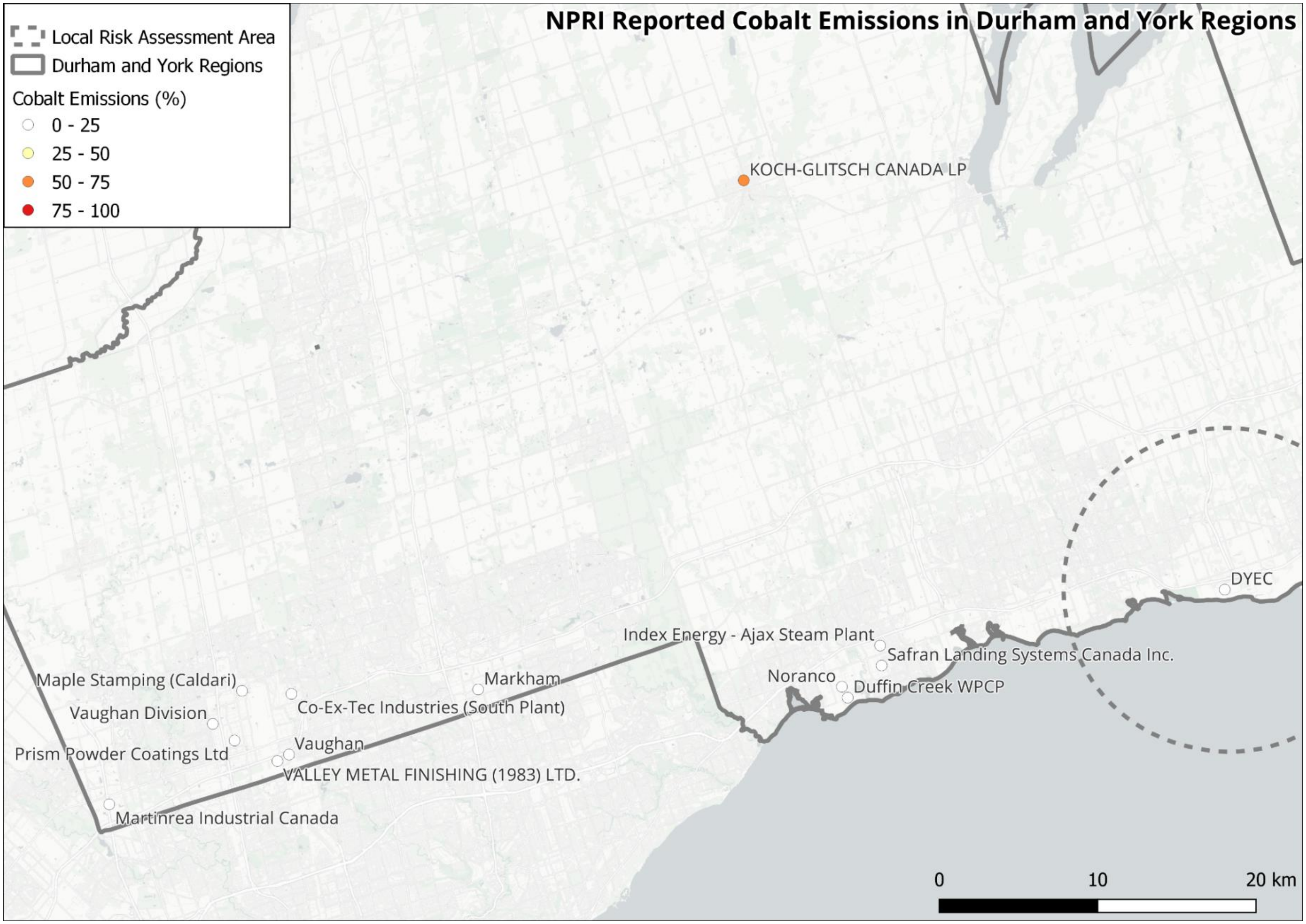
Appendix C.2: NPRI Arsenic Emission Map



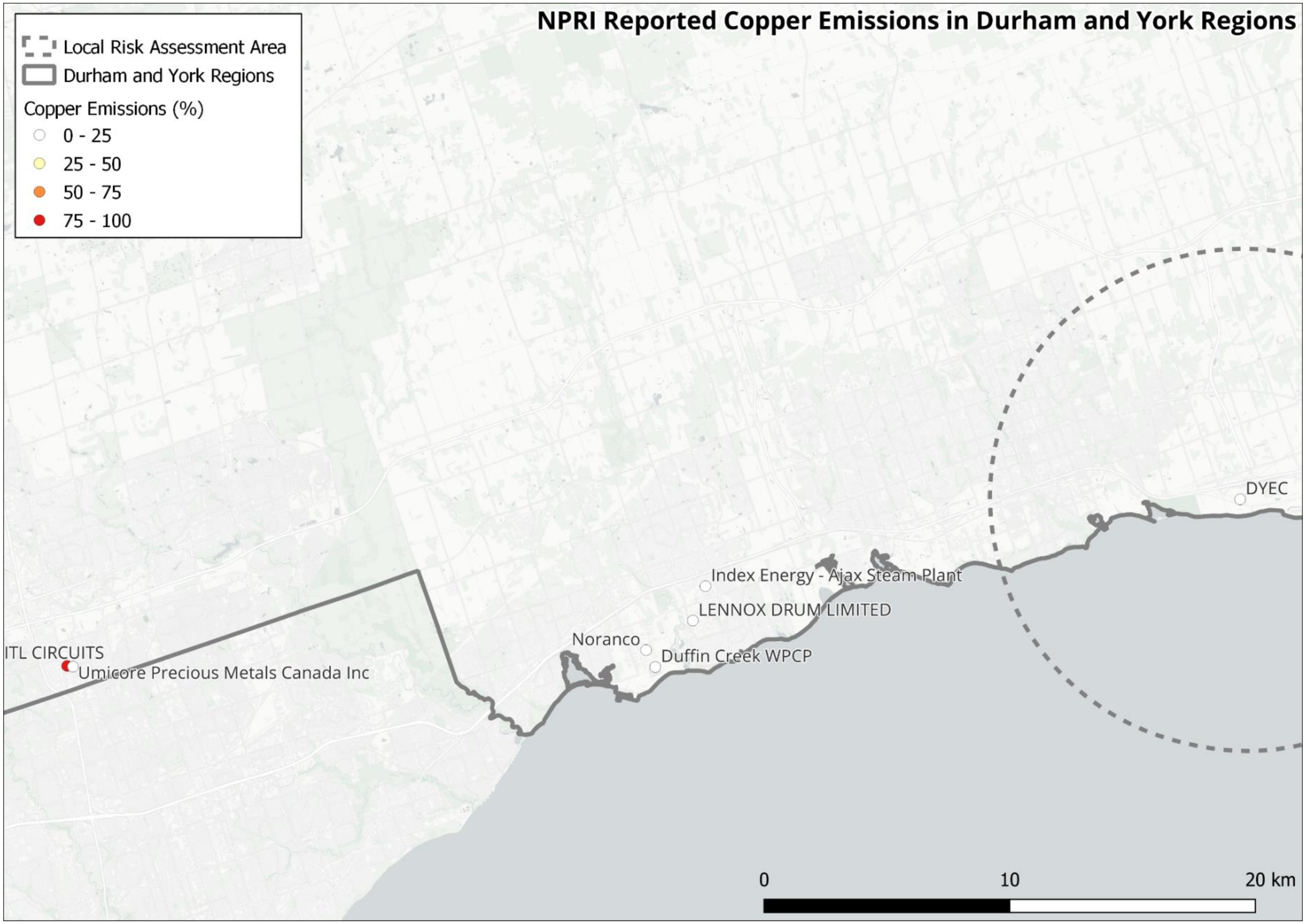
Appendix C.3: NPRI Cadmium Emissions Map



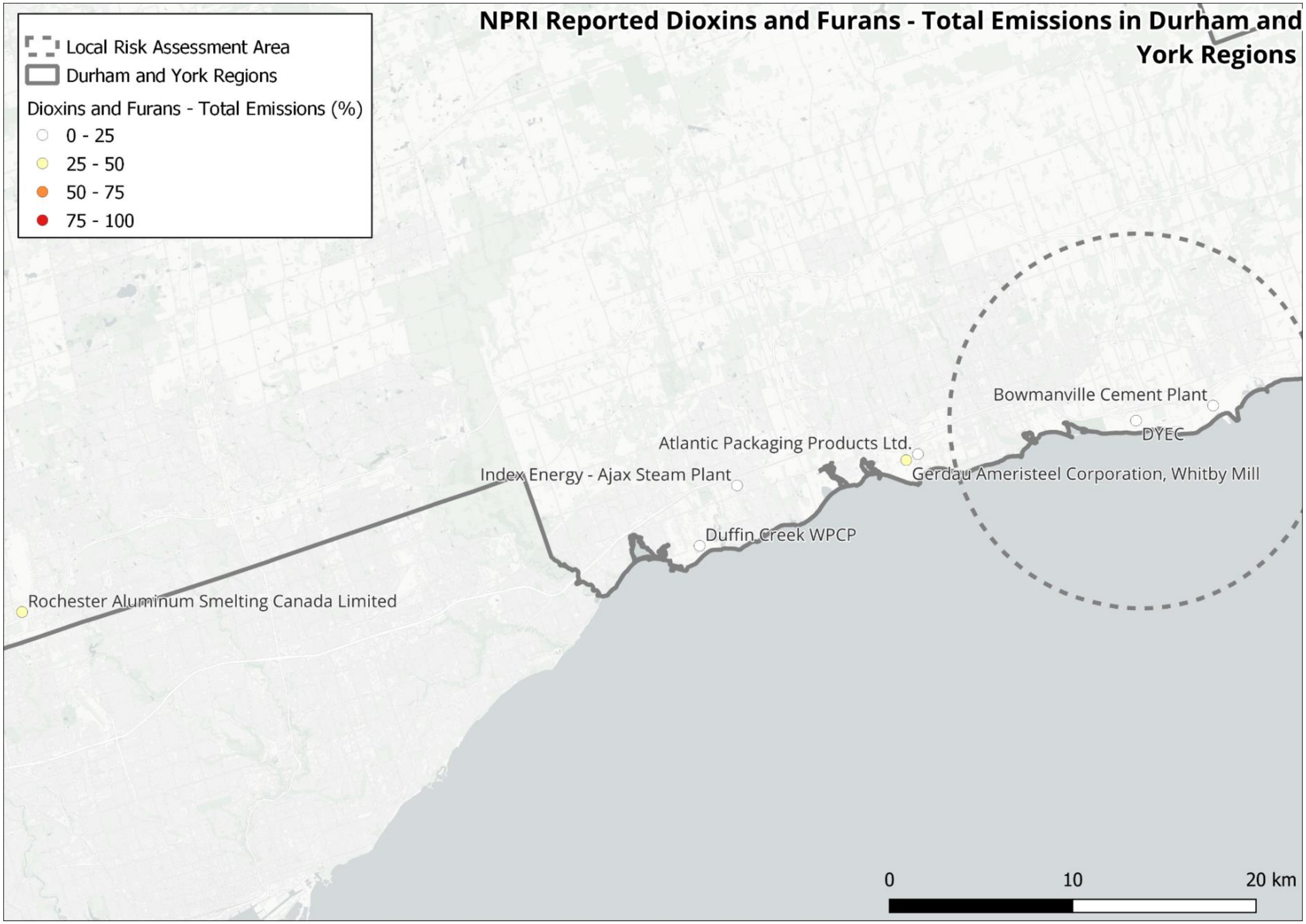
Appendix C.4: NPRI Cobalt Emissions Map



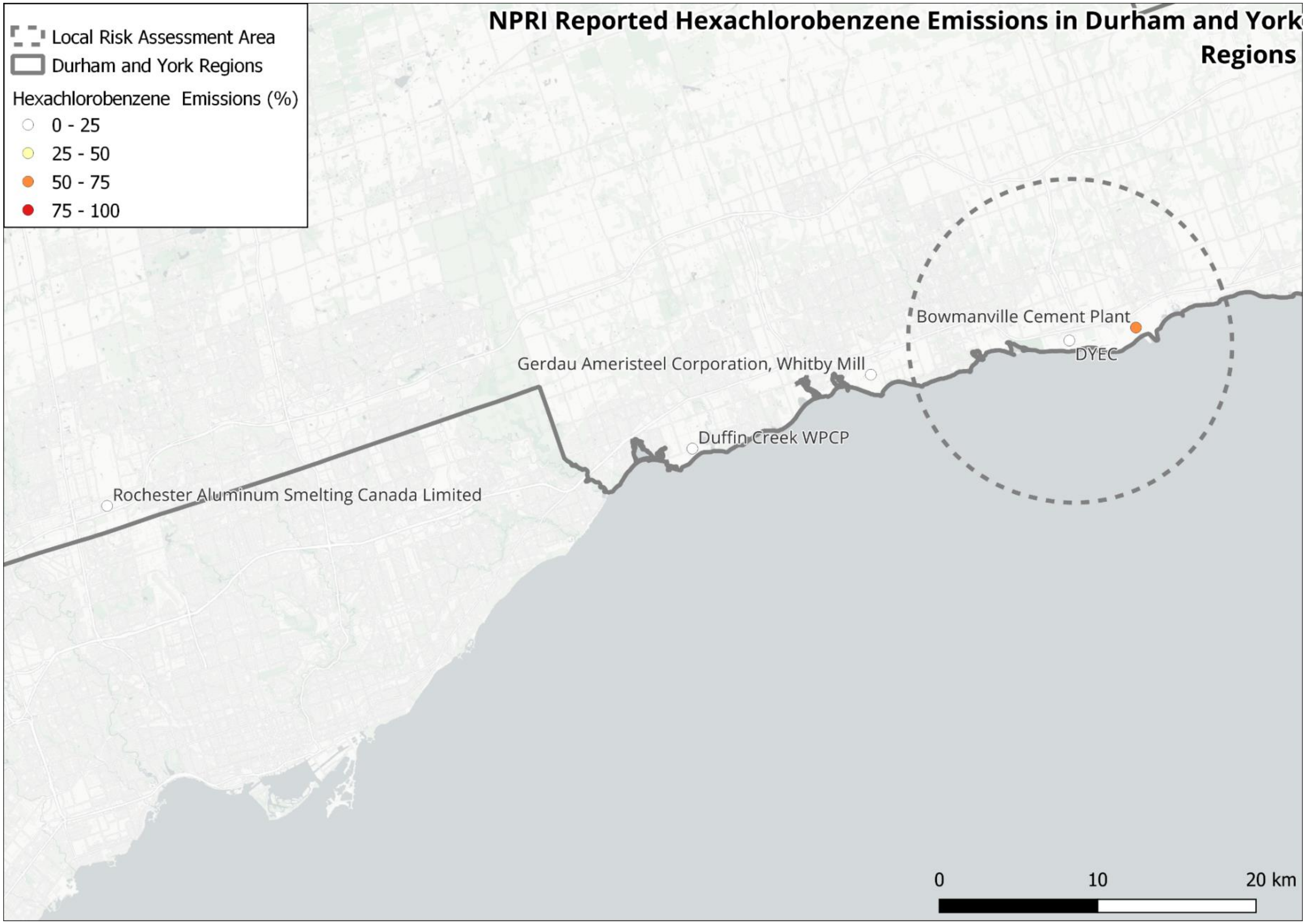
Appendix C.5: NPRI Copper Emissions Map



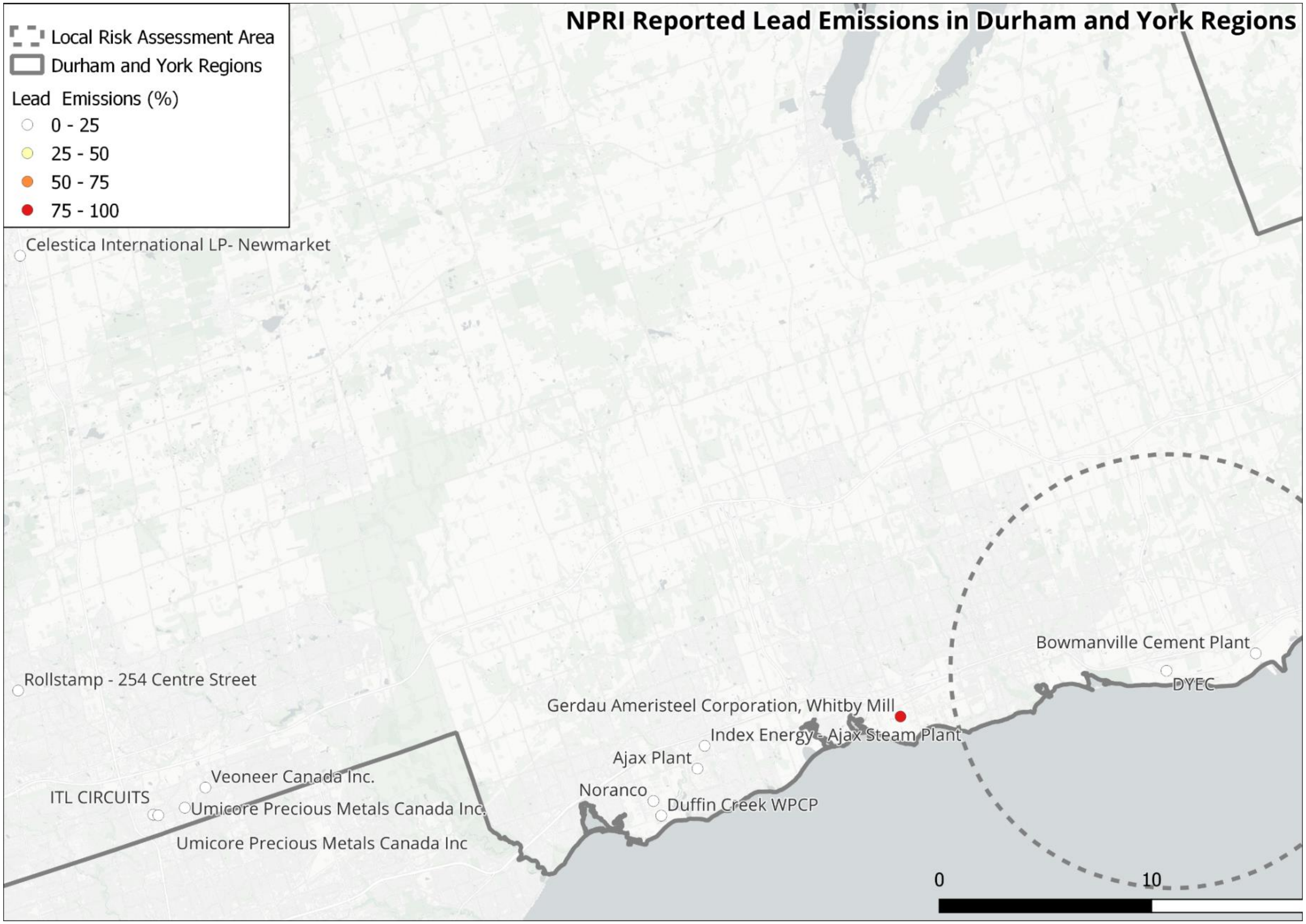
Appendix C.6: NPRI Dioxins and Furans Emissions Map



Appendix C.7: NPRI Hexachlorobenzene Emisssions Map

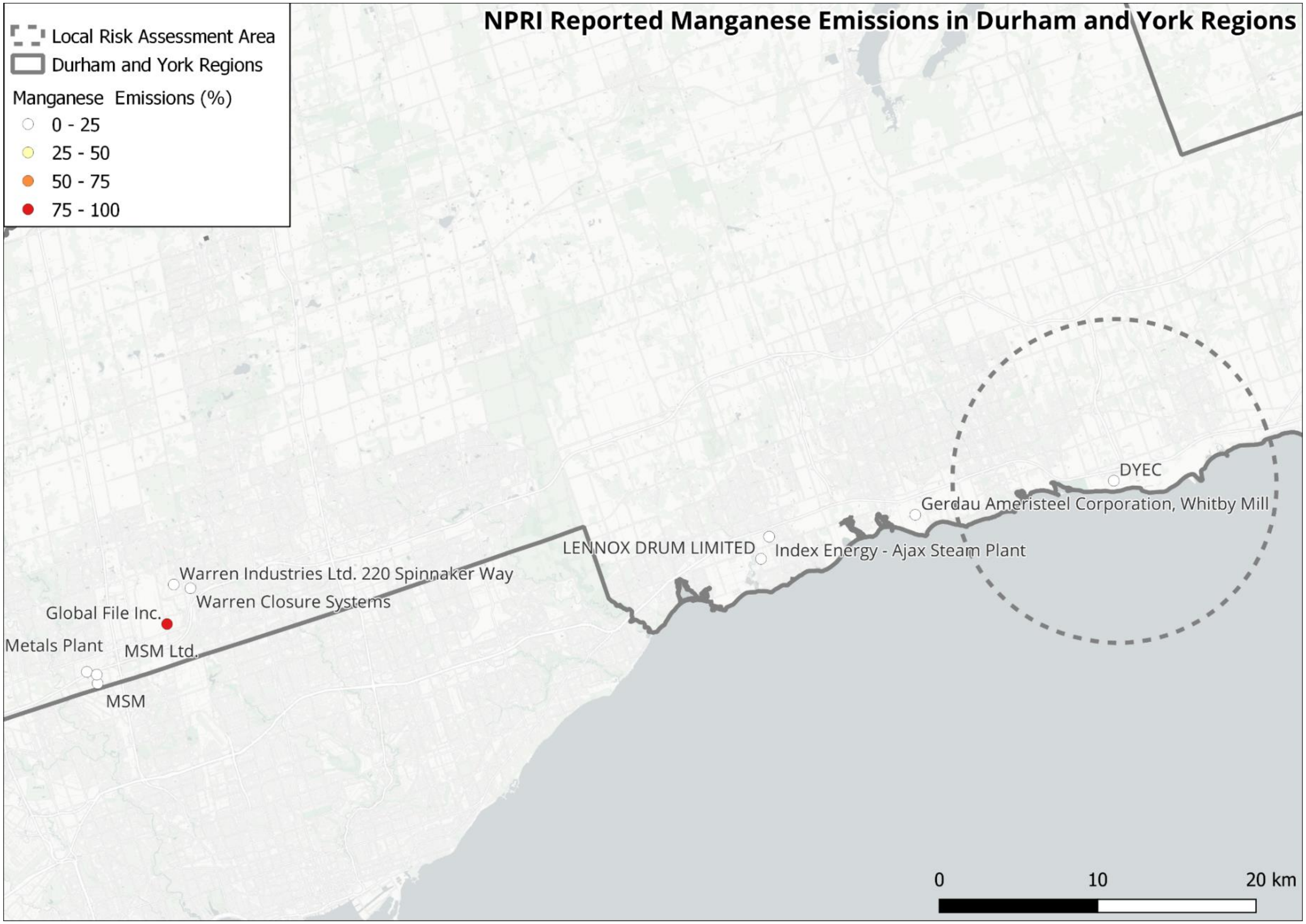


Appendix C.8: NPRI Lead Emissions Map

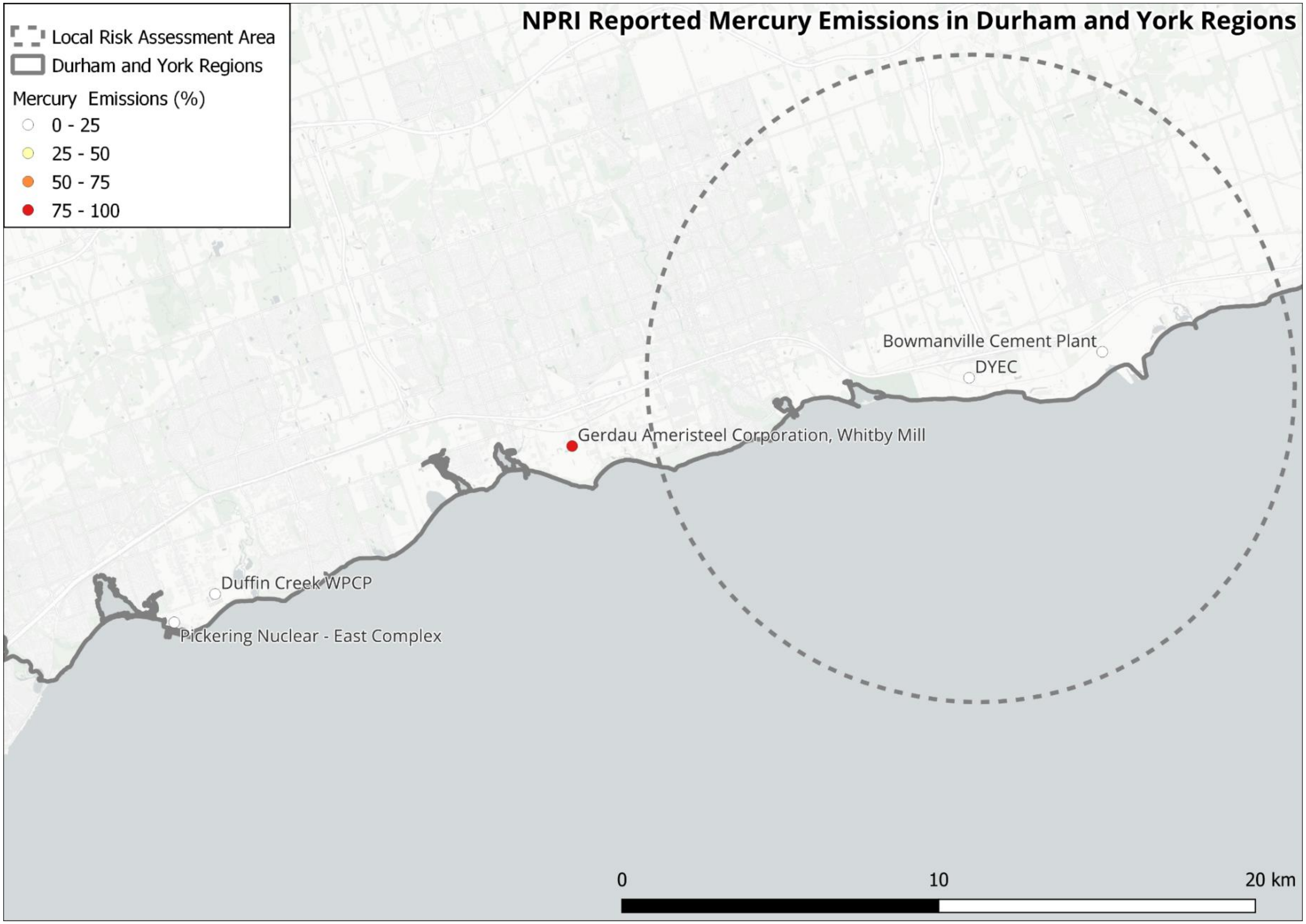


Attachment #1 to Report #2024-WR-5

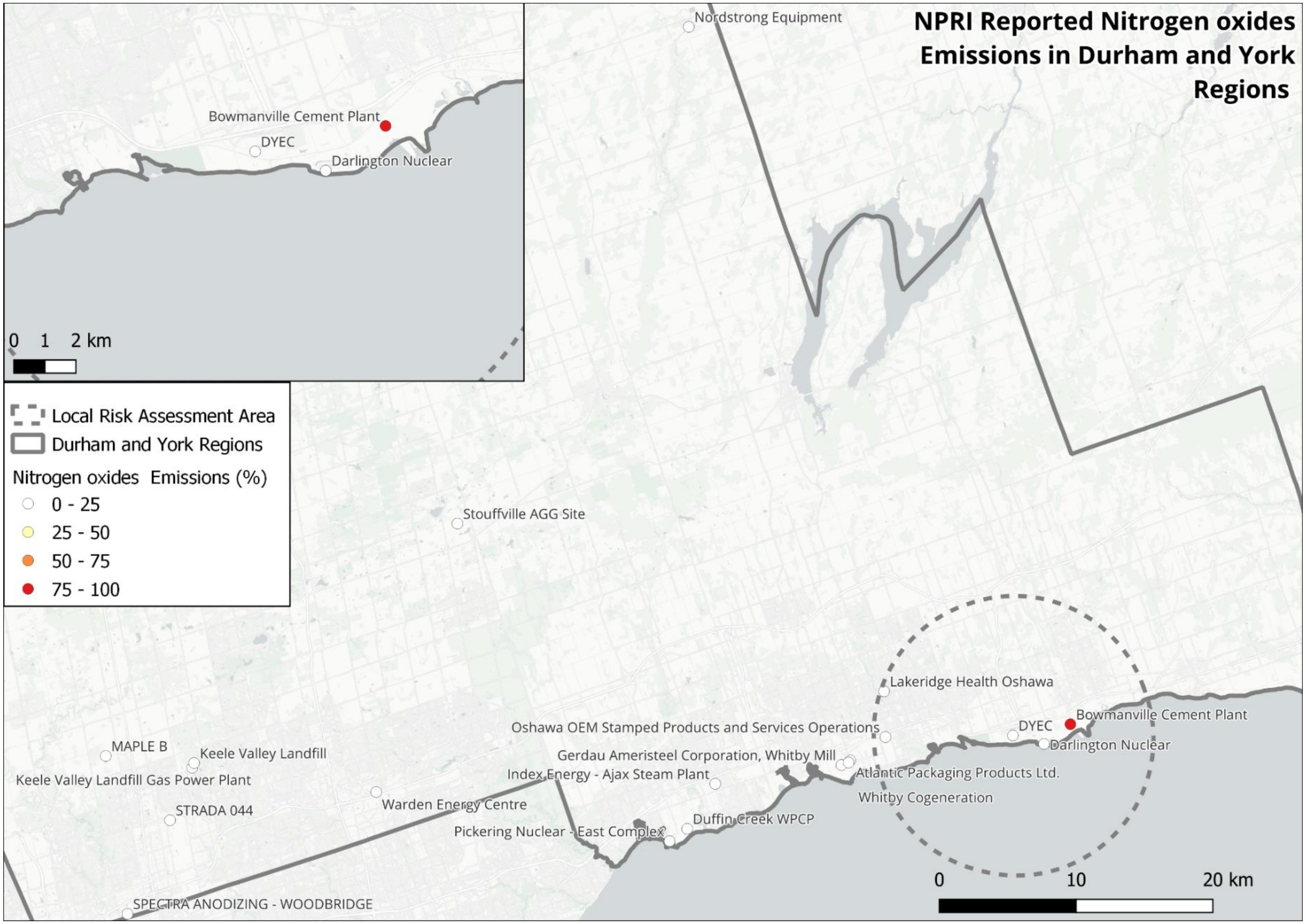
Appendix C.9: NPRI Manganese Emissions Map



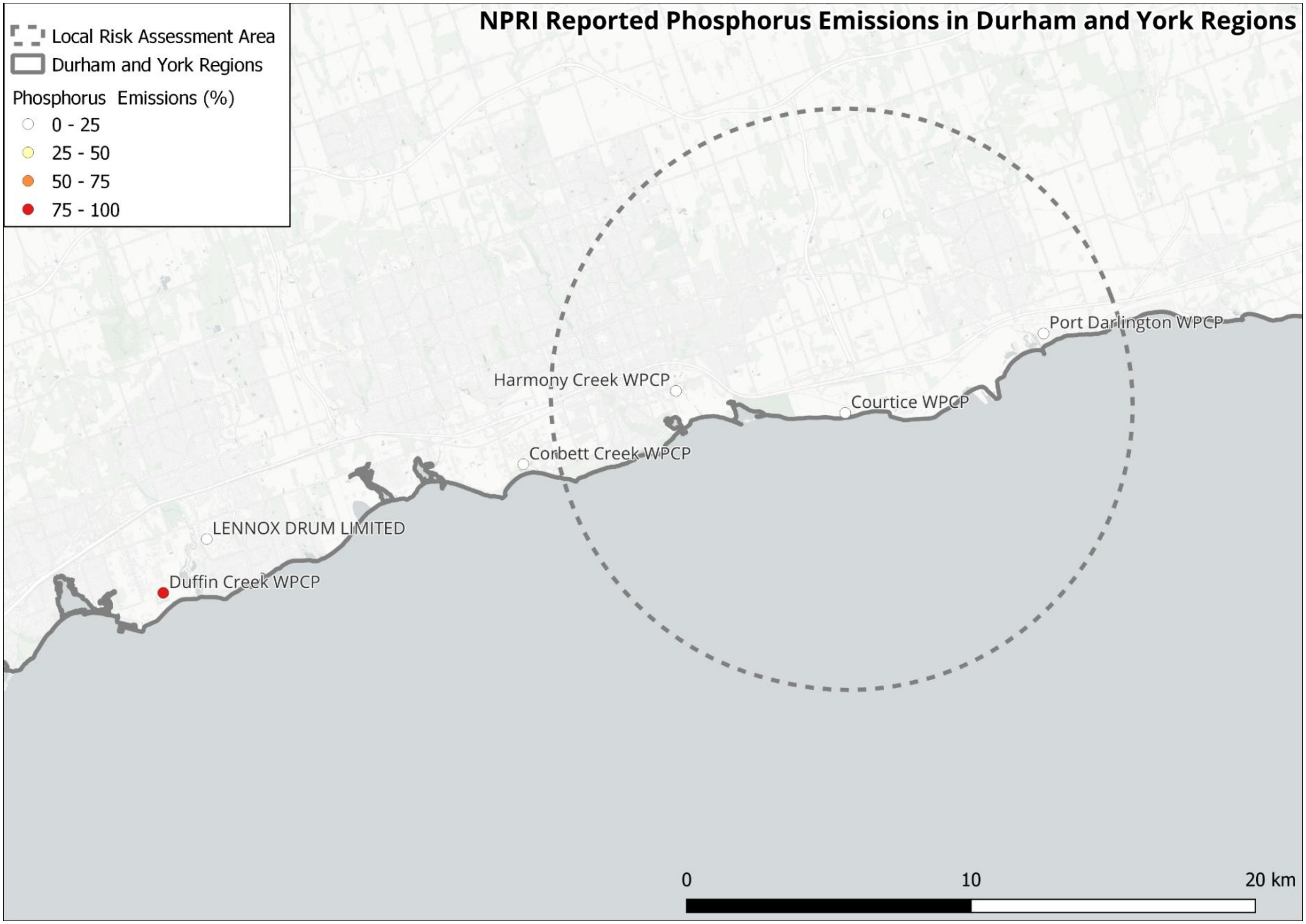
Appendix C.10: NPRI Mercury Emissions Map



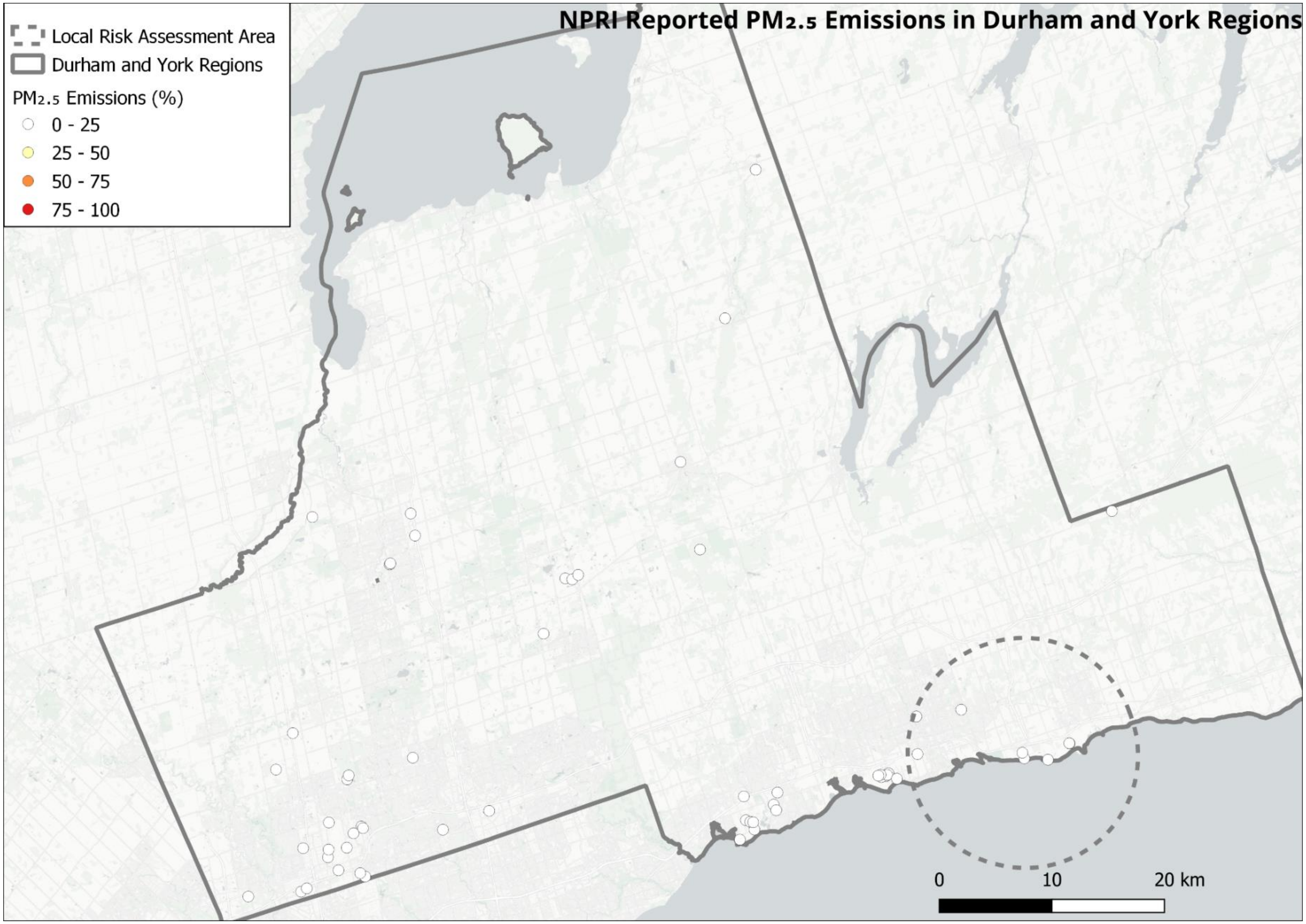
Appendix C.11: NPRI Nitrogen Oxides Emissions Map



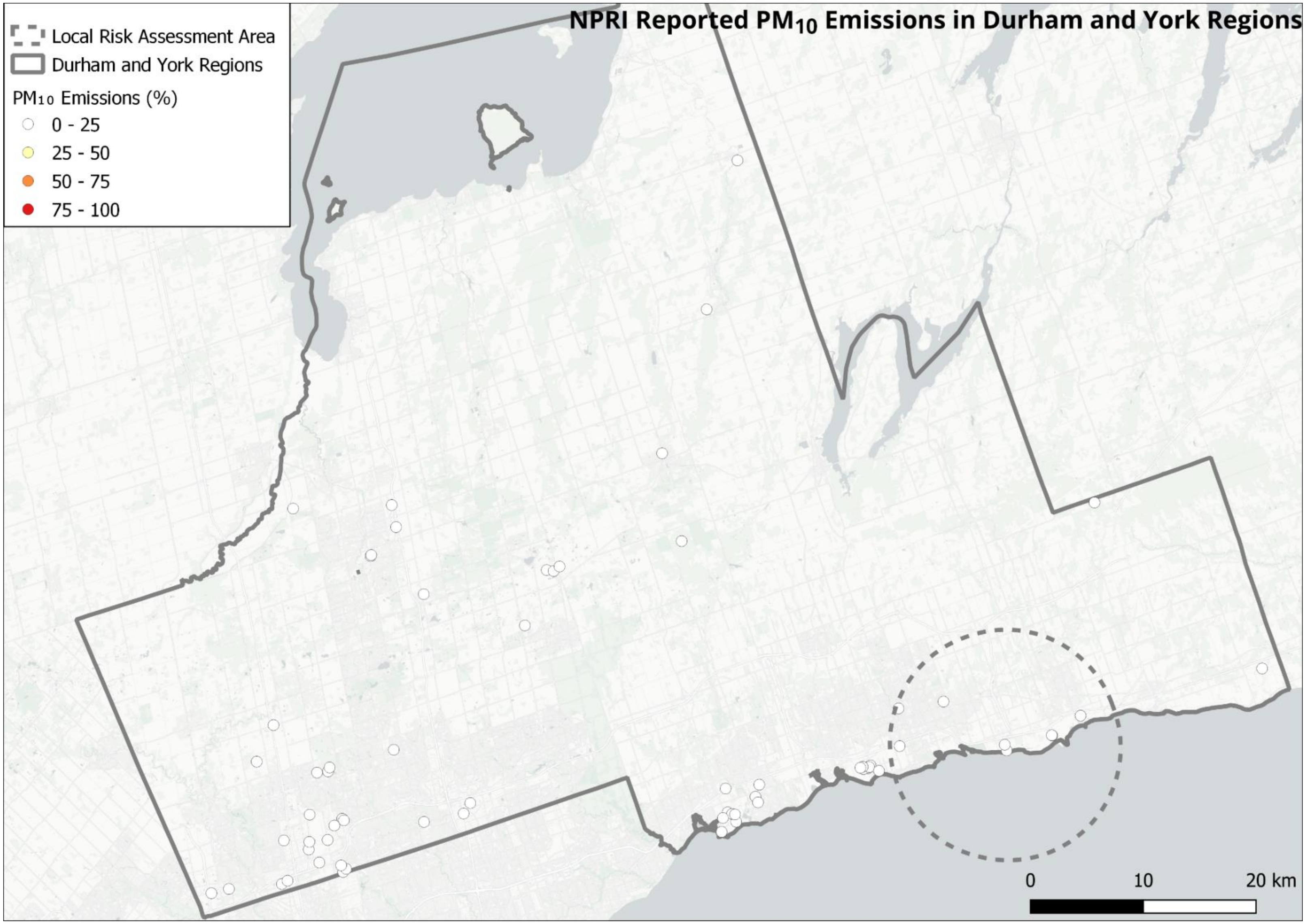
Appendix C.12: NPRI Phosphorus Emissions Map



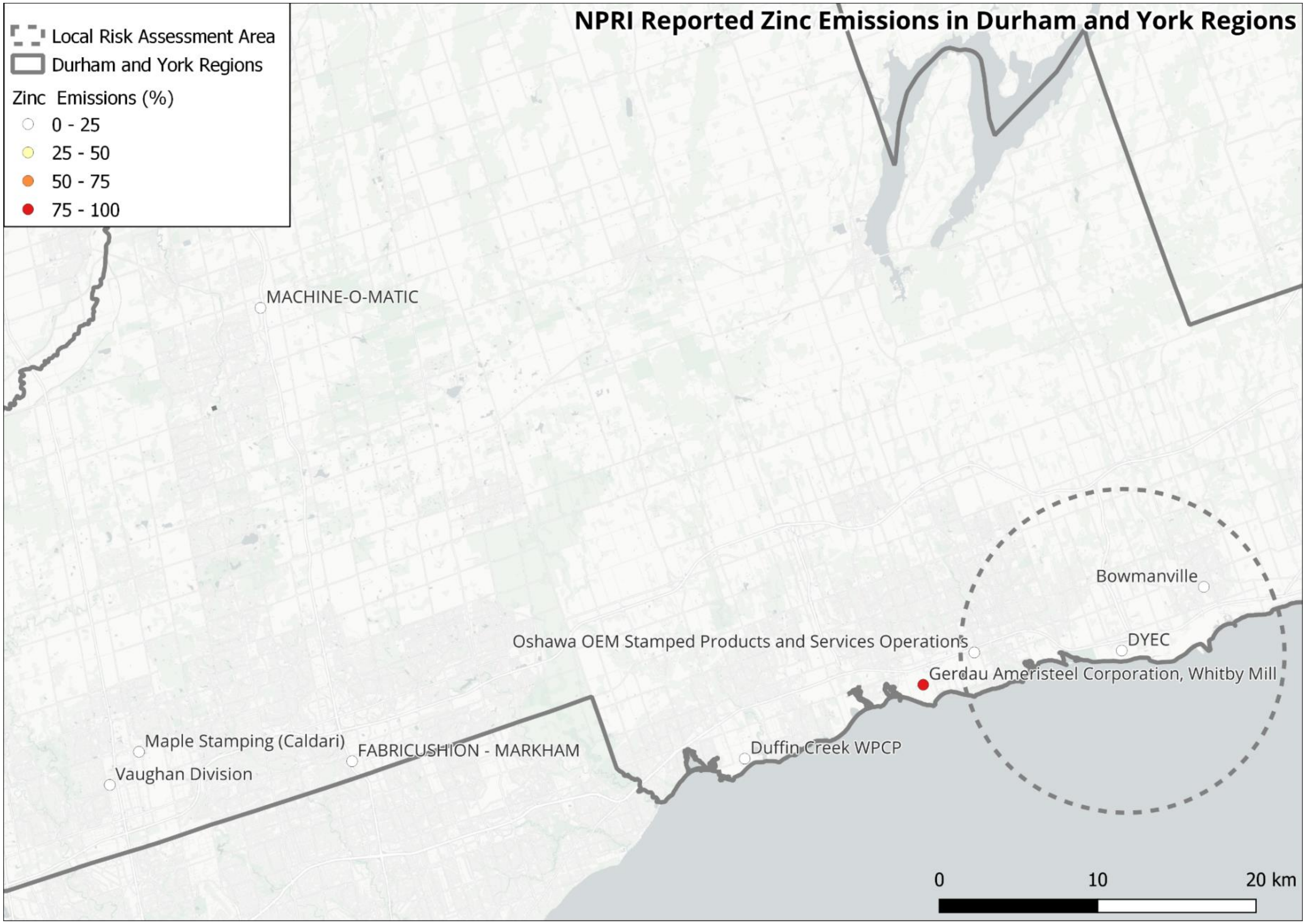
Appendix C.13: NPRI PM2.5 Emissions Map



Appendix C.14: NPRI PM10 Emissions Map



Appendix C.15: NPRI Zinc Emissions Map



DURHAM YORK ENERGY CENTRE

SUMMARY OF ANALYSIS OF AMBIENT AND EMISSION MONITORING TO IDENTIFY LOCAL AIRSHED IMPACTS

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July 17, 2023

Summary

This analysis aimed to determine whether the Durham York Energy Centre (DYEC) affects local air quality by releasing pollutants that increase air pollution levels. The study examined data from two ambient air monitoring stations, one located upwind and the other downwind of the DYEC and emission data from the DYEC itself. The pollutants analyzed in this report included fine particulate matter ($PM_{2.5}$), nitrogen oxides (NO_X), sulphur dioxide (SO_2), total suspended particulate (TSP) including metals, polycyclic aromatic hydrocarbons (PAHs), and polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDDs/PCDFs). The study compared the emissions reported by the DYEC to the National Pollutant Release Inventory with all reported emission sources in Durham and York Regions. The results showed that the DYEC's emissions did not significantly contribute to air pollution in the local area, as indicated by the measurements taken at the upwind and downwind monitoring stations. For a more comprehensive report, please review ANALYSIS OF AMBIENT AND EMISSION MONITORING TO IDENTIFY LOCAL AIRSHED IMPACTS, 2023.

Data

The DYEC has a plan in place to monitor and report on the quality of the outdoor air. This plan is required to comply with conditions set out in the Environmental Assessment Notice of Approval and the Environmental Compliance Approval. The monitoring includes both continuous and non-continuous methods. Continuous monitoring devices measure air pollution in real time as air is drawn through the device. Non-continuous methods involve sampling the air for a specific period and then analyzing the sample in a laboratory to determine the amount of pollutants present.

Three monitoring stations were established according to the plan, with one located upwind, one downwind, and one at the property line. For this analysis, we focus on the upwind and downwind sites, which are currently operational. The locations were chosen based on wind patterns, with the upwind station situated west of the DYEC and the downwind station located east of Rundle Road. The Rundle Road station was selected because it is in the dominant downwind direction from the DYEC and within the range where the highest potential air pollution impact is expected. The two monitoring stations and the DYEC stack location are presented in Figure 1.

The DYEC also has an Air Emissions Monitoring Plan in place, which involves continuous monitoring of selected pollutants emitted by the boilers at the facility. The real-time emissions data is made available on the DYEC website.

Overall, these monitoring plans ensure that the DYEC is actively monitoring the air quality in the surrounding area and complying with regulations regarding emissions.

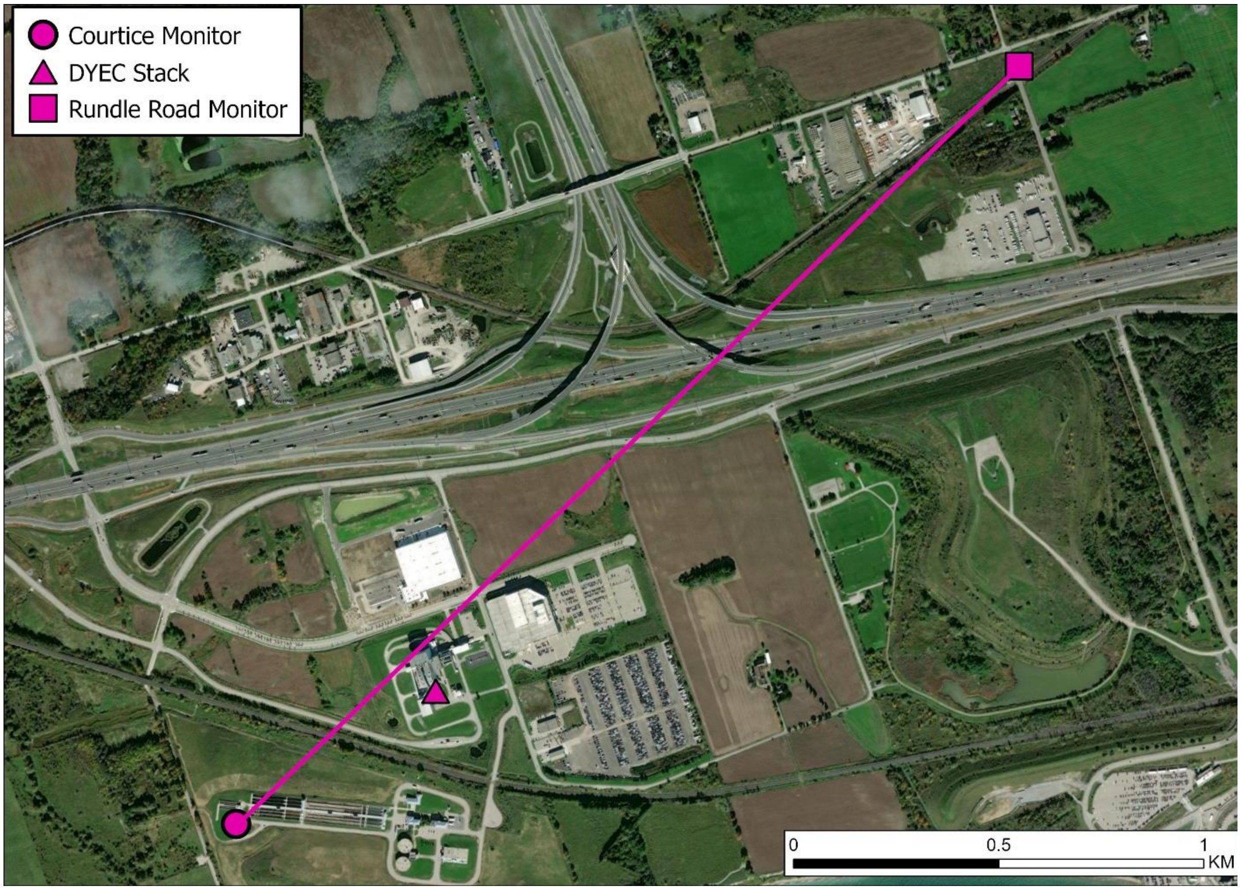

Figure 1: Map of Ambient Air Monitoring Locations Relative to the DYEC

Analysis

Upwind and downwind air monitoring data were compared. If the DYEC impacted local air quality, the downwind air monitor should demonstrate a consistently higher concentration than the upwind air monitor (Figure 2).

There are three approaches used to analyze the data on air pollution. These approaches are based on the availability of data and the air monitoring method.

The first approach is for three groups of pollutants: dioxins and furans (PCDD/PCDF), polycyclic aromatic hydrocarbons (PAHs), and total suspended particulate (TSP) including metals. Pollution in the air was sampled for 24-hour periods to obtain a 24-hour average concentration. This sampling method is known as discrete sampling.

The second approach is for nitrogen oxides (NO_X) and sulphur dioxide (SO_2), where hourly measurements were conducted at the Courtice and Rundle Road locations. In addition, both pollutants were monitored continuously at the DYEC stack.

The third approach also involves ambient monitoring but does not include continuous emissions monitoring. Fine particulate matter was included in this approach.

By using these approaches, we can analyze data on various pollutants present in the air. This information is crucial for identifying potential impacts to air quality.

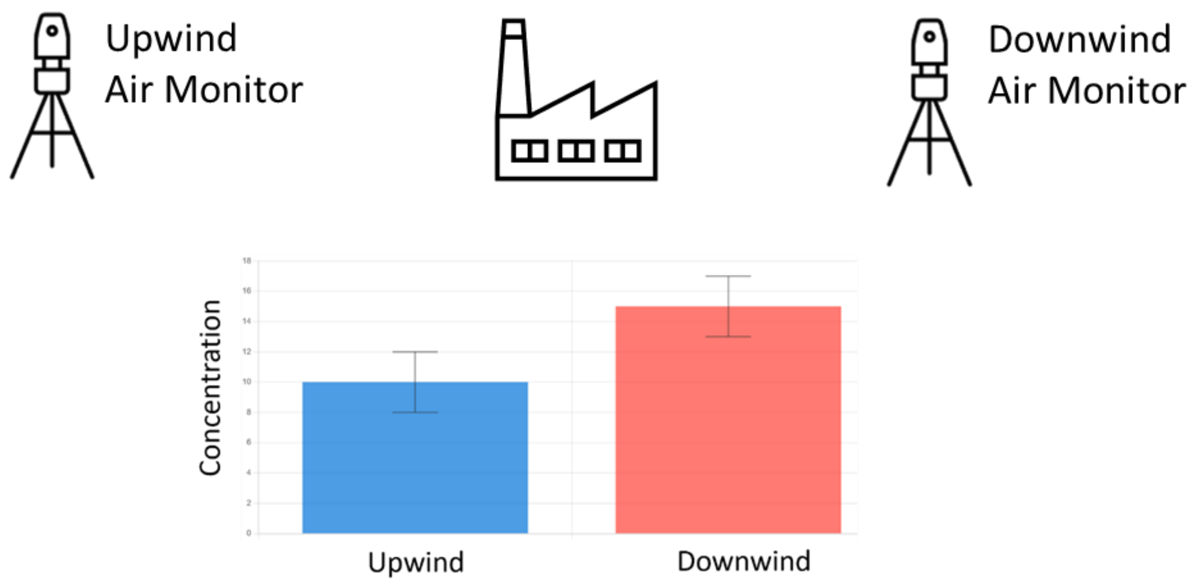

Figure 2: Concept of Upwind and Downwind Air Monitoring Comparison. The graph shown in this figure is not an actual representation of the air quality surrounding the DYEC. Instead, it illustrates what one may expect to see downwind if the DYEC was consistently contributing to the emissions to the ambient air.

Findings

This report aims to assess the impact of the Durham York Energy Centre (DYEC) on local air quality. Analyzing data from two monitoring stations, one upwind and one downwind of the DYEC, helps understand its influence. However, evaluating a single source's impact on air quality is complex due to other natural and human-caused sources in the area. The monitoring stations were strategically placed, with Rundle Road as the downwind location and Courtice as the upwind reference. Examining wind direction and speed data from January 2016 to June 2022 confirmed that Rundle Road was predominantly downwind.

DIOXINS AND FURANS

Exposure to polychlorinated dibenzo-p-dioxins (PCDDs) and dibenzo-furans (PCDFs) has been linked to various health problems, including skin disorders, liver issues, developmental effects on the nervous system, certain cancers, and disruptions to the endocrine, immune, and reproductive systems. Minimizing exposure to these substances is important due to their potential risks. Dioxins and furans are produced during combustion processes.

Dioxins and furans were sampled using discrete sampling for 94 days. Seventeen compounds were analyzed in each sample, and toxic equivalency (TEQ) values were calculated. TEQ is determined by applying toxic equivalency factors (TEF) to each compound, with the most toxic form of dioxin (2,3,7,8-TCDD) assigned a TEF of 1. The concentrations of each compound are then multiplied by their respective TEFs, and the sum of the 17 compounds can be compared to the Ontario Ministry of the Environment, Conservation and Parks (MECP) Ambient Air Quality Criteria (AAQC) of 0.1 pg TEQ/m^3.

The average TEQ/m^3 values for Rundle Road (0.0157) and Courtice (0.0127) were below the MECP AAQC, indicating that the ambient air contained only 12.7% to 15.7% of the allowable TEQ concentration. Additionally, no significant increases were observed between upwind and downwind conditions, suggesting that the DYEC did not significantly contribute to changes in air pollution levels.

DYEC's annual dioxins and furan emissions are emitted by Canada's largest emitter in less than one day.

The DYEC accounts for a small proportion (2.2%) of regional dioxins and furans emissions reported to the National Pollutant Release Inventory in the Durham and York Regions (Figure 3). Other nearby sources were responsible for a larger share of emissions. Five other locations to the west of the DYEC emit these compounds, with two sites releasing 25-50% of total regional emissions. These sites are likely why Courtice and Rundle Road during westerly winds (Rundle Road downwind) demonstrate their highest concentrations compared to concentrations during the other two wind patterns, which may explain why Courtice and Rundle Road recorded higher concentrations during westerly winds (with Rundle Road being downwind).

The DYEC emits 0.63% of dioxins and furans yearly compared to Canada's forest fires.

The forest fire emission quantity is estimated based on 5.8 ng toxic equivalent of PCDD/F per kg of carbon burned[1] and 2.7 x 10^{10} kg of carbon burned in Canadian forest fires based on historic amounts[2].

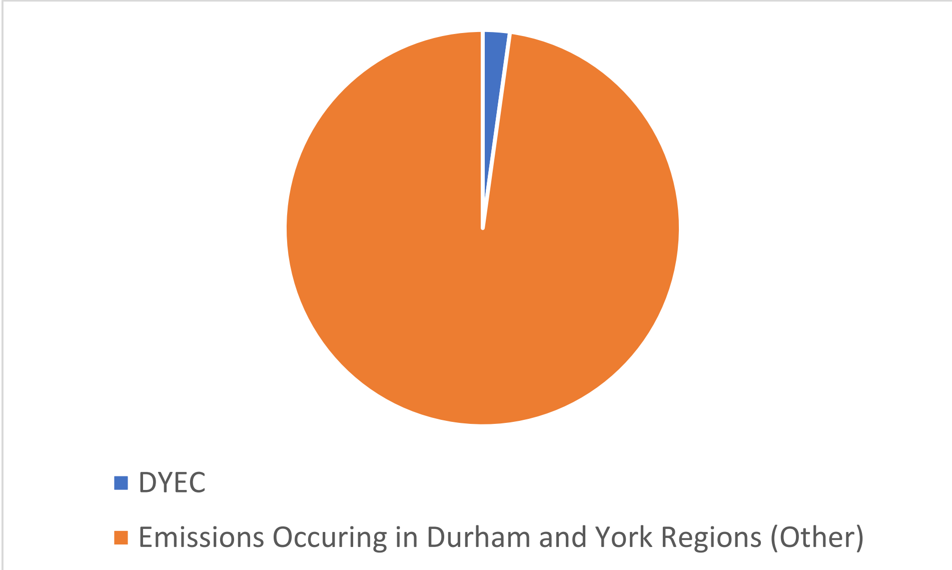

Figure 3: DYEC Proportion of Regional Dioxins and Furans Emissions

Based on the data analysis, it is unlikely that DYEC emissions significantly impact local concentrations of dioxins and furans. The concentrations measured were below the Ontario AAQC, which is positive considering other emission sources in the area.

PAHs

PAHs are chemicals that form when burning coal, oil, gas, wood, and garbage. They can be harmful, cause mutations in DNA, and are known to cause cancer. In the air, PAHs can exist as gases or attached to particles. Although many PAH compounds exist, regulations and reporting usually focus on around 14 to 20. The DYEC's monitoring plan measures 25 PAHs and adds their concentrations to get a total level. Unlike dioxins and furans, no special adjustments are made, and the values are added together evenly. Six PAHs have specific criteria to compare the measured concentrations. One of them, benzo(a)pyrene, is used to represent all PAHs during monitoring. The AAQC for benzo(a)pyrene was set to protect human health based on the cancer-causing effects of PAH exposure.

Benzo(a)pyrene concentrations are below the set limits, with measurements of 0.03 ng/m^3 at Courtice and 0.04 ng/m^3 at Rundle Road. (Ontario Ambient Air Quality Criteria: 0.05 ng/m^3; O. Reg. 419/05 Schedule Upper Risk Thresholds: 5 ng/m^3)

There was no significant increase in benzo(a)pyrene levels at the downwind air monitor compared to the upwind monitors when either Courtice or Rundle Road were downwind. However, concentrations consistently tended to be higher at the Rundle Road monitor regardless of the wind direction. The largest difference between the monitoring stations occurred during crosswind conditions, with Rundle Road showing an increase of +0.0177 ng/m^3. When Rundle Road was upwind, the increase was +0.0144 ng/m^3, and when it was downwind, the increase was the smallest at +0.0092 ng/m^3. Upwind monitor conditions indicated a background level from 0.0315 ng/m^3 (Courtice Upwind) to 0.0521 ng/m^3 (Rundle Downwind).

Based on the ambient air monitoring data analysis, no evidence suggests that the DYEC impacts the ambient air quality in terms of PAHs.

Total Suspended Particulate

Total suspended particulate (TSP) measures all particles in the air, including larger particles that settle quickly and smaller particles that can travel deeper into the body. TSP is a good indicator of local effects because it represents the mass of particles in a given volume of air. The MECP sets criteria for TSP levels, and the DYEC monitors 29 metals within TSP. The average concentrations at Courtice (25 µg/m^3) and Rundle Road (32 µg/m^3) are below the criteria (60 µg/m^3) see Figure 4, and all metal species analyzed also fall below the criteria at both locations. Rundle Road consistently shows higher TSP concentrations during all wind conditions. Eight metal species are higher at Rundle Road when downwind, except for Iron, Manganese, and Titanium during crosswinds. The DYEC's manganese emissions are minimal compared to regional emissions. Overall, the measured TSP concentrations are below the set standards. The data does not indicate any significant patterns of increased TSP or metal species concentrations due to the DYEC emissions. However, the higher concentrations at Rundle Road during all wind conditions suggest that a local source may contribute to TSP pollution.

In one day, brake dust from passenger vehicles emits more Zinc, Manganese, and Copper along the 401 in Durham than the DYEC does in a year.

Passenger vehicle counts were obtained from the MTO iCorridor tool (https://icorridor-mto-on-ca.hub.arcgis.com/), which indicated 91,500 daily passenger vehicles along the 401 through Durham Region on the 401 (58.6 km in length) for a total of 5,361,900 km driven per day. Particulate matter from brake wear was estimated from the average of many studies in a review paper, which was a rate of 5.7 mg per km driven[3]. The daily emissions were 30.8 kg of particulate matter multiplied by trace metal rates per kilogram of particulate matter[3]. Each rate was provided as a range, and the 20th percentile between those ranges was used.

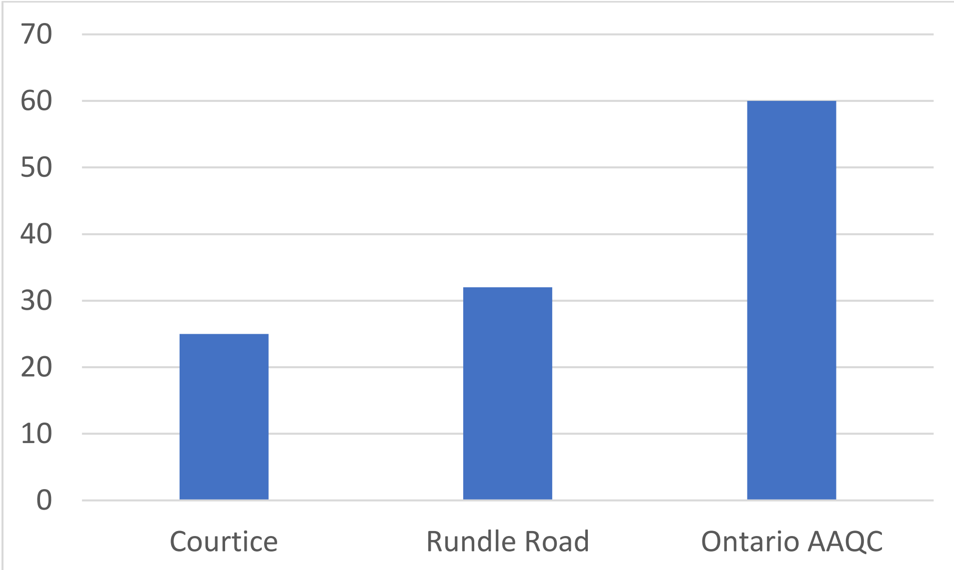

Figure 4: TSP Concentrations (µg/m^3) Compared to Ontario Ambient Air Quality Criteria

Nitrogen Oxides

Two measures were used to monitor nitrogen oxides (NO_X): ambient air monitoring and continuous emission monitoring. The long-term concentrations of NO_X at Rundle Road (7.5 ppb) and Courtice (7.1 ppb) were similar. When the DYEC boilers were not operating, the concentration difference between the two monitors was 2.6 ppb indicating background differences. The analysis also examined the relationship between emission concentrations and the difference in downwind concentrations at Rundle Road compared to Courtice. However, no relationship was found between emissions and the difference in ambient air pollution concentrations. The analysis suggests that the DYEC does not significantly impact the ambient air pollution concentrations in the area. Furthermore, the mapping of emission sources from Canada's National Pollutant Release Inventory (NPRI) indicates the presence of other local sources of NO_X.

Annual NO_X emissions of the DYEC are equivalent to 15 days of vehicle emissions along the 401 in the Durham Region.

Truck and passenger vehicle counts were obtained from the MTO iCooridor tool (https://icorridor-mto-on-ca.hub.arcgis.com/), which indicated 18,000 daily trucks and 91,500 daily passenger vehicles along the 401 through Durham Region on the 401 (58.6 km in length). The number of vehicles was multiplied by emission factors from a near-road air pollution study conducted in Canada[4], which resulted in 7,377 kg of NO_X emitted daily (15 days = 111 tonnes of NO_X emitted).

Sulphur Dioxide

Similar to NO_X, the analysis comparing measured emissions with differences in ambient measurements did not show any relationship. However, we observed that SO_2 concentrations are significantly higher at the Courtice monitor when it is upwind of the Rundle Road air monitor. This suggests the presence of a nearby emission source. Furthermore, Courtice concentrations were higher than Rundle Road when the DYEC boilers were not operating. If there is a local source of SO_2 pollution, the concentrations are likely diluted as they disperse over the short distance to the Rundle Road air monitor.

Based on the analysis, no evidence suggests that the emissions from the DYEC impact local SO_2 concentrations. However, the findings do indicate the existence of a local source near the Courtice air monitor.

Particulate Matter

The DYEC reports 0.1% of industrial emissions for $PM_{2.5}$ in Durham and York Regions based on the NPRI. The concentrations measured at the two monitoring stations did not differ meaningfully. Both monitoring locations reported the same 8.0 $\mu g/m^3$ concentration during Rundle Road downwind conditions. NPRI emission mapping of industrial sources demonstrates many sources, with no single source representing more than 25% of emissions. The analysis does not suggest any impact from the DYEC on ambient $PM_{2.5}$ concentrations.

Conclusion

The analysis of ambient air pollution data for PCDD/PCDFs, PAHs, TSP, NO_X, SO_2 and $PM_{2.5}$ indicates that the DYEC is not impacting the local airshed. The region has multiple known stressors, such as those high emitters identified in the NPRI data. After reviewing the ambient monitoring data, one primary concern arose, which included elevated concentrations of benzo(a)pyrene that have included individual samples exceeding Ontario AAQC during the period evaluated. These elevated concentrations do not seem influenced by DYEC emission, and while they may be elevated at Rundle Road, it is not possible to infer the expected concentrations at residential locations within the region. Future exceedances should be individually evaluated to examine the relative wind directions during the exceedance and identify baseline conditions using the upwind monitor; however, the analysis indicates that local and regional sources influence the ambient air monitors, both Courtice and Rundle Road. The dual monitoring program effectively compares upwind and downwind concentrations and should be maintained to evaluate future conditions.

Overall, it is concluded that the DYEC's Air Emissions Monitoring Plan effectively controls emissions so that it does not significantly contribute to air pollution in the local airshed.

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2. Amiro, B. D., Todd, J. B., Wotton, B. M., Logan, K. A., Flannigan, M. D., Stocks, B. J., ... & Hirsch, K. G. (2001). Direct carbon emissions from Canadian forest fires, 1959-1999. *Canadian Journal of Forest Research*, *31*(3), 512-525.
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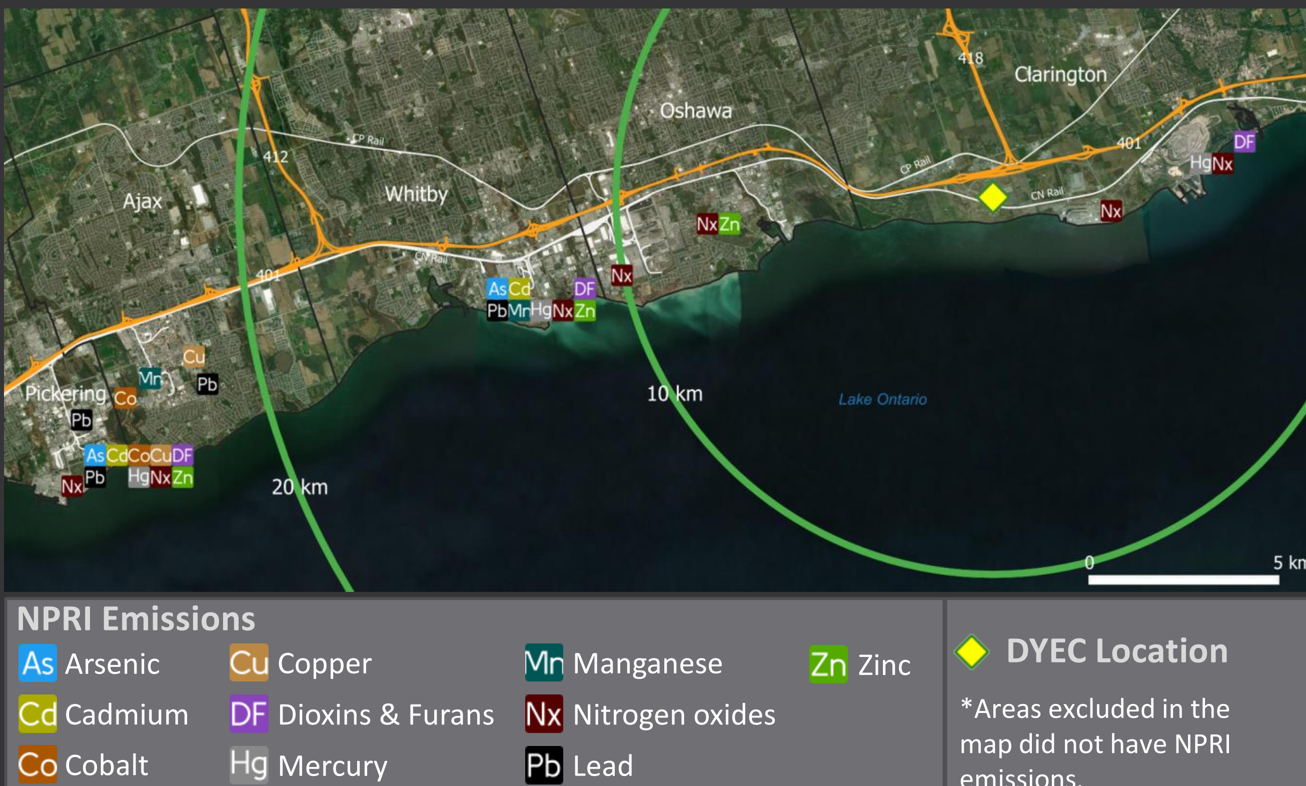
Examining Air Pollution Sources in the Proximity of Durham York Energy Centre

The National Pollutant Release Inventory contains emission values for 320 pollutants from over 7,000 facilities. In 2021, the DYEC reported air emissions for ten pollutants to the NPRI. Below you will find a map highlighting the locations reporting to the NPRI who emit any of those ten pollutants within 30 km of the DYEC.



Additional Sources of Air Pollution

Non-point sources: Non-point source pollution adds to local air pollution along with point sources. It includes contaminants from activities such as construction, vehicles, agriculture, and residential sources. Estimating and controlling non-point sources is challenging due to their dispersed nature, requiring collaboration among different sectors and government levels.

Highways - In the region, the major highways and roads contribute nitrogen oxides from exhaust, particulate matter from brake and tire wear including copper, lead, zinc, cadmium and manganese. These pollutants will impact ambient air quality measurements near the DYEC. For example, the 401 through Durham has more than 130,000 vehicles daily adding pollution to the region.

Industry – Within 20km of the DYEC is a steel mill that in 2022, had the highest air emissions of dioxins and furans in Ontario, one-hundred times greater than the DYEC. Within 10km of the DYEC is a cement plant that was the 8^{th} highest air emitter of dioxins and furans in Ontario (2022), producing eight times the emissions of the DYEC.

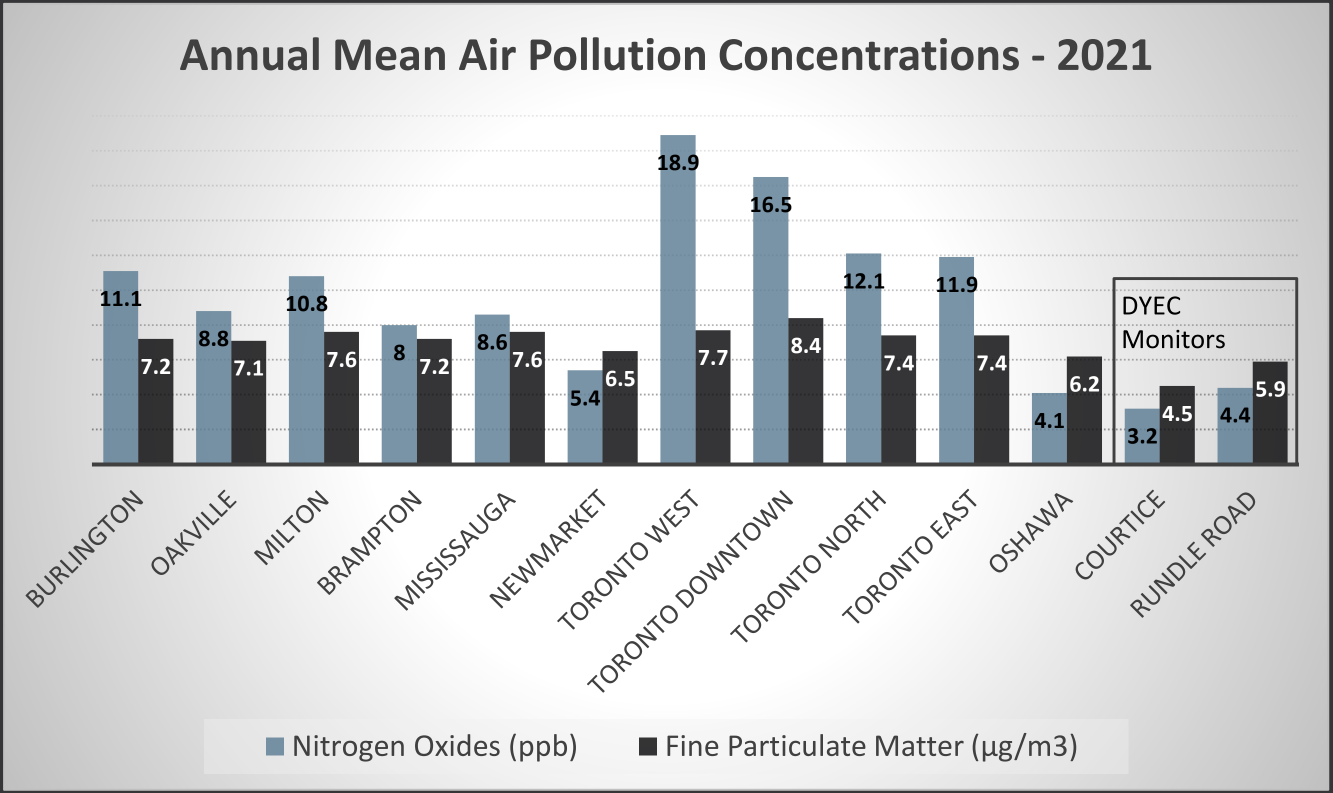
Transboundary Air Pollution

Transboundary air pollution originates in one region or country and crosses international boundaries, affecting neighbouring countries or regions' air quality and environmental conditions. This can occur through the long-range transport of pollutants, such as fine particulate matter, sulphur dioxide, and nitrogen oxide, which can be carried over long distances by wind and weather patterns. As a result, transboundary air pollution can negatively impact human health, natural ecosystems, and economic activities, making it a significant global environmental issue that requires international cooperation and coordinated efforts to mitigate and control its effects.

Durham and York Regions are impacted by nitrogen oxides emitted from coal fire power plants in the Ohio Valley that travel toward Ontario. Additionally, transboundary air pollution contributions account for between 25% and 60% of fine particulate matter concentrations in the region (Air Quality in Ontario 2020 Report).

Ambient Air Quality Regional Comparison

Compared to air pollution concentrations measured by the Ontario Ministry of Environment, Conservation and Parks' air monitors in the GTA, both nitrogen oxides (NO_x) and fine particulate matter ($PM_{2.5}$) near the DYEC (Courtice and Rundle Road) are low compared to regional concentrations.



Prepared by Matthew Adams, Ph.D.

Analysis of Ambient Air Exceedances in the Proximity of Durham York Energy Centre

Air quality at the Durham York Energy Center (DYEC) is monitored at two locations: Courtice (upwind) and Rundle Road (downwind). Various pollutants are measured using continuous monitoring and 24-hour average samples. The concentrations of these pollutants were compared to the Ambient Air Quality Criteria (AAQC) set by The Ontario Ministry of the Environment, Conservation and Parks between 2016 and 2022.

Total Suspended Particulate (TSP)

A 24-hour TSP sample is collected at the Rundle Road and Courtice air monitoring stations every six days. These samples are then analyzed in the laboratory to determine the total amount of particulate matter and its various components, including metals.

The AAQC (24-hour) for TSP is set at 120 µg/m^3, and it was exceeded on seven occasions between 2016 and 2022. However, only three exceedances occurred when the monitoring station was downwind of the DYEC. During these exceedances, DYEC's real-time air emissions data and boiler parameters were all within normal operational range. On one of the exceedance days (May 2, 2018), the boiler was offline for 14 hours. Based on the evidence, it is not likely that the DYEC was the cause of these exceedances.

The components of TSP, including Antimony, Arsenic, Barium, Beryllium, Boron, Cadmium, Chromium, Cobalt, Copper, Iron, Lead, Manganese, Mercury, Molybdenum, Nickel, Selenium, Silver, Strontium, Tin, Titanium, Uranium, Vanadium, and Zinc, did not exceed their respective ambient air quality criteria between 2016 and 2022.

Polycyclic Aromatic Hydrocarbons (PAHs)

Every 12 days, a 24-hour sample of PAHs is obtained at both the Rundle Road and Courtice air monitoring stations. Two PAHs are included in the Ontario AAQC, benzo(a)pyrene and naphthalene (no exceedances). Benzo(a)pyrene exceeded the AAQC at Courtice (12.5% of samples) and at Rundle Road (22.4% of samples); however, of the 43 exceedances at Rundle Road, during 21 of those, Courtice was also above the AAQC. In addition, more extensive analysis in the "ANALYSIS OF AMBIENT AND EMISSION MONITORING TO IDENTIFY LOCAL AIRSHED IMPACTS" suggests other sources, including a generally high benzo(a)pyrene background, are responsible for the locally high concentrations.

Dioxins and Furans

Every 24 days, a 24-hour sample of dioxins and furans is obtained at each Rundle Road and Courtice air monitoring station. One AAQC is included for dioxins and furans based on the cumulative toxicity of multiple pollutants. Each pollutant is multiplied by a toxicity equivalency factor, which adjusts concentrations based on different levels of associated toxicity. One exceedance of the AAQC has occurred, which happened at the Courtice Monitor on May 26, 2018. The exceedance occurred with Courtice monitor showing an elevated concentration; however, this station was upwind of the DYEC, and the Rundle Road (downwind) concentrations were lower than Courtice. The evidence does not suggest a contribution from the DYEC to this event; however, it may suggest a separate local source impacting air quality near the DYEC.

Nitrogen Dioxide (NO_2)

Air pollution measurements are made continuously at both Courtice and Rundle Road air monitors. Nitrogen dioxide did not exceed the 24-hour Air Quality Criteria (100 ppb) or the 1-hour criteria (200 ppb) at either air monitoring station.

Sulphur Dioxide (SO_2)

The Courtice air monitor identified 151 hourly exceedances; however, only 25 occurred when Courtice was downwind from the DYEC. Far fewer exceedances occurred at Rundle Road (21), which never occurred when Rundle Road was downwind of the DYEC.

Fine Particulate Matter

Few 24-hour exceedances occurred at either Courtice (0.5% of days) or Rundle Road (0.7% of days); however, less than one-quarter of the Rundle Road exceedances occurred when it was downwind of the DYEC, and the Courtice exceedances never occurred when it was downwind of the DYEC. The few exceedances and that they did not generally occur during downwind conditions suggest no impact from the DYEC.

Prepared by Matthew Adams, Ph.D.