



**Expanded Air Dispersion
Modelling Study**

Replacement Effluent Treatment Facility

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EXPANDED AIR DISPERSION MODELLING STUDY

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Abbreviations

ADMT	air dried metric tonnes
AST	activated sludge treatment
B[a]P	Benzo[a]pyrene
BLOX	black liquor oxidation tank
CACs	criteria air contaminants
CO	carbon monoxide
EA	Environmental Assessment
ESP	electrostatic precipitator
ETF	effluent treatment facility
FPAC	Forest Products Association of Canada
GLCs	ground-level concentrations
HLRV	high-level roof vent
H ₂ S	hydrogen sulphide
MECP	Ontario Ministry of Environment, Conservation and Parks
NAD	North American Datum
NCASI	National Council for Air Stream Improvement Inc.
NO _x	nitrogen oxides
NO ₂	nitrogen dioxide
NPRI	National Pollutant Release Inventory
NSE	Nova Scotia Environment
O ₃	ozone
PAHs	polycyclic aromatic hydrocarbons
SO ₂	sulphur dioxide
The Project	replacement AST ETF and co-combustion of biomass and biosludge in the biomass boiler
TSP	total suspended particulate matter
TRS	total reduced sulphur
PM ₁₀	particulate matter smaller than 10 microns
PM _{2.5}	particulate matter smaller than 2.5 microns
UTM	Universal Transverse Mercator
VOCs	volatile organic compounds



Executive Summary

Northern Pulp Nova Scotia Corporation (Northern Pulp) currently operates a Kraft pulp mill (the Facility) located at Abercrombie Point, Pictou County, Nova Scotia (approximately 3 kilometers from the town of Pictou and 9 km from New Glasgow). The Facility has been in operation since September 1967 and currently produces 280,000 to 300,000 air dried metric tonnes (ADMT) of bleached Kraft pulp per year. Northern Pulp is planning to replace their current effluent treatment facility (ETF) with an activated sludge treatment (AST) system, including a primary clarifier, an aeration basin and two secondary clarifiers. The replacement ETF will be located within the site boundaries of the mill. In addition, Northern Pulp is planning to co-combust a mixture of biomass and biosludge obtained from the AST system in the Facility biomass boiler. The replacement ETF and co-combustion of biomass and biosludge in the biomass boiler are referred to throughout this report as “the Project”.

In the winter of 2018, Stantec Consulting Ltd. (Stantec) was retained by Northern Pulp to conduct an air dispersion modelling study to support the Environmental Assessment (EA) for the replacement ETF. The original air dispersion modelling study focused on criteria air contaminants (CACs) regulated by the Government of Nova Scotia under Regulation 150/2017 - *Air Quality Regulations*, as amended on October 12, 2017, and those included in the Facility’s Industrial Approval (2011-076657-A01). The EA for the Project was registered with Nova Scotia Environment (NSE) on February 9, 2019 and on March 29, 2019, the Minister of Environment determined that the EA was insufficient to make a decision on the Project and that a Focus Report, pursuant to clause 13(1)c of the Environmental Assessment Regulations, in accordance to Part IV of the Environment Act, would be required. Subsequently, the “Terms of Reference for the Preparation of a Focus Report Regarding the Replacement Effluent Treatment Facility Project” (NSE 2019b) were issued on April 23, 2019 and included the following conditions pertaining to air quality:

“6.1 Provide a revised inventory of all potential air contaminants to be emitted from the proposed Project, including but not limited to, speciated volatile organic compounds, semi-volatile organic compounds, reduced sulphur compounds, polyaromatic hydrocarbons and metals.

6.2 Update the air dispersion modelling for the pulp mill facility for all potential air contaminants of concern related to the Project.

6.3 Complete an updated ambient air monitoring plan for the Project site based on the air dispersion modelling results. This plan must include the potential air contaminants to be monitored and proposed air monitoring locations.”



EXPANDED AIR DISPERSION MODELLING STUDY

In response to the Terms of Reference for the Focus Report, Stantec developed a revised inventory of potential air contaminants emitted from the Project and conducted an expanded air dispersion modelling study. This expanded dispersion modelling study was conducted to fulfill the requirements stated in Section 6.1 and 6.2 of the Terms of Reference. The development of an ambient air monitoring plan, as per Section 6.3 of the Terms of Reference, is being completed by Northern Pulp and will be submitted under a separate cover.

The expanded dispersion modelling assessment was conducted with the objective of assessing the Project's potential effects on ground-level concentrations (GLCs) for air contaminants of interest to the Project. The air contaminants considered in the development of the revised inventory for the Project included criteria air contaminants (CACs), metals, polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs), reduced sulphur compounds, dioxins and furans and terpenes, as per Section 6.1 of the Terms of Reference (NSE 2019b) and further communication with NSE (S. Vervaeet, personal communication, July 12, 2019). The considered list was refined using published literature focused on the pulp and paper industry, including the National Council for Air Stream Improvement Inc.'s (NCASI) Handbook of Substance-Specific Information for National Pollutant Release Inventory Reporting (NPRI) for Pulp and Paper Mills (NCASI 2007) and those presented as being released from pulp and paper mills in Ontario's Technical Standards to Manage Air Pollution (Appendix 4-A) (MECP 2018a). Of the refined contaminant list, those included in the revised emission inventory, and therefore assessed through modelling, were identified based on site-specific data, data obtained from Kraft mills with similar operations (e.g. AST ETF and co-combustion of biosludge and biomass – mills included Howe Sound and Crofton), and published literature specific to the Project operations, as per the following considerations:

- the contaminant was found to be present in the Northern Pulp biomass boiler stack emissions testing data when combusting biomass
- the contaminant was found to be present in the analysis of site un-treated effluent
- the contaminant is expected to be released from Kraft pulp mill AST effluent, as presented in NCASI 2007
- the contaminant is identified in NCASI 2007 as being released from power boiler combustion of biomass (i.e. hog fuel)
- the contaminant was found to be present in sludge analyzed from a similar Kraft pulp mill that has an AST ETF (sludge analyzed from Howe Sound Kraft pulp mill)
- the contaminant was found to be present in power boiler stack emissions testing data of similar Kraft pulp mills co-combusting biomass and AST biosludge (stack testing data from Howe Sound and Crofton Kraft pulp mills)

The air contaminants of interest that were assessed in this expanded modelling study were those identified to be potentially emitted specifically from the Project (i.e. the proposed ETF and/or from the co-combustion of biomass with a mixture of biosludge in the biomass boiler). If other mill sources are also expected to emit the identified air contaminants of interest, they were included in the assessment.



EXPANDED AIR DISPERSION MODELLING STUDY

Dispersion modelling was performed using the AERMOD dispersion modelling system (v16216r) considering hourly meteorological data for 2013-2017. The receptor grid used for the dispersion modelling consisted of a 30 km by 30 km grid surrounding the Facility. The model included ten discrete receptors representing nearby residential areas. Predicted concentrations of carbon monoxide, nitrogen dioxide, sulphur dioxide, total particulate matter, and hydrogen sulphide were assessed against the Maximum Permissible Ground Level Concentration Limits presented in Government of Nova Scotia under Regulation 150/2017 - *Air Quality Regulations*, as amended on October 12, 2017. Fine particulate matter was assessed against ambient air quality standards included in Northern Pulp's Industrial Approval (2011-076657-A01) which are consistent with the Canadian Ambient Air Quality Standards. The remaining air contaminants of interest were compared to Ontario Regulation 419/05 -- *Air Pollution – Local Air Quality* (O. Reg. 419/05) criteria, in the absence of Nova Scotia provincial standards and for comparison purposes.

The maximum predicted GLCs for the air contaminants regulated by the Nova Scotia -- *Air Quality Regulation* (2017) were below applicable limits. The remaining air contaminants of interest were compared against the limits prescribed in O. Reg. 419/05. Of the contaminants compared to O. Reg. 419/05 limits, ammonia, chloroform, total reduced sulphur (TRS), and hexavalent chromium were found to be above applicable limits. At the discrete receptors, the contaminants with health-based limits (ammonia, chloroform, 24-hour average TRS, and hexavalent chromium) were predicted to be above their respective limits infrequently or not at all. At the discrete receptors, hexavalent chromium was not predicted to exceed its limit, while exceedances of ammonia, chloroform and 24-hour average TRS were predicted to occur less than 0.5% of the time.

Emission rates were based on a combination of site-specific data, data from alternative Kraft pulp mills, and published emission estimation methods, and as such, emissions are expected to be conservative and maximum predicted GLCs may not be representative. Stantec therefore recommends that once the replacement ETF is operational, source emissions testing (with follow-up air dispersion modelling) and ambient air monitoring of selected contaminants of interest be conducted to evaluate compliance with the applicable ambient air quality criteria. If the revised air dispersion modelling results and/or the monitoring results indicate the need for mitigation (i.e. an air criteria exceedance is measured or found), an air emission reduction plan will be developed and submitted to NSE for review and approval prior to implementing mitigation actions.



EXPANDED AIR DISPERSION MODELLING STUDY

INTRODUCTION

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1.0 INTRODUCTION

Northern Pulp Nova Scotia Corporation (Northern Pulp) currently operates a Kraft pulp mill (the Facility) located at Abercrombie Point, Pictou County, Nova Scotia (approximately 3 kilometers from the town of Pictou and 9 km from New Glasgow). The Facility has been in operation since September 1967 and currently produces 280,000 to 300,000 air dried metric tonnes (ADMT) of bleached Kraft pulp per year. The Facility is approved to operate up to 330,000 ADMT annually, however, there are no current plans to increase production. The effluent waste from the Facility is treated in an existing effluent treatment facility (ETF) located approximately 4 km east of the mill site and consists of a series of sedimentation, aeration, and stabilization basins. The existing ETF is owned by the Government of Nova Scotia and operated by Northern Pulp. This system must be closed by 2020 in accordance with the *Boat Harbour Act*. The design of a replacement effluent treatment facility (ETF) is currently underway and will consist of an activated sludge treatment (AST) system, including a primary clarifier, an aeration basin and two secondary clarifiers. The replacement ETF will be located within the site boundaries of the mill. The locations of the existing and replacement ETFs are displayed in Figure 1.1. In addition, Northern Pulp is planning to co-combust a mixture of biomass with primary and secondary biosludge from the replacement ETF in the Facility biomass boiler. These two future changes (replacement ETF and combustion of biosludge in the biomass boiler) are referred to throughout this report as “the Project”.

In the winter of 2018 Stantec Consulting Ltd. (Stantec) was retained by Northern Pulp to conduct an air dispersion modelling study to support the Environmental Assessment (EA) for the replacement ETF. The original air dispersion modelling study focused on criteria air contaminants regulated by the Government of Nova Scotia under Regulation 150/2017 - *Air Quality Regulations*, as amended on October 12, 2017, and those included in the Facility’s Industrial Approval (2011-076657-A01). The EA for the Project was registered with Nova Scotia Environment (NSE) on February 9, 2019 and on March 29, 2019, the Minister of Environment determined that the EA was insufficient to make a decision on the Project and that a Focus Report, pursuant to clause 13(1)c of the Environmental Assessment Regulations, in accordance to Part IV of the Environment Act, would be required. Subsequently, the “Terms of Reference for the Preparation of a Focus Report Regarding the Replacement Effluent Treatment Facility Project” (NSE 2019b) were issued on April 23, 2019 and included the following conditions pertaining to air quality:

“6.1 Provide a revised inventory of all potential air contaminants to be emitted from the proposed Project, including but not limited to, speciated volatile organic compounds, semi-volatile organic compounds, reduced sulphur compounds, polyaromatic hydrocarbons and metals.

6.2 Update the air dispersion modelling for the pulp mill facility for all potential air contaminants of concern related to the Project.

6.3 Complete an updated ambient air monitoring plan for the Project site based on the air dispersion modelling results. This plan must include the potential air contaminants to be monitored and proposed air monitoring locations.”



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INTRODUCTION

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In response to the Terms of Reference for the Focus Report, Stantec developed a revised inventory of potential air contaminants emitted from the Project and conducted an expanded air dispersion modelling study. This expanded dispersion modelling study was conducted to fulfill the requirements stated in Section 6.1 and 6.2 of the Terms of Reference. The development of an ambient air monitoring plan, as per Section 6.3 of the Terms of Reference, is being completed by Northern Pulp and will be submitted under a separate cover.

The expanded dispersion modelling assessment was conducted with the objective of assessing the Project's potential effects on ground-level concentrations (GLCs) for air contaminants of interest to the Project. The dispersion modelling was performed for the Project as per Section 6.2 of the Terms of Reference (NSE 2019b). The Project includes the replacement ETF and the co-combustion of biosludge from the replacement ETF and biomass in the biomass boiler, while the operation of all other Facility activities remains the same.

This report is divided into the following sections:

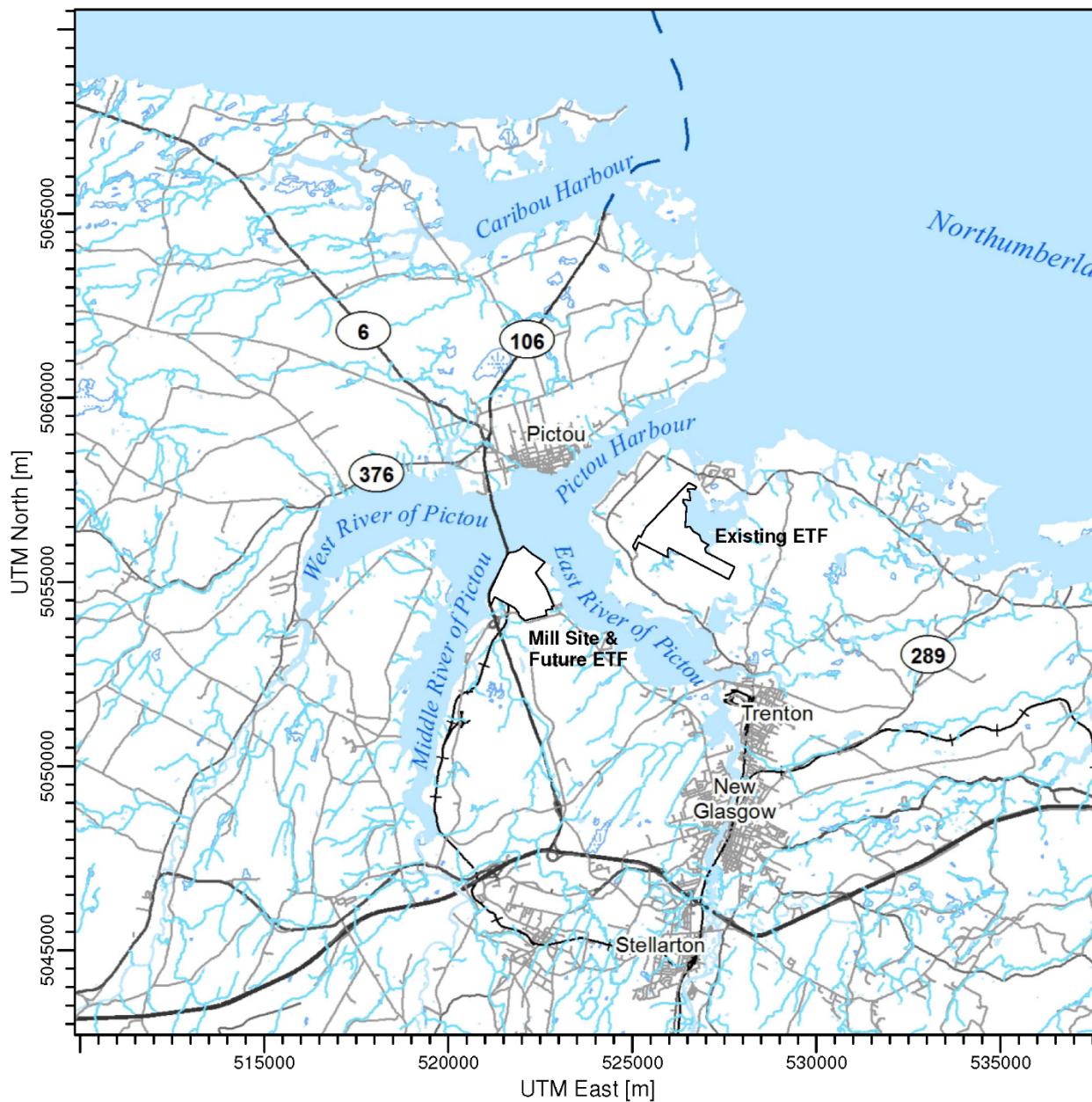
- Section 1 provides a general introduction to the Project;
- Section 2 provides a description of the Facility and operations;
- Section 3 describes the air contaminants of interest to this study and applicable air quality criteria;
- Section 4 provides an overview of the Project emissions;
- Section 5 provides the methods and inputs used to conduct the air dispersion modelling;
- Section 6 provides the results of the modelling study;
- Section 7 provides a discussion of the results;
- Section 8 provides a summary and the overall conclusions;
- Section 9 provides closing remarks;
- Section 10 provides the list of references used in the report; and
- Appendices A to D provide additional supporting documentation.



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INTRODUCTION
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Figure 1.1 Location of the Northern Pulp Kraft Mill, Existing and Future Effluent Treatment Facilities (ETFs)¹



¹ North American Datum (NAD) 83, UTM Zone 20.



EXPANDED AIR DISPERSION MODELLING STUDY

FACILITY DESCRIPTION AND PROCESS OVERVIEW

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2.0 FACILITY DESCRIPTION AND PROCESS OVERVIEW

The pulping process at the Facility consists of digesting wood chips in white liquor at elevated temperature and pressure in a continuous digester to separate lignin from cellulose fibers. Once the cooking of the wood chips is complete, the stock is transferred to a blow tank and then to brown stock washers, where the pulp is separated from the cooking liquor by continuous washing of progressively cleaner water. The separated pulp is further washed, bleached, pressed and dried into the finished product, with ventilation in place during the washing and the bleaching stages to remove water vapour and airborne contaminants. The remainder of the process is designed to recover cooking liquor (for reuse) and heat.

The spent cooking liquor and the pulp wash liquid are combined to form weak black liquor, which is sent through a series of evaporators to concentrate solids to about 55%. This liquor is then further concentrated within a direct-contact evaporator to form strong black liquor (approximately 70% solids). The strong black liquor is burned in the recovery boiler to provide heat and power for the mill's processes. Gases from storage tanks at each stage of the concentration process are vented into either the high-level roof vent (HLRV) or into the recovery boiler for direct incineration. The inorganic material that is collected following the burning of strong black liquor is called smelt. Smelt is combined with weak wash to form green liquor in the smelt dissolving tank. The green liquor is clarified then converted back to white liquor (for re-use in the chip digestion process), in the slaker and causticizer system by adding calcium oxide (quicklime). The mud precipitate from the green liquor clarification process is sent to a lime kiln to regenerate the calcium oxide (quicklime).

The mill also operates a biomass boiler that primarily burns biomass (coarse wood chips and bark); however, natural gas is used as needed. The proposed Project will include the combustion of a mixture of biomass and AST biosludge at an approximate ratio of 14:1.

In addition to the major emissions sources (recovery boiler, smelt dissolving tank, lime kiln and biomass boiler) described above, a number of smaller exhausts at the mill are directed to a single vent, referred to as the high level roof vent (HLRV), and released to the atmosphere. Currently, the mill's effluent is piped under the East River to the existing ETF located at Boat Harbour. Here, the effluent is treated by a series of sedimentation, aeration and stabilization basins prior to being released to the Northumberland Strait. The replacement ETF will consist of an activated sludge treatment (AST) system including; a primary clarifier, an aeration basin, and two secondary clarifiers. The replacement ETF will be located within the site boundaries of the mill.

The primary sources of air contaminants of interest to this study include:

- biomass boiler
- recovery boiler
- smelt dissolving tank
- lime kiln
- high level roof vent
- replacement AST ETF



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FACILITY DESCRIPTION AND PROCESS OVERVIEW

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Of the primary emissions sources described above, the following are equipped with pollution control technology:

- recovery boiler – ESP and wet scrubber
- smelt dissolving tank – wet scrubber
- lime kiln – wet scrubber
- biomass boiler – wet scrubber

There are a number of other secondary emissions sources associated with the pulping process. These emissions sources include:

- bleach pulp dryer
- causticizer
- salt cake mix tank
- lime mud precoat filter
- precoat filter vacuum pump exhaust
- white liquor tank
- dregs filter hood exhaust
- green liquor clarifier
- slaker with a wet scrubber
- unbleached pulp storage tank
- steam stripper-off gases (when not able to be incinerated)



EXPANDED AIR DISPERSION MODELLING STUDY

AIR CONTAMINANTS OF INTEREST

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3.0 AIR CONTAMINANTS OF INTEREST

The air contaminants considered in the original air dispersion modelling study (Stantec 2019) included those regulated by the Government of Nova Scotia under the *Air Quality Regulations* (2017) as well as fine particulate matter (PM_{2.5}), as it is regulated under Northern Pulp's Industrial Approval (2011-076657-A01). These contaminants are:

- carbon monoxide (CO)
- hydrogen sulphide (H₂S)
- nitrogen dioxide (NO₂)
- sulphur dioxide (SO₂)
- total suspended particulate matter (TSP)
- fine particulate matter (PM_{2.5})

In this expanded air dispersion modelling study, an extensive list of air contaminants potentially released from the Project, beyond those regulated in Nova Scotia, have been considered as required in Section 6.1 of the Terms of Reference for the Focus Report.

The air contaminants considered in the development of the revised inventory for the Project included criteria air contaminants (CACs), metals, polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs), reduced sulphur compounds, dioxins and furans and terpenes, as per Section 6.1 of the Terms of Reference (NSE 2019b) and further communication with NSE (S. Vervaeet, personal communication, July 12, 2019). The considered list was refined using published literature focused on the pulp and paper industry, including the National Council for Air Stream Improvement Inc.'s (NCASI) Handbook of Substance-Specific Information for National Pollutant Release Inventory Reporting (NPRI) for Pulp and Paper Mills (NCASI 2007) and those presented as being released from pulp and paper mills in Ontario's Technical Standards to Manage Air Pollution (Appendix 4-A) (MECP 2018a). Of the refined contaminant list, those included in the revised emission inventory, and therefore assessed through modelling, were identified based on site-specific data, data obtained from Kraft mills with similar operations (e.g. AST ETF and co-combustion of biosludge and biomass – mills included Howe Sound and Crofton), and published literature specific to the Project operations, as per the following considerations:

- the contaminant was found to be present in the Northern Pulp biomass boiler stack emissions testing data when combusting biomass
- the contaminant was found to be present in the analysis of site un-treated effluent
- the contaminant is expected to be released from Kraft pulp mill AST effluent, as presented in NCASI 2007
- the contaminant is identified in NCASI 2007 as being released from power boiler combustion of biomass (i.e. hog fuel)
- the contaminant was found to be present in sludge analyzed from a similar Kraft pulp mill that has an AST ETF (sludge analyzed from Howe Sound Kraft pulp mill)
- the contaminant was found to be present in power boiler stack emissions testing data of similar Kraft pulp mills co-combusting biomass and AST biosludge (stack testing data from Howe Sound and Crofton Kraft pulp mills)



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The revised inventory of air contaminants determined to be potentially emitted from the Project, based on the above considerations, include:

Metals:

- Aluminum (Al)
- Antimony (Sb)
- Arsenic (As)
- Barium (Ba)
- Beryllium (Be)
- Boron (B)
- Cadmium (Cd)
- Calcium Oxide (CaO)
- Chromium (Cr)
- Hexavalent Chromium Cr(VI)
- Cobalt (Co)
- Copper (Cu)
- Iron (Fe)
- Ferric Oxide (Fe₂O₃)
- Lead (Pb)
- Lithium (Li)
- Magnesium (Mg)
- Magnesium Oxide (MgO)
- Manganese (Mn)
- Mercury (Hg)
- Nickel (Ni)
- Phosphorus (P)
- Selenium (Se)
- Silver (Ag)
- Strontium (Sr)
- Titanium (Ti)
- Vanadium (V)
- Zinc (Zn)

Criteria Air Contaminants (CACs):

- Carbon Monoxide (CO)
- Total suspended particulate matter (TSP)
- Particulate Matter smaller than 10 microns (PM₁₀)
- Particulate Matter smaller than 2.5 microns (PM_{2.5})
- Nitrogen oxides (NO_x), expressed as nitrogen dioxide (NO₂)
- Sulphur Dioxide (SO₂)

VOCs:

- Acetaldehyde
- Acetone
- Acrolein
- Benzene
- 1,3-Butadiene
- Butanol, n
- Chloroform
- Chloromethane

- Cyclohexane
- Dichloromethane
- Ethyl Benzene
- Ethylene Dichloride (1,2-Dichloroethane)
- Formaldehyde
- Hexane, n
- Methanol
- Methyl Ethyl Ketone
- Methyl Isobutyl Ketone
- Phenol
- Propionaldehyde
- Terpenes (α-pinene and β-pinene)
- Toluene
- Xylenes

PAHs:

- Acenaphthene
- Acenaphthylene
- Benz(a)anthracene
- Benzo(a)phenanthrene (Chrysene)
- Benzo(a)pyrene
- Benzo(b)fluoranthene
- Benzo(b,j) fluoranthene
- Benzo(e)pyrene
- Benzo(g,h,i)perylene
- Benzo(j)fluoranthene
- Benzo(k)fluoranthene
- Dibenz(a,j)acridine
- Fluoranthene
- Fluorene
- Hexachlorobenzene
- Indeno(1,2,3-c,d)pyrene
- Naphthalene
- Perylene
- Phenanthrene
- Pyrene
- Quinoline

TRS:

- Carbon Disulphide
- Dimethyl sulphide
- Dimethyl Disulphide
- Hydrogen Sulphide
- Methyl Mercaptan

Other:

- Ammonia (NH₃)
- Hydrochloric Acid
- Dioxins and Furans



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The specific considerations for why each of the considered air contaminants were included or excluded from the revised inventory, and subsequent modelling, are summarized in Appendix A.

The air contaminants of interest that were assessed in this modelling study were those identified to be potentially emitted specifically from the Project (i.e. the proposed AST ETF and the co-combustion of biomass with a mixture of biosludge in the biomass boiler). If other mill sources were also expected to emit the identified air contaminants of interest, they were also included in the assessment.

3.1 AMBIENT AIR QUALITY CRITERIA

Air quality in Nova Scotia is regulated under the *Air Quality Regulations* (NSE 2017). The Regulations specify concentrations for CACs including nitrogen dioxide (NO₂), total suspended particulate matter (TSP), carbon monoxide (CO), sulphur dioxide (SO₂), ozone (O₃) and hydrogen sulphide (H₂S). The regulations also address other issues such as the provincial cap on the emission of SO₂. The Nova Scotia *Air Quality Regulations* (NSE 2017) under Schedule A are presented in Table 3.1.

Table 3.1 Nova Scotia Air Quality Regulations, Schedule “A”

Air Contaminant	Averaging	Nova Scotia Maximum Permissible Ground Level Concentration Limits	
	Period	µg/m ³	pphm
Carbon monoxide (CO)	1 hour	34 600	3000
	8 hours	12 700	1100
Hydrogen sulphide (H ₂ S)	1 hour	42	3
	24 hours	8	0.6
Nitrogen dioxide (NO ₂)	1 hour	400	21
	Annual	100	5
Ozone (O ₃)	1 hour	160	8.2
Sulphur dioxide (SO ₂)	1 hour	900	34
	24 hours	300	11
	Annual	60	2
Total suspended particulate (TSP)	24 hours	120	-
	Annual	70 ¹	-

¹ geometric mean
 µg/m³ - micrograms per cubic metre
 pphm - parts per hundred million

Currently, there are no provincial ambient air quality standards for fine particulate matter (i.e. particulate matter less than 2.5 microns in diameter (PM_{2.5})). However, ambient air quality standards for PM_{2.5} are included in Northern Pulp’s Industrial Approval (2011-076657-A01, Table 1 Section 9 c)). These criteria are consistent with the Canadian Ambient Air Quality Standards for PM_{2.5}. For a 24-hour time averaging period the criterion is 27 µg/m³ (criteria as of 2020) and for the annual time averaging period it is 8.8 µg/m³ (criteria as of 2020). The 24-hour standard is based on a 3-year average of the 98th percentile of



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the daily 24-hour average concentrations in each consecutive year and the annual standard is based on a 3-year average of the annual average concentrations in three consecutive years.

The remaining contaminants of interest to this study do not have Nova Scotia provincial standards. Therefore, these were assessed against the limits prescribed in Ontario Regulation 419/05: Air Pollution – Local Air Quality, and published in Ontario’s Ministry of the Environment, Conservation and Parks (MECP) Air Contaminants Benchmarks list (MECP 2018b). The O. Reg. 419/05 limits for the air contaminants of interest to this study are presented in Table 3.2 along with the limiting effects (e.g. health, odour, particulate, corrosion) in which these limits were based on.

As per O. Reg. 419/05, Benzo[a]pyrene (B[a]P) is considered a surrogate for all PAHs. If B[a]P complies with the air standard, all other PAHs are considered to meet the standard and to have negligible carcinogenic risks. There are a few other individual PAHs that have specific Ontario Air Quality standards (e.g. naphthalene) which are assessed individually.

As per O. Reg. 419/05, if a facility emits multiple total reduced sulphur (TRS) compounds, then the TRS-specific standard applies and the standards for the individual TRS compounds do not. As hydrogen sulphide has a limit in Nova Scotia, it was assessed individually and as part of TRS. The other TRS compounds (i.e. dimethyl disulphide, dimethyl sulphide, mercaptans and carbon disulphide) will only be assessed as part of TRS.

In Schedule 6 of O. Reg. 419/05, thresholds known as “Upper Risk Thresholds” (URTs) are set, which are higher than the corresponding air standards. URTs are not standards but are instead used to manage risk and are considered when evaluating requests for site-specific standards. Respective URTs have been included in Table 3.2. If an URT is exceeded, timely action may be required by a facility to reduce emissions.

Table 3.2 Ontario Regulation 419/05 Air Quality Limits (MECP 2018b)

Air Contaminant	CAS No.	Averaging Period	Ontario Air Quality Limits ($\mu\text{g}/\text{m}^3$)	Limiting Effect
Aluminum	7429-90-5	24-hour	12	Health
Antimony	7440-36-0	24-hour	25	Health
Arsenic	7440-38-2	24-hour	0.3	Health
Barium	7440-39-3	24-hour	10	Health
Beryllium	7440-41-7	24-hour	0.01	Health
Boron	7440-42-8	24-hour	120	Particulate
Cadmium	7440-43-9	24-hour	0.025	Health
		24-hour	0.25 ¹	—
Calcium Oxide	1305-78-8	24-hour	10	Corrosion
Chromium	7440-47-3	24-hour	0.5	Health
		24-hour	5 ¹	—
Hexavalent Chromium	18540-29-9	Annual	0.00014	Health
		24-hour	0.07	—
Cobalt	7440-48-4	24-hour	0.1	Health



EXPANDED AIR DISPERSION MODELLING STUDY

AIR CONTAMINANTS OF INTEREST

September 27, 2019

Table 3.2 Ontario Regulation 419/05 Air Quality Limits (MECP 2018b)

Air Contaminant	CAS No.	Averaging Period	Ontario Air Quality Limits (µg/m³)	Limiting Effect
Copper	7440-50-8	24-hour	50	Health
Iron	7439-89-6	24-hour	4	Health
Ferric Oxide	1309-37-1	24-hour	25	Soiling
Lead	7439-92-1	24-hour	0.5	Health
		30-day	0.2	Health
		24-hour	2 ¹	—
Lithium	7439-93-2	24-hour	20	Health
Magnesium	7439-95-4	24-hour	72	Health
Magnesium Oxide	1309-48-4	24-hour	120	Particulate
Manganese	7439-96-5	24-hour	0.4	Health
		24-hour	4 ¹	—
Mercury	7439-97-6	24-hour	2	Health
Nickel	7440-02-0	Annual	0.04	Health
		24-hour	2 ¹	—
Phosphorus	7723-14-0	24-hour	0.5	Health
Selenium	7782-49-2	24-hour	10	Health
Silver	7440-22-4	24-hour	1	Health
Strontium	7440-24-6	24-hour	120	Particulate
Titanium	7440-32-6	24-hour	120	Particulate
Vanadium	7440-62-2	24-hour	2	Health
Zinc	7440-66-6	24-hour	120	Particulate
Particulate matter less than 10 microns in diameter (PM ₁₀) ²	N/A	24-hour	50	Health
Ammonia	7664-41-7	24-hour	100	Health
		24-hour	1000 ¹	—
Hydrochloric Acid	7647-01-0	24-hour	20	Health
		24-hour	200 ¹	—
Dioxins and Furans	N/A	24-hour	0.1 pg TEQ/m ³	Health
Acetaldehyde	75-07-0	24-hour	500	Health
		½-hour	500	Health
		24-hour	5000 ¹	—
Acetone	67-64-1	24-hour	11880	Health
		24-hour	118800 ¹	—
Acrolein	107-02-8	24-hour	0.4	Health
		1-hour	4.5	Health
Benzene	71-43-2	Annual	0.45	Health
		24-hour	100 ¹	—
1,3-Butadiene	106-99-0	Annual	2	Health
		24-hour	300 ¹	—
Butanol, n	71-36-3	10-minute	2100	Odour
Chloroform	67-66-3	24-hour	1	Health
		24-hour	100 ¹	—
Chloromethane	74-87-3	24-hour	320	Health
		24-hour	3200 ¹	—



EXPANDED AIR DISPERSION MODELLING STUDY

AIR CONTAMINANTS OF INTEREST

September 27, 2019

Table 3.2 Ontario Regulation 419/05 Air Quality Limits (MECP 2018b)

Air Contaminant	CAS No.	Averaging Period	Ontario Air Quality Limits ($\mu\text{g}/\text{m}^3$)	Limiting Effect
Cyclohexane	110-82-7	24-hour	6100	Health
		24-hour	61,000 ¹	—
Dichloromethane	75-09-2	24-hour	220	Health
		24-hour	22000 ¹	—
Ethyl Benzene	100-41-4	10-minute	1900	Odour
Ethylene Dichloride (1,2-Dichloroethane)	107-06-2	24-hour	2	Health
		24-hour	200 ¹	—
Formaldehyde	50-00-0	24-hour	65	Health
Hexane, n	110-54-3	24-hour	7500	Health
		24-hour	25,000 ¹	—
Methanol	67-56-1	24-hour	4000	Health
Methyl Ethyl Ketone	78-93-3	24-hour	1000	Health
		24-hour	10,000 ¹	—
Methyl Isobutyl Ketone	108-10-1	24-hour	1200	Odour
Phenol	108-95-2	24-hour	30	Health
		24-hour	300 ¹	—
Propionaldehyde	123-38-6	10-minute	10	Odour
a-pinene	80-56-8	24-hour	1350	Health
b-pinene	127-91-3	24-hour	1350	Health
Toluene	108-88-3	24-hour	2000	Odour
Xylenes	1330-20-7	10-minute	3,000	Odour
		24-hour	730	Health
Benzo(a)pyrene [as a surrogate of total Polycyclic Aromatic Hydrocarbons (PAHs)] ³	50-32-8	Annual	0.00001	Health
		24-hour	0.005	—
Hexachlorobenzene	118-74-1	24-hour	0.011	Health
Naphthalene	91-20-3	24-hour	22.5	Health
		10-minute	50	Health
Quinoline	91-22-5	24-hour	0.005	Odour
Total Reduced Sulphur ⁴	N/A	24-hour	14	Health
		10-minute	13	Odour

1 – Upper Risk Threshold
 2 – Limit from Ontario's Ambient Air Quality Criteria
 3 – Project PAHs surrogated by B[a]P include: Acenaphthene, Acenaphthylene, Benz(a)anthracene, Benzo(a)phenanthrene (Chrysene), Benzo(b)fluoranthene, Benzo(b,j) fluoranthene, Benzo(e)pyrene, Benzo(g,h,i)perylene, Benzo(j)fluoranthene, Benzo(k)fluoranthene, Dibenz(a,j)acridine, Indeno(1,2,3-c,d)pyrene, Phenanthrene, Fluorene, Perylene, Pyrene, and Fluoranthene.
 4 – Total Reduced Sulphur is a combination of hydrogen sulphide, dimethyl disulphide, dimethyl sulphide, methyl mercaptan, and carbon disulphide



EXPANDED AIR DISPERSION MODELLING STUDY

EMISSIONS INVENTORY

September 27, 2019

4.0 EMISSIONS INVENTORY

A revised emissions inventory representing the Facility operations after implementation of the proposed Project was developed. Once the replacement ETF is operational, the major differences between the existing operation of the Facility and the operation of the Project will be:

- the change in the design of the ETF (i.e. activated sludge treatment, AST, vs aerated stabilization basins, ASB), as well as its location (i.e. within the mill property boundary); and
- the co-combustion of biosludge and biomass in the Facility's biomass boiler (vs. biomass and natural gas).

There are no planned changes to the operation of the recovery boiler, lime kiln, smelt dissolving tank, and high-level roof vent.

Rates of emission for each air contaminant included in the revised inventory (Section 3.0) were estimated using various methods such as stack testing results, published emission factors, and engineering calculations. Facility-specific source test data was preferentially used over literature data, as site-specific data has a higher quality and is more representative. For example, if a specific contaminant had an emission factor presented in NCASI for the combustion of biomass (i.e. hog fuel) in power boilers but the site-specific stack test indicated the contaminant was non-detect, it was assessed as non-detect.

As outlined in Section 3.0, the revised emissions inventory considered in this assessment included those air contaminants that could potentially be released from the Project, based on the considerations outlined in Section 3.0. As noted in Section 2.0, the primary contaminant emissions sources at the Facility include the biomass boiler, the recovery boiler, the lime kiln, the dissolving tank, the high-level roof vent, and the proposed replacement ETF. The methodologies used in the emission estimation for each of the Facility sources are described in the following sub-sections.

The emissions inventory for the Project is provided in Table 4.1. Table 4.1 includes emissions data for the primary sources of emission from the Project. The complete emission inventory, including secondary emission sources, is included in Appendix B.



EXPANDED AIR DISPERSION MODELLING STUDY

EMISSIONS INVENTORY

September 27, 2019

Table 4.1 Emissions Inventory – Project (AST and Biosludge in Biomass Boiler)

Contaminant	CAS No.	Emission Rate (g/s)								
		Biomass Boiler	Recovery Boiler	Lime Kiln	Smelt Dissolving Tank	High Level Roof Vent	Primary Clarifier	Aeration Basin	Secondary Clarifier No.1	Secondary Clarifier No.2
Aluminum	7429-90-5	7.85E-02	-	-	-	-	-	-	-	-
Antimony	7440-36-0	3.76E-05	1.33E-05	-	2.83E-05	6.70E-06	-	-	-	-
Arsenic	7440-38-2	2.89E-04	2.30E-07	6.64E-07	1.24E-07	-	-	-	-	-
Barium	7440-39-3	2.07E-03	-	-	-	-	-	-	-	-
Beryllium	7440-41-7	3.22E-06	-	-	-	-	-	-	-	-
Boron	7440-42-8	5.32E-04	-	-	-	-	-	-	-	-
Cadmium	7440-43-9	1.94E-04	6.37E-05	1.39E-05	8.85E-06	-	-	-	-	-
Chromium	7440-47-3	5.25E-04	4.42E-05	1.95E-04	2.65E-06	-	-	-	-	-
Hexavalent Chromium	18540-29-9	2.17E-04	1.24E-04	1.93E-05	3.01E-05	-	-	-	-	-
Cobalt	7440-48-4	4.10E-05	2.48E-05	1.07E-05	3.36E-06	-	-	-	-	-
Copper	7440-50-8	9.52E-04	1.95E-04	1.07E-04	1.06E-04	-	-	-	-	-
Iron	7439-89-6	7.98E-02	-	-	-	-	-	-	-	-
Ferric Oxide	1309-37-1	1.14E-01	-	-	-	-	-	-	-	-
Lead	7439-92-1	8.39E-04	1.06E-04	1.71E-04	3.01E-05	-	-	-	-	-
Lithium	7439-93-2	2.53E-05	-	-	-	-	-	-	-	-
Magnesium	7439-95-4	3.58E-01	-	-	-	-	-	-	-	-
Magnesium Oxide	1309-48-4	5.93E-01	-	-	-	-	-	-	-	-
Manganese	7439-95-5	2.01E-02	4.60E-04	3.21E-04	9.73E-05	-	-	-	-	-
Mercury	7439-97-6	4.42E-05	3.26E-06	9.64E-09	-	-	-	-	-	-
Nickel	7440-02-0	4.27E-04	2.83E-04	1.03E-04	4.07E-05	-	-	-	-	-
Phosphorus	7723-14-0	5.73E-04	1.77E-03	1.82E-03	1.59E-04	-	-	-	-	-
Selenium	7782-49-2	2.24E-05	7.08E-06	-	2.30E-05	2.71E-06	-	-	-	-
Silver	7440-22-4	3.92E-04	3.72E-05	1.67E-06	1.95E-05	-	-	-	-	-
Strontium	7440-24-6	2.37E-03	-	-	-	-	-	-	-	-
Titanium	7440-32-6	6.00E-03	-	-	-	-	-	-	-	-



EXPANDED AIR DISPERSION MODELLING STUDY

EMISSIONS INVENTORY

September 27, 2019

Table 4.1 Emissions Inventory – Project (AST and Biosludge in Biomass Boiler)

Contaminant	CAS No.	Emission Rate (g/s)								
		Biomass Boiler	Recovery Boiler	Lime Kiln	Smelt Dissolving Tank	High Level Roof Vent	Primary Clarifier	Aeration Basin	Secondary Clarifier No.1	Secondary Clarifier No.2
Vanadium	7440-62-2	3.28E-04	-	-	-	-	-	-	-	-
Zinc	7440-66-6	5.29E-02	5.13E-04	8.99E-05	9.73E-04	-	-	-	-	-
TSP	N/A	3.96E+00	3.22E-01	2.36E+00	3.06E+00	-	-	-	-	-
PM ₁₀	N/A	2.32E+00	2.40E+00	1.24E+00	1.33E+00	4.42E-02	-	-	-	-
PM _{2.5}	N/A	1.10E+00	9.26E-03	5.28E-01	4.86E-01	-	-	-	-	-
Carbon Monoxide	630-08-0	1.30E+01	7.98E+01	-	2.40E-02	4.61E+00	-	-	-	-
Nitrogen oxides (expressed as Nitrogen Dioxide)	10102-44-0	3.60E+00	5.82E+00	2.57E+00	5.65E-02	7.40E-01	-	-	-	-
Sulphur Dioxide	7446-09-5	8.13E-02	-	-	1.38E+00	4.02E-01	-	-	-	-
Ammonia	7664-41-7	-	4.60E+00	-	7.43E-01	0.00E+00	1.48E+00			
Hydrochloric Acid	7647-01-0	1.82E-02	7.62E-01	-	-	1.09E-01	-	-	-	-
Dioxins and Furans (total)	N/A	1.20E-09	2.30E-12	-	-	-	-	-	-	-
Acetaldehyde	75-07-0	8.24E-03	9.76E-03	9.21E-03	9.73E-03	4.22E-01	3.52E-02			
Acetone	67-64-1	4.20E-01	5.14E-02	1.66E-03	5.71E-03	1.49E-01	3.37E+00			
Acrolein	107-02-8	2.81E-03	2.30E-03	6.00E-06	4.78E-04	1.52E-04	-	-	-	-
Cyclohexane	110-82-7	2.11E-04	1.30E-03	4.20E-05	1.45E-04	3.78E-03	1.18E-01			
Benzene	71-43-2	1.29E-03	1.59E-02	2.57E-04	6.73E-06	1.28E-04	1.13E-04			
1,3-Butadiene	106-99-0	Below DL	1.44E-04	9.85E-06	2.48E-05	1.32E-04	6.94E-04			
Butanol, n	71-36-3	-	-	-	-	-	5.34E-01			
Chloroform	67-66-3	5.85E-04	8.28E-06	1.07E-05	8.49E-07	2.29E-02	9.33E-03			
Chloromethane	74-87-3	3.96E-05	2.83E-03	1.82E-03	9.73E-04	8.91E-03	3.13E-05			
Dichloromethane	75-09-2	1.02E-03	4.44E-04	1.43E-05	3.36E-06	4.85E-04	7.06E-04			
Ethyl Benzene	100-41-4	4.61E-05	-	-	-	-	-	-	-	-



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EMISSIONS INVENTORY

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Table 4.1 Emissions Inventory – Project (AST and Biosludge in Biomass Boiler)

Contaminant	CAS No.	Emission Rate (g/s)								
		Biomass Boiler	Recovery Boiler	Lime Kiln	Smelt Dissolving Tank	High Level Roof Vent	Primary Clarifier	Aeration Basin	Secondary Clarifier No.1	Secondary Clarifier No.2
Ethylene Dichloride (1,2-Dichloroethane)	107-06-2	1.31E-04	2.66E-04	1.56E-05	8.85E-07	1.13E-04	5.47E-05			
Formaldehyde	50-00-0	2.98E-02	7.28E-02	3.43E-03	3.36E-03	2.64E-02	3.82E-04			
n-hexane	110-54-3	7.35E-02	9.79E-05	1.37E-05	2.12E-05	2.72E-04	2.84E+00			
Methanol	67-56-1	3.06E-02	1.66E-01	1.37E-02	9.73E-02	8.12E+00	7.21E-02			
Methyl Ethyl Ketone	78-93-3	2.58E-03	6.51E-03	6.64E-05	3.19E-05	1.50E-01	4.17E-03			
Methyl Isobutyl Ketone	108-10-1	2.71E-06	1.61E-04	1.69E-05	8.32E-06	1.07E-03	1.53E-03			
Phenol	108-95-2	3.81E-04	1.19E-02	6.21E-03	1.24E-02	1.72E-03	-	-	-	-
Propionaldehyde	123-38-6	2.15E-03	4.79E-03	1.76E-04	5.84E-04	2.52E-02	-	-	-	-
a-pinene	80-56-8	-	3.21E-02	4.92E-07	8.14E-05	3.52E-02	3.54E+00			
b-pinene	127-91-3	-	6.13E-03	4.71E-07	6.55E-05	9.47E-02	8.95E-01			
Toluene	108-88-3	3.14E-04	8.81E-04	4.50E-05	1.04E-04	6.32E-03	5.47E-05			
Xylenes	1330-20-7	2.94E-04	4.36E-05	8.35E-06	5.31E-07	4.78E-02	9.24E-05			
Acenaphthene	83-32-9	1.44E-06	3.04E-06	-	-	-	-	-	-	-
Acenaphthylene	208-96-8	5.91E-06	8.57E-05	-	-	-	-	-	-	-
Benz(a)anthracene	56-55-3	2.32E-07	4.12E-06	5.60E-06	4.00E-05	-	-	-	-	-
Benzo(a)phenanthrene (Chrysene)	218-01-9	1.77E-06	1.08E-04	5.60E-06	9.42E-05	-	-	-	-	-
Benzo(a)pyrene	50-32-8	1.90E-07	5.38E-07	5.60E-06	3.19E-06	-	-	-	-	-
Benzo(b)fluoranthene	205-99-2	4.99E-07	5.40E-06	5.60E-06	8.12E-06	-	-	-	-	-
Benzo(b,j)fluoranthene	205-82-3	1.12E-07	-	-	-	-	-	-	-	-
Benzo(e)pyrene	192-97-2	4.43E-08	2.55E-06	-	4.19E-06	-	-	-	-	-
Benzo(g,h,i)perylene	191-24-2	4.24E-07	5.77E-07	5.60E-06	5.10E-07	-	-	-	-	-
Benzo(j)fluoranthene	191-24-2	4.24E-07	-	-	-	-	-	-	-	-
Benzo(k)fluoranthene	207-08-9	2.39E-07	1.11E-06	5.60E-06	7.11E-06	-	-	-	-	-



EXPANDED AIR DISPERSION MODELLING STUDY

EMISSIONS INVENTORY

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Table 4.1 Emissions Inventory – Project (AST and Biosludge in Biomass Boiler)

Contaminant	CAS No.	Emission Rate (g/s)								
		Biomass Boiler	Recovery Boiler	Lime Kiln	Smelt Dissolving Tank	High Level Roof Vent	Primary Clarifier	Aeration Basin	Secondary Clarifier No.1	Secondary Clarifier No.2
Dibenz(a,j)acridine	224-42-0	1.56E-06	-	-	-	-	-	-	-	-
Fluoranthene	206-44-0	1.75E-05	8.34E-05	1.15E-05	7.91E-04	-	-	-	-	-
Fluorene	86-73-7	6.16E-06	1.26E-05	-	-	-	-	-	-	-
Hexachlorobenzene	118-74-1	1.14E-07	-	-	-	-	-	-	-	-
Indeno(1,2,3-c,d)pyrene	193-39-5	2.09E-07	6.78E-07	5.60E-06	7.77E-07	-	-	-	-	-
Naphthalene ¹	91-20-3	1.14E-03	3.01E-03	9.42E-04	4.96E-04	3.54E-02	3.19E-03			
Phenanthrene	85-01-8	9.57E-05	3.73E-04	5.60E-06	2.53E-03	-	-	-	-	-
Perylene ¹	198-55-0	8.87E-09	6.02E-08	-	7.52E-07	-	-	-	-	-
Pyrene	129-00-0	7.35E-06	2.19E-04	4.39E-05	4.02E-04	-	-	-	-	-
Quinoline	91-22-5	5.26E-06	-	-	-	-	-	-	-	-
Hydrogen Sulphide	7783-06-4	-	2.39E-01	2.30E-03	3.52E-04	1.34E+00	2.27E-02	3.52E-02	1.09E-02	1.09E-02
Methyl Mercaptan	74-93-1	-	6.16E-01	3.29E-01	8.22E-02	1.64E-01	1.24E-03	5.10E-02	-	-
Dimethyl Sulphide	75-18-3	-	6.16E-01	3.29E-01	8.22E-02	1.64E-01	5.87E-03	1.28E-01	-	-
Dimethyl Disulphide	624-92-0	-	6.16E-01	3.29E-01	8.22E-02	1.64E-01	1.74E-03	3.14E-01	-	-
Carbon Disulphide	75-15-0	5.53E-05	-	1.01E-03	4.60E-04	3.61E-02	-	-	-	-
Total Reduced Sulphur ¹	N/A	1.11E-03	1.46E+00	6.54E-01	1.63E-01	1.70E+00	8.43E-03	3.39E-01	1.09E-02	1.09E-02

"-" air contaminant is not released in a substantial amount from this source
¹ - Expressed as H₂S



EXPANDED AIR DISPERSION MODELLING STUDY

EMISSIONS INVENTORY

September 27, 2019

4.1 BIOMASS BOILER

The biomass boiler, which is proposed to co-combust biomass and biosludge, is expected to potentially release metals, CACs, PAHs, dioxins and furans, and VOCs.

4.1.1 Metals

Metal emission rates from the biomass boiler were estimated for each fuel type (biosludge and biomass), separately and summed together for the total emission rate for each metal.

The biomass portion of the emissions from the Project (i.e. co-combustion of a mixture of biosludge and biomass) of the biomass boiler were estimated using the following information:

- anticipated biomass feed rate
- the 2019 stack emissions testing data and operational data (i.e., biomass feed rate and heat input), where available
- emission factors for combustion of biomass (i.e. hog fuel) published by NCASI 2007 in the absence of stack testing data

The 2019 stack testing emission rates were scaled based on the future projected biomass feed rate and the biomass feed rate during stack testing. For metals that were not measured in the stack tests, emission factors published by NCASI (NACSI 2007) for wood combustion boilers were used in conjunction with anticipated biomass usages.

The sludge portion of the metal emission rates were estimated using two methods as described below. The higher of the two (varying by contaminant) was conservatively used in the modelling assessment.

Sludge Metals Emission Rate - Method 1

The first method to estimate metal emissions from the combustion of biosludge in the biomass boiler used the following information:

- anticipated biosludge feed rate
- sludge analysis data from a similar Kraft pulp mill with an AST ETF (Howe Sound, British Columbia) (Maxxam 2018)

The metal emission rates from the combustion of biosludge were estimated based on metal concentrations in the sludge, with the assumption that metals present in the sludge would be emitted upon combustion. A control efficiency of the wet scrubber was applied, being the same as that for particulate matter (tested to be 81.3%). The portion of specific metals that remained in the ash not emitted to air, as provided by a similar Kraft pulp mill (Powell River) co-combusting biomass and biosludge, was also taken into consideration. As the ETF is not yet operational, site-specific sludge composition could not be obtained, and the sludge composition noted above was used as a surrogate.



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Sludge Metals Emission Rate - Method 2

The second method to estimate metal emissions from the combustion of biosludge in the biomass boiler used the following information:

- anticipated biosludge feed rate
- power boiler stack emissions testing data and operational data (i.e., biomass and biosludge feed rates and heat inputs) from a similar Kraft pulp mill with AST ETF (Howe Sound) (Lanfranco 2018), that combusts a mixture of biosludge and biomass
- emission factors for combustion of biomass (i.e. hog fuel) published by NCASI (2007)

The stack testing emission data from the Howe Sound mill consisted of the emissions from the combustion of both biomass and biosludge. The portion of the emissions expected to be from biomass (estimated using biomass feed rates and NACSI emission factors) were removed from the total emissions to isolate the contribution from combustion of biosludge. The contribution from the combustion of biosludge was then scaled based on the future biosludge feed rate for the Project and the biosludge feed rate at the time of stack testing from the Howe Sound mill.

4.1.2 CACs

The emission rates of CO, SO₂, NO_x, TSP, PM₁₀, and PM_{2.5}, from the Project operations (i.e. co-combustion of a mixture of biosludge and biomass) of the biomass boiler were estimated using the following information:

- anticipated fuel feed rates for both fuel types
- the Facility's stack emissions testing data (averaged of 2015, 2016, 2017 and 2018 testing data) and operational data (i.e., biomass feed rate and heat input)
- guidance published by the United States Environmental Protection Agency (US EPA) AP-42: Compilation of Air Emissions Factors, Chapter 2.2 Sewage Sludge Incineration (US EPA 1995)

As there is limited information publicly available pertaining to the combustion of biosludge from pulp and paper mills, Stantec used guidance published by the US EPA for Sewage Sludge Incineration (AP-42, Chapter 2.2) to estimate emission rates of CO, SO₂, NO_x, TSP, PM₁₀, and PM_{2.5} from this proposed activity. It is emphasized that biosludge is considered by Environment and Climate Change Canada (ECCC) to be a non-hazardous fuel, and the combustion of biosludge in an industrial boiler (such as the biomass boiler) is not considered a form of incineration. This is consistent with guidance published by ECCC (ECCC 2016), "incineration does not include industrial processes where fuel derived from waste is fired as an energy source, such as industrial boilers". Furthermore, during the Project operations, it is anticipated that biomass will remain the primary fuel for the biomass boiler, and biosludge would be combusted at a 14:1 ratio (14 parts biomass to 1 part biosludge). Thus, the emissions profile for the biomass boiler would not be expected to change substantively and is likely to be similar to existing operations.

The total emission rates of CACs included the sum of the contribution from biomass (stack tested data, scaled) and the contribution from biosludge (AP-42, Chapter 2.2).



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4.1.3 VOCs

The emission rates of VOCs from the Project operation of the biomass boiler (i.e. co-combustion of biosludge and biomass) were estimated using the following information:

- anticipated fuel usage for both fuel types
- the 2019 stack emissions testing data and operational data (i.e., biomass feed rate and heat input), where available
- emission factors for combustion of biomass (i.e. hog fuel) published by NCASI (2007) in the absence of stack testing data
- guidance published by the United States Environmental Protection Agency (US EPA) AP-42: Compilation of Air Emissions Factors, Chapter 2.2 Sewage Sludge Incineration (US EPA 1995)

As for CACs, VOC emission estimates were the cumulative emissions from the combustion of biomass (scaled stack testing data, where available, otherwise NCASI (2007) emission factors) and from combustion of biosludge (AP-42, Chapter 2.2).

4.1.4 PAHs and Dioxins and Furans

The emission rates of PAHs and Dioxins and Furans from the Project operation of the biomass boiler were estimated using the following information:

- anticipated biosludge usage
- power boiler stack emissions testing data and operational data (i.e., biomass and sludge feed rates and heat inputs) from two similar Kraft pulp mills with AST ETF - Howe Sound for PAHs and Crofton for Dioxins and Furans, both which co-combust a mixture of biosludge with biomass
- emission factors for combustion of hog fuel (biomass) published by NCASI (2007)

The PAHs and Dioxins and Furans emission rates from the biomass boiler were estimated using the same method as presented for metals (second method). The contribution of emissions from biosludge combustion were isolated from the stack testing results from the similar Kraft mill by removing the expected portion of emissions attributed to the combustion of biomass. This value was scaled based on biosludge usage between the similar facility and Northern Pulp's proposed usage.

4.2 ACTIVATED SLUDGE TREATMENT - EFFLUENT TREATMENT FACILITY

The AST ETF is expected to potentially release TRS, VOCs, ammonia and some species of PAHs.

4.2.1 Total Reduced Sulphur (TRS) Compounds

Emissions of total reduced sulphur (TRS) compounds from the AST ETF were estimated using site-specific effluent concentrations from the 2019 composition analysis performed for the Focus Report (BV Labs 2019) and emission factors presented in a memo from NCASI dated April 26, 2010 titled "Estimation of Reduced Sulphur (TRS) Compound Emissions from Pulp and Paper Wastewater Treatment Plants for NPRI Reporting" (NCASI 2010). Emission rates of the TRS species (hydrogen sulphide, methyl



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mercaptan, dimethyl sulphide, dimethyl disulphide and carbon disulphide) were estimated separately and summed to estimate TRS emissions.

4.2.2 Remaining Contaminants

For the remaining contaminants released from the AST ETF, emissions were estimated based on expected percent volatilization (NCASI 2007) and the concentration in the effluent. Effluent concentrations were preferentially obtained from site-specific data. If site-specific effluent concentrations/data were not available, NCASI published expected concentrations were used, when available. In the instance a contaminant that was a non-detect in the site-specific analysis and did not have a NCASI published effluent concentration despite indicating its expected presence, half of the detection limit was used. If all the above data sources were exhausted, i.e. the contaminant was not analyzed in the site-specific effluent and not presented in NCASI despite indicating its presence is expected, then online published concentrations were used (Lehtinen 2012; Environment Australia 1998). In the case that the expected percent volatilized was not presented in NCASI 2007, it was conservatively assumed that 100% of the contaminant present in the effluent would be emitted except for α -pinene, which has a low volatility, and it was assumed that 50% would be volatilized.

4.3 OTHER EXISTING SOURCES

The emission rates for the other existing sources, for the air contaminants of interest to this study (refer to Section 3.0), were estimated as follows:

- TSP, PM_{2.5}, NO_x, SO₂, CO and TRS from the biomass boiler, dissolving tank, HLRV (including sources that vent to this source), were obtained from Facility stack emissions testing reports from 2015-2018
- emission rate of TRS from the recovery boiler was obtained from continuous emission monitor (CEM) data for 2015, 2016, 2017 and 2018
- emission rate of TRS from the lime kiln was based on CEM data from March 2017 to March 2018 (the CEM on the lime kiln was installed in the winter of 2017)
- H₂S from the biomass boiler, dissolving tank, recovery boiler, lime kiln and HLRV were calculated based on the Facility's specific emissions tests for total reduced sulphur (TRS). This data was speciated for H₂S based on information published by the National Council for Air and Steam Improvement (NCASI) (NCASI 2007)
- TRS emission rates from sources other than the ETF were estimated using emission factors published in the US EPA AP-42 Chapter 10.2 – Chemical Wood Pulping
- emission rates for the remaining contaminants from the other Facility sources (described in Section 2.0) were estimated using emission factors published by NCASI (2007)



5.0 AIR DISPERSION MODELLING METHODOLOGY

5.1 MODEL SELECTION

In the fall of 2012 and winter of 2013, a Facility Air Dispersion Modelling Study was conducted by Stantec (Stantec 2013) on behalf of Northern Pulp to satisfy various conditions in the Facility's Industrial Approval that were in effect at that time. The AERMOD dispersion modelling system was used in the study and was approved by Nova Scotia Environment (NSE). Therefore, AERMOD (version 16216r) was used to complete this air dispersion modelling study.

AERMOD is a steady-state Gaussian plume dispersion model developed by the United States Environmental Protection Agency (U.S. EPA, 2014). The model is designed to incorporate planetary boundary layer concepts to predict downwind concentrations from one or more industrial sources within a defined modelling domain. The AERMOD model system consists of three components: the plume dispersion model (AERMOD), a meteorological pre-processor (AERMET), and a terrain pre-processor (AERMAP). Details pertaining to the AERMOD modelling system are provided in the following paragraphs.

AERMOD makes use of two continuous stability parameters, friction velocity, and Monin-Obukhov length to characterize the atmosphere turbulence. The friction velocity is a measure of mechanical effects alone, such as wind shear at ground-level. The Monin-Obukhov length indicates the relative strengths of mechanical and buoyancy effects on atmospheric turbulence. Thus, AERMOD can account for turbulence both from wind shear and from buoyancy effects due to solar heating during the day and radiational cooling at night. To properly account for these effects, AERMOD requires three land use parameters: albedo, Bowen ratio, and surface roughness. Albedo is defined as the fraction of total incident solar radiation reflected by a particular surface without absorption. Bowen ratio is an indicator of surface moisture conditions and can be defined as the ratio of the sensible heat flux to the latent heat flux and is an indicator of surface moisture conditions. Bowen ratio can vary significantly over the course of the day; however, it usually remains fairly constant during mid-day. Surface roughness is a length scale that characterizes the mechanical mixing of air due to roughness of the earth's surface.

Modern planetary boundary layer theory is used to scale turbulence and other parameters to the height of the plume. AERMET derives hourly mixing heights based on the morning upper air temperature profiles and the surface meteorology, including available solar radiation. AERMAP is a terrain pre-processor that is designed to handle the input of receptor terrain elevation data for the AERMOD dispersion model. With the assumption that the effect of terrain on an individual receptor is directly proportional to the difference between the elevation of the receptor and the height of the local terrain features and inversely proportional to the distance between the receptor and terrain features, AERMAP searches for the terrain height and location that has the greatest influence on dispersion for an individual receptor. This height is referred to as the height scale. The height scale, which is uniquely defined for each receptor location, is



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used to calculate the dividing streamline height along which a plume is assumed to travel under stable atmospheric conditions. Output from AERMAP therefore includes the location and height scale for each receptor, which are used for the computation of air flow around and over elevated terrain features.

5.2 MODELLING APPROACH

Ground level concentrations of the air contaminants of interest (refer to Section 3.0) were predicted for the proposed Project operations.

5.3 MODEL DOMAIN

The modelling domain for the current modelling study consists of a 30 km by 30 km area centered at the mill site (Zone 20, UTM coordinate 522,065 m easting, 5,055,526 m northing). The modelling domain is illustrated in Figure 5.1.

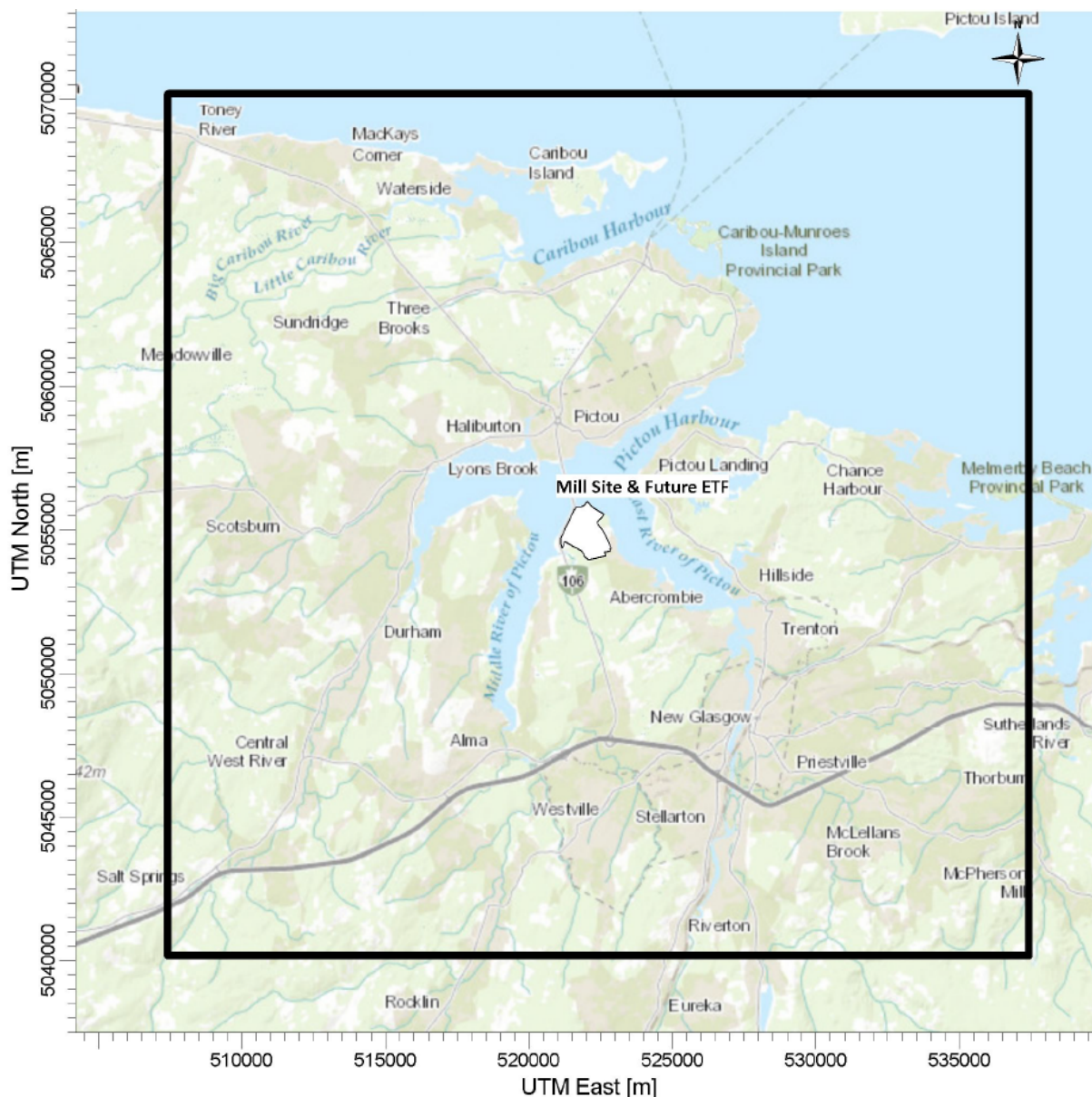


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Figure 5.1 Modelling Domain¹



¹ – North American Datum (NAD) 83 UTM Zone 20



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5.4 TERRAIN DATA

The terrain surrounding the Facility to the south and south-east, is complex, meaning that the height of the surrounding terrain is higher than the release heights (stacks or vents) of the emission sources. Water (i.e. Pictou Harbour) surrounds the Facility to the west, north, and east. The town of Pictou lies to the north of the plant directly across the Pictou Harbour, and Pictou Landing lies north-east of the plant on the east side of Pictou Harbour.

The terrain elevations used in this modelling study were acquired from the online version of Global 30 Arc-Second Elevation (GTOPO30), as available through the United States Geological Survey.

5.5 METEOROLOGICAL DATA

A meteorological data set for a 5-year period (2013-2017) was obtained from Lakes Environmental for both surface and upper air data, corresponding to the location of the Facility (Lakes Environmental Software 2018). The AERMET ready meteorological data files were then processed with AERMET, according to the US EPA Guideline on Air Quality Models, and incorporated into each model run.

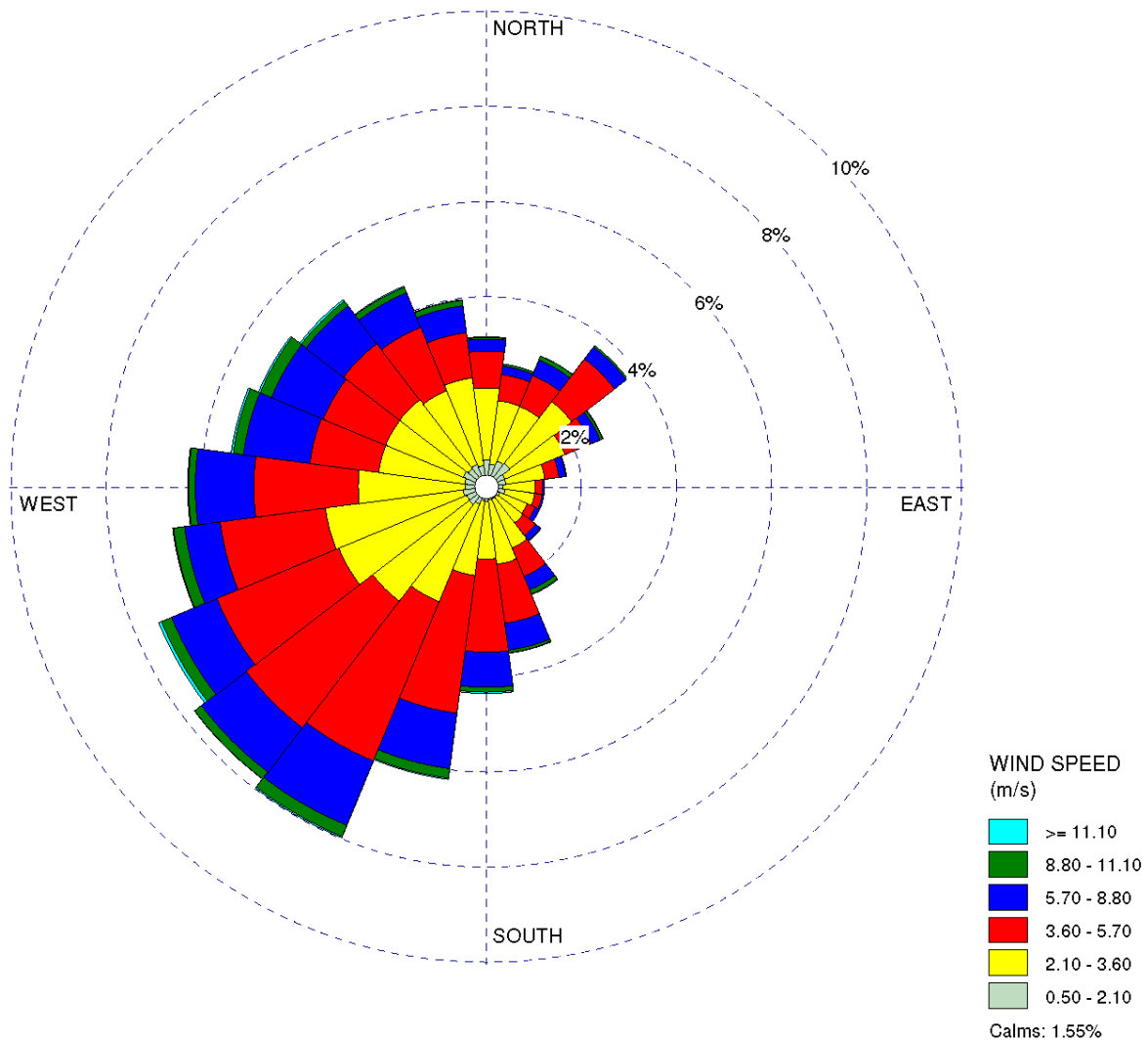
A joint wind direction and speed frequency diagram, or “wind rose”, of these data is presented in Figure 5.2. For wind direction, the convention used is “wind blowing from”.



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Figure 5.2 Annual Windrose (2013-2017) (wind blowing from)



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5.6 BUILDINGS

The buildings at Northern Pulp are relatively large in dimension. Because of their size, they represent aerodynamic structures that can cause the formation of turbulent flow over and around the buildings, and where the flow may interact with the exhaust gases released from stacks and vents. For example, if not released at sufficient height, these exhaust gases may be entrained in the turbulent flow around the building and can be brought down to near ground level in the lee of the building by a process known as downwash. In order to calculate building downwash effects, the Building Profile Input Program (BPIP) was run prior to AERMOD and results were incorporated in the AERMOD runs. BPIP is a program that takes as input the building location, heights and widths and then uses this information to determine whether or not a particular source(s) is subject to wake effects from surrounding structures. If a source is found to be subject to wake effects, BPIP goes on to calculate building downwash parameters. These parameters are then used within AERMOD in the “PRIME” algorithm, to estimate the downwind concentrations at ground level.

For the Facility, building and tank geometries were obtained from AutoCAD drawings provided by Northern Pulp. This information included the building/tank perimeter, elevations of all roof sections, and locations of stacks/vents. For the replacement ETF, information was provided by the design engineers.

5.7 RECEPTORS

Receptors represent specific locations where the air dispersion modelling program (i.e. AERMOD) will compute a ground level concentration value. The receptor grid used for the dispersion modelling consisted of a 30 km by 30 km grid with receptors spaced as follows:

- 20 m spacing for 200 m in all directions surrounding a box enclosing all sources
- 50 m spacing from 500 m out to 800 m
- 100 m spacing from 800 m out to 1,300 m
- 200 m spacing from 1,300 m to 2300 m
- 500 m spacing beyond 7,500 m.

The receptor grid was developed following the Ontario Guideline A-11: Air Dispersion Modelling Guideline for Ontario (MECP 2017). The first tier of the receptor grid (20 m spacing) surrounded every source for a minimum of 200 m. Receptors were not placed within property boundaries.

The receptor grid for modelling is displayed in Figure 5.3.

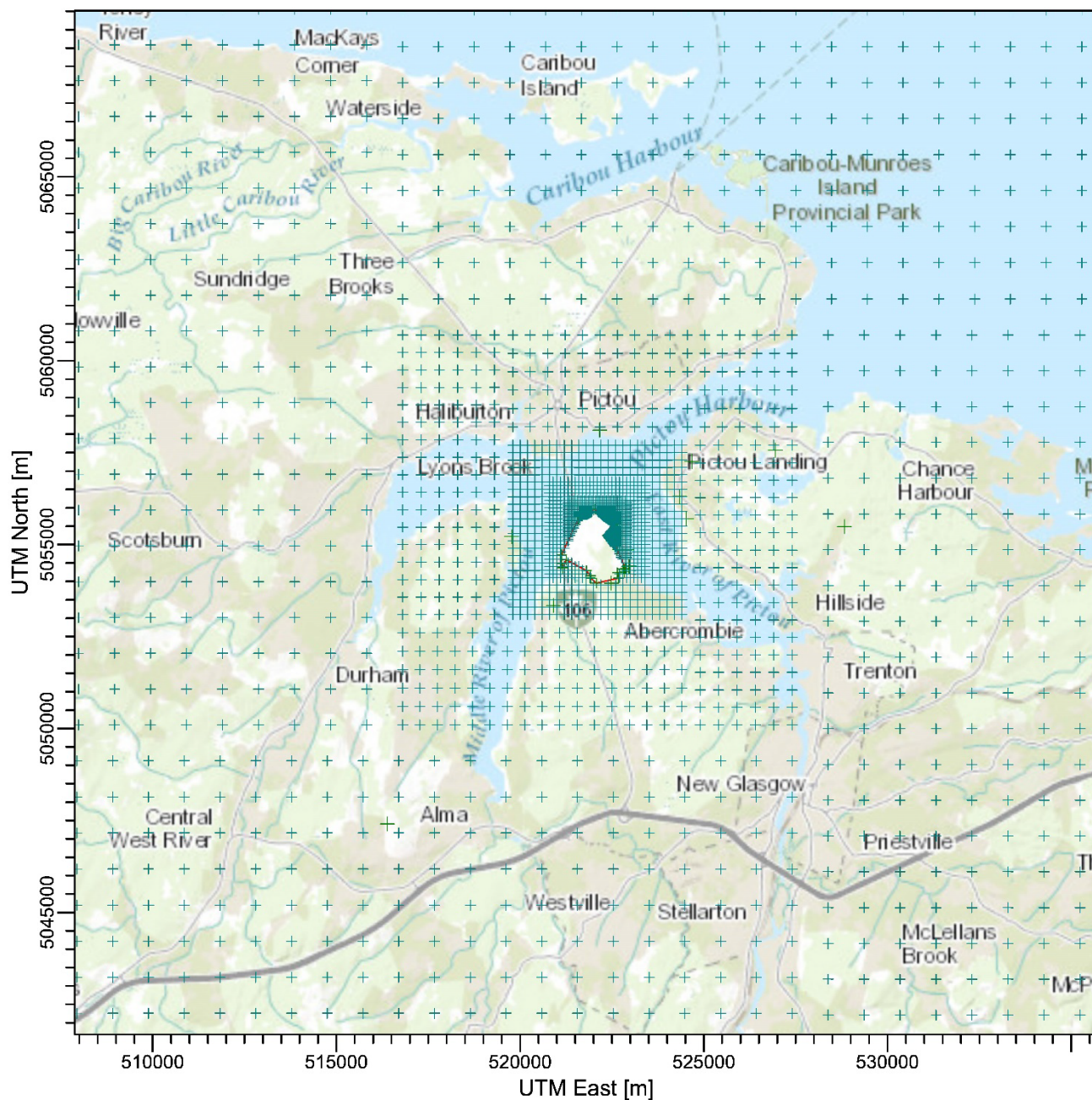


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Figure 5.3 Modelling Receptor Grid¹



¹ – North American Datum (NAD) 83 UTM Zone 20



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Ten discrete receptors were also included in the assessment and are consistent with the ten discrete receptors that were included in the original modelling study. These represent nearby residential areas outside of Northern Pulp's property boundary. The locations of these receptors, and a brief description, are provided in Table 5.1 and illustrated on Figure 5.4.

Table 5.1 Discrete Receptors Used in Dispersion Modelling

Receptor ID	UTM Coordinates ¹		Description
	Easting (m)	Northing (m)	
1	519768	5055219	Residence
2	520907	5053346	Residence
3	522480	5053951	Residence
4	522963	5054415	Residence
5	522899	5054854	Residence
6	524552	5055699	Residence
7	524337	5056312	Residence
8	526942	5057565	Residence
9	528826	5055486	Residence
10	522169	5058110	Residence

¹- North American Datum (NAD_ 83 UTM Zone 20

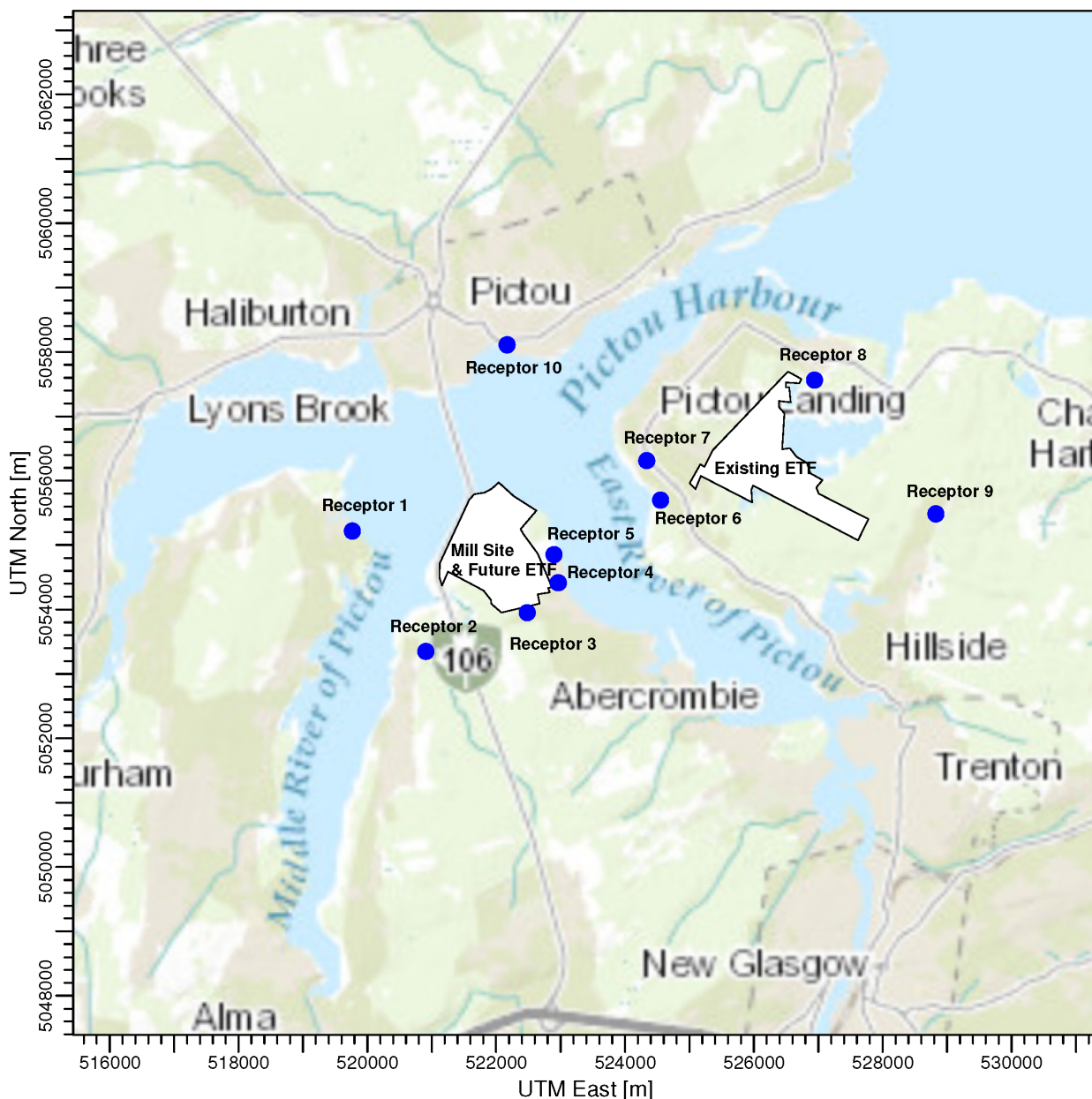


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Figure 5.4 Discrete Receptors¹



¹ – North American Datum (NAD) 83 UTM Zone 20



5.8 SOURCE INFORMATION

The sources of emissions at the Facility can be categorized as either a point source or an area source, based on structural and physical properties of the source and how air contaminants are released. A point source is simply a single location where the exhaust is released to the atmosphere, e.g., an exhaust stack. An area source is typically a single location with air contaminants being released over the area at or near ground level (such as a water treatment lagoon). These groupings are further described below.

5.8.1 Point Sources

The primary point sources of emissions incorporated into the modelling study, along with the source characteristics, are presented in Table 5.2. Emissions information for each of these sources was presented in Section 4. A full source parameter list, containing the secondary sources, is provided in Appendix C.

Table 5.2 Point Emissions Sources and Stack Parameters

Point Sources	UTM Coordinates ¹		Stack Parameters					
	Easting (m)	Northing (m)	Base Elevation (m)	Release Height (m)	Stack Diameter (m)	Gas Exit Flow Rate (m ³ /s)	Gas Exit Velocity (m/s)	Gas Exit Temp. (°C)
Biomass Boiler Scrubber Stack	522111	5055475	10.0	50.6	1.5	25.4	14.4	58
Recovery Boiler Scrubber Stack	522098	5055487	10.0	69.2	3.51	121	12.5	66
Lime Kiln Stack	522187	5055397	10.0	37.0	1.07	11.4	12.7	73
Smelt Dissolving Tank Stack	522105	5055482	10.0	50.6	1.22	8.85	7.57	88
High Level Roof Vent Stack	522077	5055507	10.0	65.4	1.83	49.3	18.8	60

¹ – North American Datum (NAD) 83 UTM Zone 20

5.8.2 Area Sources

For modelling the replacement ETF, the individual components of the system were modelled as area emissions sources. The source parameters, including the area of each component, is presented in Table 5.3. The UTM coordinates provided in Table 5.3 represent the approximate center of the area source.



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Table 5.3 Area Emissions Sources and Source Parameters – Replacement ETF

Area Sources	UTM Coordinates ¹		Base Elevation (m) ²	Area of the Release Surface (m ²)	Release Height above Ground Level (m)
	Easting (m)	Northing (m)			
Primary Clarifier	522199	5055159	22.5	2,462	4.3
Aeration Basin	522589	5055145	17.5	4,183	8.2
Secondary Clarifier No.1	522333	5055211	21.0	2,462	3.7
Secondary Clarifier No.2	522312	5055277	20.2	2,462	3.7

¹ - North American Datum (NAD) 83 UTM zone 20
² - Terrain information acquired from GOTOP030

5.9 NO_x TO NO₂ CONVERSION

Oxides of nitrogen (NO_x) comprise nitric oxide (NO) and nitrogen dioxide (NO₂). Most combustion sources emit primarily NO that can react with ambient ozone (O₃) to produce NO₂. The concentration of NO₂ in the atmosphere then becomes a function of the available O₃ in the atmosphere during the release and mixing in the atmosphere as it travels downwind.

Only ground-level concentrations of NO₂ are regulated in Nova Scotia, therefore the Plume Volume Molar Ratio Method (PVMRM) was used to determine the amount of NO_x emitted from the stack that ends up as NO₂. The PVMRM in AERMOD is used to determine the conversion rate of NO_x to NO₂ based on a calculation of the moles of NO_x emitted into the plume and the amount of O₃ moles contained within the volume of the plume between the source and receptor (US EPA 2002).

The in-stack and equilibrium NO₂/NO_x ratios and ambient concentrations of O₃ are required for input to the AERMOD-PVMRM model. Since the actual values for the NO₂/NO_x ratios are not known, the US EPA AERMOD default values for the in-stack and equilibrium ratios of 0.1 and 0.9 were used in the assessment. The ambient concentration of O₃ included in the AERMOD-PVMRM model was acquired from data collected by ECCC in Pictou, NS through the National Air Pollutant Surveillance (NAPS) monitoring program. The background concentration of O₃ (46 µg/m³) was calculated by averaging the 98th percentile of the maximum 1-hour concentrations for 2014, 2015 and 2016, as collected at the in Pictou, NS monitoring station (ECCC 2017).



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6.0 AIR DISPERSION MODELLING RESULTS

A summary of the air dispersion modelling results are presented in Table 6.1. The results presented include the highest predicted GLCs, after removal of anomalies, over the full receptor grid (approximately 3,800 receptors).

In Nova Scotia, the *Air Quality Regulations* (2017) stipulate a maximum permissible ground level concentration limit and the averaging time for the criterion. Other provinces, including Newfoundland and Labrador, Ontario, and Alberta, in more recent guidance protocols, recognize that the highest few predicted concentrations in dispersion modelling are “outliers” in a statistical sense and are found to be the result of anomalous meteorological conditions. The presence of outliers in the data is recognized in the data presented below, anomalies were removed following the Ontario Air Dispersion Modelling Guidelines (MECP 2017).

Table 6.1 Summary of Maximum Predicted GLCs from the Operation of the Project

Contaminant	Averaging Period	Ambient Air Quality Criteria	Limiting Effect	Predicted Concentration ($\mu\text{g}/\text{m}^3$)	Location of Max. Predicted GLC UTM Coordinates ¹	
					Easting (m)	Northing (m)
Aluminum	24-hour	12	Health	0.83	522540	5055120
Antimony	24-hour	25	Health	8.40E-04	522460	5055180
Arsenic	24-hour	0.3	Health	3.05E-03	522540	5055120
Barium	24-hour	10	Health	0.02	522580	5055300
Beryllium	24-hour	0.01	Health	3.00E-05	Multiple Locations	
Boron	24-hour	120	Particulate	5.60E-03	522540	5055120
Cadmium	24-hour	0.025	Health	2.22E-03	522580	5055080
	24-hour	0.25 ¹	—	2.22E-03	522580	5055080
Chromium	24-hour	0.5	Health	6.75E-03	522600	5055060
	24-hour	5 ¹	—	6.75E-03	522600	5055060
Hexavalent Chromium	Annual	0.00014	Health	2.20E-04	Multiple Locations	
	24-hour	0.07 ¹	—	2.89E-03	522580	5055080
Cobalt	24-hour	0.1	Health	5.60E-04	522580	5055080
Copper	24-hour	50	Health	0.01	522580	5055080
Iron	24-hour	4	Health	0.84	522540	5055120
Ferric Oxide	24-hour	25	Soiling	1.12	522580	5055300
Lead	24-hour	0.5	Health	0.01	522580	5055080
	30-day	0.2	Health	1.93E-03	522240	5055800
	24-hour	2 ¹	—	0.01	522580	5055080
Lithium	24-hour	20	Health	2.70E-04	Multiple Locations	
Magnesium	24-hour	72	Health	3.76	522580	5055300
Magnesium Oxide	24-hour	120	Particulate	6.23	522580	5055300
Manganese	24-hour	0.4	Health	0.22	522600	5055280
	24-hour	4 ¹	—	0.22	522600	5055280



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Table 6.1 Summary of Maximum Predicted GLCs from the Operation of the Project

Contaminant	Averaging Period	Ambient Air Quality Criteria	Limiting Effect	Predicted Concentration (µg/m ³)	Location of Max. Predicted GLC UTM Coordinates ¹	
					Easting (m)	Northing (m)
Mercury	24-hour	2	Health	4.70E-04	522580	5055300
Nickel	Annual	0.04	Health	4.40E-04	Multiple Locations	
	24-hour	2 ¹	—	5.84E-03	522580	5055080
Phosphorus	24-hour	0.5	Health	0.02	522540	5055120
Selenium	24-hour	10	Health	5.90E-04	Multiple Locations	
Silver	24-hour	1	Health	4.42E-03	522580	5055300
Strontium	24-hour	120	Particulate	0.02	522540	5055120
Titanium	24-hour	120	Particulate	0.06	522580	5055300
Vanadium	24-hour	2	Health	3.45E-03	522580	5055300
Zinc	24-hour	120	Particulate	0.57	522540	5055120
Carbon Monoxide ²	1-hour	34600	Health	665	513777	5040300
	8-hour	12700	Health	391	522460	5055160
TSP ²	24-hour	120	Health	91.3	522540	5055320
	Annual	70	Health	7.77	522480	5055300
PM _{2.5}	24-hour	27	Health	19.5	522580	5055300
	Annual	8.8	Health	1.66	522480	5055280
PM ₁₀ ²	24-hour	50	Health	47.1	522580	5055300
Nitrogen Dioxide ²	Annual	100	Health	1.93	522350	5056000
	1-hour	400	Health	43.3	522440	5055180
Sulphur Dioxide ²	24-hour	300	Health	22.9	522440	5055200
	1-hour	900	Health	87.4	522600	5055140
	Annual	60	Health	1.98	522380	5055780
Ammonia	24-hour	100	Health	406	522400	5055220
	24-hour	1000 ¹	—	406	522400	5055220
Hydrochloric Acid	24-hour	20	Health	1.27	522650	5055200
	24-hour	200 ¹	—	1.27	522650	5055200
Dioxins and Furans	24-hour	0.1 pg TEQ/m ³	Health	0.013	522580	5055300
Acetaldehyde	24-hour	500	Health	10.7	522200	5055840
	1/2-hour	500	Health	106	522180	5055860
	24-hour	5000 ¹	—	10.7	522200	5055840
Acetone	24-hour	11880	Health	919	522400	5055220
	24-hour	118800 ¹	—	919	522400	5055220
Acrolein	24-hour	0.4	Health	0.11	522200	5055840
	1-hour	4.5	Odour	0.78	522240	5055820
	24-hour	4 ¹	—	0.11	522400	5055220
Benzene	Annual	0.45	Health	0.01	522200	5055840
	24-hour	100 ¹	—	0.14	522200	5055840
1,3-Butadiene	Annual	2	Health	0.04	522379	5055250
	24-hour	300 ¹	—	0.19	522400	5055220



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Table 6.1 Summary of Maximum Predicted GLCs from the Operation of the Project

Contaminant	Averaging Period	Ambient Air Quality Criteria	Limiting Effect	Predicted Concentration ($\mu\text{g}/\text{m}^3$)	Location of Max. Predicted GLC UTM Coordinates ¹	
					Easting (m)	Northing (m)
Butanol, n	10-minute	2100	Health	1413	522420	5055200
Chloroform	24-hour	1	Health	2.55	522400	5055220
	24-hour	100 ¹	—	2.55	522400	5055220
Chloromethane	24-hour	320	Odour	0.04	522700	5055250
	24-hour	3200 ¹	—	0.04	522700	5055250
Cyclohexane	24-hour	6100	Health	32.2	522400	5055220
	24-hour	61,000 ¹	—	32.2	522400	5055220
Dichloromethane	24-hour	220	Health	0.80	522480	5055280
	24-hour	22000 ¹	—	0.80	522480	5055280
Ethyl Benzene	10-minute	1900	Health	2.84E-03	522650	5055100
Ethylene Dichloride (1,2-Dichloroethane)	24-hour	2	Health	0.02	522400	5055220
	24-hour	200 ¹	—	0.02	522400	5055220
Formaldehyde	24-hour	65	Health	0.50	522700	5055250
Hexane, n	24-hour	7500	Odour	919	522400	5055220
	24-hour	25,000 ¹	—	919	522400	5055220
Methanol ¹	24-hour	4000	Health	38.0	522540	5055020
Methyl Ethyl Ketone	24-hour	1000	Odour	1.16	522400	5055220
	24-hour	10,000	—	1.16	522400	5055220
Methyl Isobutyl Ketone	24-hour	1200	Health	0.43	522400	5055220
Phenol	24-hour	30	Health	10.0	522200	5055840
	24-hour	300 ¹	—	10.0	522200	5055840
Propionaldehyde	10-minute	10	Odour	5.27	522240	5055820
a-pinene	24-hour	1350	Odour	965	522400	5055220
b-pinene	24-hour	1350	Health	244	522400	5055220
Toluene	24-hour	2000	Health	0.14	522600	5055280
Xylenes	10-minute	3000	Health	1.02	522650	5055200
	24-hour	730	Health	0.14	522600	5055280
Hexachlorobenzene	24-hour	0.011	Health	1.20E-06	522450	5055120
Naphthalene	24-hour	22.5	Health	0.88	522400	5055220
	10-minute	50	Health	8.43	522420	5055200
Quinoline	24-hour	0.005	Odour	6.00E-05	522580	5055060
Benzo(a)pyrene ³	Annual	0.00001	Health	7.82E-06	522320	5055740
	24-hour	0.005 ¹	—	0.07	522600	5055080



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Table 6.1 Summary of Maximum Predicted GLCs from the Operation of the Project

Contaminant	Averaging Period	Ambient Air Quality Criteria	Limiting Effect	Predicted Concentration ($\mu\text{g}/\text{m}^3$)	Location of Max. Predicted GLC UTM Coordinates ¹	
					Easting (m)	Northing (m)
Total Reduced Sulphur ⁴	24-hour	14	Health	64.5	522439	5055151
	10-minutes	13	Odour	528	522474	5055103
	24-hour	70 ¹	—	64.5	522433	5055159
Hydrogen Sulphide ²	24-hour	8	Health	3.85	522626	5055535
	1-hour	42	Health	17.4	522420	5055200

Bold indicates exceedance of ambient air quality criteria.
 1 – Upper Risk Threshold
 2 – Nova Scotia provincial limits without defined limiting effects - assumed standards were based on health effects.
 3 – Project PAHs surrogated by B[a]P include: Acenaphthene, Acenaphthylene, Benz(a)anthracene, Benzo(a)phenanthrene (Chrysene), Benzo(b)fluoranthene, Benzo(b,j) fluoranthene, Benzo(e)pyrene, Benzo(g,h,i)perylene, Benzo(j)fluoranthene, Benzo(k)fluoranthene, Dibenz(a,j)acridine, Indeno(1,2,3-c,d)pyrene, Phenanthrene, Fluorene, Perylene, Pyrene, and Fluoranthene.
 4 – Total Reduced Sulphur is a combination of hydrogen sulphide, dimethyl disulphide, dimethyl sulphide, methyl mercaptan, and carbon disulphide

Four contaminants were predicted to have maximum GLCs over their respective criteria. They are ammonia, chloroform, TRS, and hexavalent chromium. None of these contaminants have permissible GLC limits under Nova Scotia's *Air Quality Regulations*; they were therefore compared against Ontario Reg. 419/05 criteria. Of the contaminants that exceeded the O. Reg. 419/05 standards, those with associated Upper Risk Thresholds were below their respective URT. The maximum predicted GLCs of these contaminants at the 10 discrete receptors are presented in Table 6.2. For these contaminants with health-based criteria, concentration plots graphically indicating the location of maximum GLCs are also included in Appendix D.

Table 6.2 Maximum Predicted GLCs at Discrete Receptors

Receptor ID	UTM Coordinates ¹		Concentration ($\mu\text{g}/\text{m}^3$)				
			Ammonia	Chloroform	Total Reduced Sulphur		Hexavalent Chromium
	Easting (m)	Northing (m)	24-hour	24-hour	24-hour	10-Minute	Annual
1	519768	5055219	58.4	0.37	4.94	109	0.00001
2	520907	5053346	69.4	0.44	5.62	104	0.00002
3	522480	5053951	74.2	0.44	17.7	241	0.00004
4	522963	5054415	126	0.79	7.5	87	0.00006
5	522899	5054854	132	0.82	9.4	168	0.0001
6	524552	5055699	17.7	0.11	4.0	59	0.00002
7	524337	5056312	313	1.98	15.4	110	0.00002
8	526942	5057565	117	0.74	17.5	135	0.00001
9	528826	5055486	4.00	0.02	1.14	24	0.00001
10	522169	5058110	14.6	0.09	3.47	43	0.00001
Ambient Air Quality Criteria	-	-	<i>100</i>	<i>1</i>	<i>14</i>	<i>13</i>	<i>0.00014</i>

Bold indicates exceedance of ambient air quality criteria
¹ – North American Datum (NAD) 83 UTM Zone 20



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It is shown in Table 6.2 that the maximum predicted GLC for hexavalent chromium was below its applicable ambient air criteria at each discrete receptor. The maximum predicted GLCs for ammonia, chloroform, and TRS exceeded applicable criteria at one or more of the discrete receptors.



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7.0 DISCUSSION

As presented above, the maximum predicted GLCs of, ammonia, chloroform, TRS, and hexavalent chromium, were above applicable ambient air quality criteria during the operation of the Project. All remaining contaminants were below applicable ambient air quality criteria.

The ambient air quality criteria which predicted GLCs were compared to included the Nova Scotia *Air Quality Regulations* (2017) for carbon monoxide (CO), nitrogen dioxide (NO₂), sulphur dioxide (SO₂), total suspended particulate (TSP), and hydrogen sulphide, the 2020 Canadian Ambient Air Quality Standard for fine particulate matter (PM_{2.5}), and the Ontario Reg. 419/05 standards for the remaining contaminants. Only contaminants that were compared against O. Reg. 419/05 were found to have predicted GLCs above the respective criteria.

A frequency analysis was performed to estimate the frequency for which the predicted concentrations exceeded ambient air quality criteria for each contaminant, at each of the discrete receptor locations. The results are presented in Table 7.1. Of the contaminants that were being compared to a health-based standard, the exceedances occurred at discrete receptors less than 1% of the time. TRS exceeded the odour-based 10-minute limit more frequently.

Table 7.1 Frequency of Exceedances at Discrete Receptors

Receptor ID	UTM Coordinates ¹		Contaminant / Averaging Period				
			Ammonia	Chloroform	Total Reduced Sulphur		Hexavalent Chromium
	Easting (m)	Northing (m)	24-hour	24-hour	24-hour	10-minute	Annual
1	519768	5055219	0.00%	0.00%	0.00%	1.51%	0.00%
2	520907	5053346	0.00%	0.00%	0.00%	2.85%	0.00%
3	522480	5053951	0.00%	0.00%	0.16%	6.02%	0.00%
4	522963	5054415	0.16%	0.00%	0.00%	9.05%	0.00%
5	522899	5054854	0.49%	0.00%	0.00%	19.24%	0.00%
6	524522	5055699	0.00%	0.00%	0.00%	0.75%	0.00%
7	524337	5056312	0.05%	0.05%	0.05%	10.43%	0.00%
8	526942	5057565	0.05%	0.00%	0.05%	7.56%	0.00%
9	528826	5055486	0.00%	0.00%	0.00%	0.08%	0.00%
10	522169	5058110	0.00%	0.00%	0.00%	0.27%	0.00%

Bold indicates exceedance of ambient air quality criteria
¹ – North American Datum (NAD) 83 UTM Zone 20

In addition, a more detailed assessment of the potential for health effects associated with the predicted concentrations was made based on toxicologically derived exposure limits published by health agencies such as the US EPA and Health Canada. These exposures limits (such as reference concentrations and



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residential indoor air quality guidelines) are estimates of a concentration limit for continuous long-term exposure (up to a lifetime) below which adverse health effects are not expected to occur.

The air contaminants with modelled exceedances are further discussed below.

Ammonia

The most frequent predicted exceedances of the 24-hour ammonia criterion occurs at Receptor 5 and corresponds to approximately two days annually. The AST ETF was the main contributor to the maximum ammonia GLC, contributing over 99% to the GLC. The volatilization percentage for ammonia from an AST ETF was not presented in NCASI's NPRI Handbook (2007), therefore it was conservatively assumed that 100% of ammonia present in the effluent would be volatilized, which most likely is an overestimation. Biological treatment of the effluent oxidizes ammonia into nitrite (NO_2^-) through a process known as nitrification (Tchobanoglous and Burton 1991). A portion of the ammonia will be removed through nitrification, as opposed to being released to the atmosphere as ammonia, and thus assuming 100% volatilization is likely an overestimation. The maximum predicted ammonia GLC was below its respective URT at 41%.

The critical health effects associated with inhalation of elevated concentrations of ammonia in air are respiratory effects, including cough, wheezing, and other asthma-related symptoms and decreased lung function (US EPA IRIS 2016). The 24-hour health-based standard for ammonia used for comparison ($100 \mu\text{g}/\text{m}^3$) selected by the MECP (2001; 2008) was based on the US EPA IRIS (1991) ammonia long-term exposure limit of $100 \mu\text{g}/\text{m}^3$. The US EPA IRIS (2016) recently revised their long-term exposure limit for ammonia, concluding that a more appropriate concentration for ammonia is $500 \mu\text{g}/\text{m}^3$. As the maximum 24-hour predicted concentration at a receptor location ($313 \mu\text{g}/\text{m}^3$ at Receptor 7) is less than this exposure limit, no health concerns are expected.

Chloroform

The most frequent exceedance of the 24-hour chloroform criteria (at Receptor 7) was only predicted to occur once (i.e. one day) over the 5-year modelling period. The AST ETF was the main contributor (greater than 99%) to the maximum chloroform GLC. The maximum chloroform GLC was predicted to be well below its respective URT at 2.5%. Although the health-basis of the Ontario air quality guideline is not clear, Health Canada (2017) identified the critical health effect associated with exposure to elevated concentrations of chloroform in air as kidney and liver effects and recently recommended a long-term exposure limit of $300 \mu\text{g}/\text{m}^3$. As the maximum predicted concentration at a receptor location ($1.98 \mu\text{g}/\text{m}^3$ at Receptor 7) is less than this exposure limit, no health concerns are expected.

Total Reduced Sulphur

TRS compounds potentially emitted from the Project include hydrogen sulphide, methyl mercaptan, dimethyl sulphide, dimethyl disulphide and carbon disulphide. The most frequent exceedance of the 24-hour TRS criterion (at Receptor 3) was predicted to occur three days over the 5-year modelling period, or approximately once per one and a half years. The maximum predicted TRS 24-hour GLC was below the URT at 92%. The most frequent exceedance of the 10-minute odour-based TRS limit (Receptor 5) was



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predicted to occur approximately 19% of the time. The AST ETF was predicted to be the main contributor to the maximum TRS GLCs, contributing >99%. Site-specific concentrations of hydrogen sulphide in the effluent were not available, however, total sulphide concentration was. It was conservatively assumed that the total sulphide concentration, excluding known concentrations of methyl mercaptan, dimethyl sulfide, and dimethyl disulphide, was equal to the concentration of hydrogen sulphide. As the total sulphide concentration most likely includes additional sulphide species to those listed above, this is likely an overestimation that may have resulted in a conservative estimation of TRS emissions from the AST ETF.

The 10-minute TRS standard is based on odour as opposed to health (MECP 2018b). This indicates that concentrations at the limit may result in odour nuisances but not necessarily pose a threat to human health. Although guidelines for 10-minute average TRS are not based on health effects, a number of epidemiological studies suggest that the effects of exposure to TRS are similar as that observed with exposure to hydrogen sulphide (e.g., irritation, respiratory and central nervous system effects) (Ontario 2007). By using hydrogen sulphide as a surrogate, and emissions inventories that suggest half of TRS emissions from pulp and paper industries was made up of hydrogen sulphide, Ontario (2007) derived the 24-hour air quality guideline for TRS of 14 $\mu\text{g}/\text{m}^3$ based on 2 times the health-based air quality guideline for hydrogen sulphide of 7 $\mu\text{g}/\text{m}^3$. As there were no exceedance of the hydrogen sulphide guideline, and the predicted exceedances at receptor locations are very limited (less than 1% of the time), the potential for adverse health effects, while not negligible, is considered low.

The proposed AST ETF is a more advance treatment technology compared to the current ASB ETF. It is expected that odourous emissions from the new system will be lower than the current ETF. Aeration in the existing ETF system is provided by surface aerators, in which effluent is sprayed into the air, potentially releasing odorous compounds through vaporization. The proposed ETF introduces air through a coarse bubbler diffuser at the bottom of the basin, reducing the emissions from the existing spraying method. In addition, currently, solids can settle and decompose at the bottom of the basin, causing odours. The continuous aeration in the proposed ETF will not allow solids to settle at the bottom of the basin.

The maximum measured 10-minute TRS concentration in 2017 (converted from a 1-hour averaging period using MECP Guidance, MECP 2018c) at the Pictou Landing Ambient Air Monitoring Station was 8.94 $\mu\text{g}/\text{m}^3$, below the 10-minute odour-based criteria of 13 $\mu\text{g}/\text{m}^3$. In addition, monitoring results from another Paper Excellence Kraft mill currently operating with similar AST technology (Crofton) were below their hourly target of 5 ppb TRS (approximately 7 $\mu\text{g}/\text{m}^3$ expressed as H_2S) over 90% of the time. Ambient air monitoring for TRS at the Pictou Landing Ambient Air Monitoring Station will continue upon operation of the Project.



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Hexavalent Chromium

Hexavalent chromium is not expected to exceed its criteria at any of the human receptors, however, exceedances were predicted to occur north-east of the Facility property boundary. The biomass boiler was the main contributor to the maximum hexavalent chromium GLC, contributing >99% to the maximum GLC. Hexavalent chromium emissions were estimated using NCASI published emission factors whose representativeness for the Project can be assessed after the EFT becomes operational. The maximum predicted hexavalent chromium 24-hour GLC was well below its respective URT at 4.1%.



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SUMMARY AND CONCLUSIONS

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8.0 SUMMARY AND CONCLUSIONS

As presented above, the maximum predicted GLCs during the operation of the Project were below the Nova Scotia *Air Quality Regulations* (2017) for carbon monoxide (CO), nitrogen dioxide (NO₂), sulphur dioxide (SO₂), and total suspended particulate (TSP) and the Canadian Ambient Air Quality Standard for fine particulate matter (PM_{2.5}).

The remaining contaminants of interest were assessed against the limits prescribed in O. Reg. 419/05. Of the contaminants compared to O. Reg. 419/05 limits, ammonia, chloroform, TRS, and hexavalent chromium, were found to be above applicable limits. At the discrete receptors, the contaminants with health-based limits (ammonia, chloroform, 24-hour average TRS, and hexavalent chromium) were predicted to be above their respective limits infrequently or not at all. At the discrete receptors, hexavalent chromium was not predicted to exceed its limit, while exceedances of ammonia, chloroform and 24-hour average TRS were predicted to occur less than 0.5% of the time.

Emission rates were based on a combination of site-specific data, data from alternative Kraft pulp mills, and published emission estimation methods, and as such, emissions are expected to be conservative and maximum predicted GLCs may be overestimated.

As the biomass boiler is not yet operating with the co-combustion of biosludge and biomass, Facility-specific stack testing results are not available. As such, emissions were estimated using emission factors, stack testing results from similar operations at other Kraft pulp mills (Howe Sound and Crofton), and/or sludge composition from another Kraft mill with similar operations (Howe Sound). The data quality is lower when non-site-specific data is used, as there is a level of uncertainty on representativeness of actual operations.

Once the replacement ETF is operational, pending approval by the province, Northern Pulp will conduct stack testing of the co-combustion of biomass and biosludge in the biomass boiler. Upon receipt of the stack testing results, the emission rate of hexavalent chromium will be revised, and the air dispersion modelling will be updated to determine if the maximum predicted GLC is below the corresponding ambient air quality standards. In addition, the contaminants that were predicted to exceed ambient air quality criteria with the main contribution being from the AST ETF (ammonia, chloroform, and TRS) will be monitored at ambient monitoring station(s) surrounding the Facility to assess whether air criteria are being met. It is recommended that the monitoring data be used to refine the emission rates and the air dispersion modelling be updated at that time. If the revised air dispersion modelling results and/or the monitoring results indicate the need for mitigation (i.e. an air criteria exceedance is measured or predicted), an air emission reduction plan will be developed and submitted to NSE for review and approval, prior to implementing mitigation actions.



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CLOSING

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9.0 CLOSING

This report has been prepared by Stantec Consulting Ltd. with the input and assistance of Northern Pulp for the sole benefit of Northern Pulp. The report may not be relied upon by any other person, entity, other than for its intended purposes, without the express written consent of Stantec Consulting Ltd. and Northern Pulp.

This report was undertaken exclusively for the purpose outlined herein and is limited to the scope and purpose specifically expressed in this report. This report cannot be used or applied under any circumstances to another location or situation or for any other purpose without further evaluation of the data and related limitations. Any use of this report by a third party, or any reliance on decisions made based upon it, are the responsibility of such third parties. Stantec accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this report.

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This report presents the best professional judgment of Stantec personnel available at the time of its preparation. Stantec reserves the right to modify the contents of this report, in whole or in part, to reflect any new information that becomes available. If any conditions become apparent that differ significantly from our understanding of conditions as presented in this report, we request that we be notified immediately to reassess the conclusions provided herein.



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APPENDIX A

Detailed Contaminant List

Table A1 Detailed Contaminant List

Contaminant	CAS No.	Contaminant Type	Potentially Released from Project?	Reasoning
Aluminum	7429-90-5	Metal	Yes	Present in sludge analyzed from a similar Kraft pulp mill with AST treatment; release from power boilers combusting biosludge. Also released from power boilers combusting biomass (i.e.g. hog fuel), as presented in NCASI (2007).
Antimony	7440-36-0	Metal	Yes	Released from power boilers combusting biomass (i.e. hog fuel), as presented in NCASI (2007). Present in Northern Pulp's boiler stack testing results while combusting biomass.
Arsenic	7440-38-2	Metal	Yes	Present in sludge analyzed from a similar Kraft pulp mill with AST treatment; release from power boilers combusting biosludge. Also released from power boilers combusting biomass (i.e. hog fuel), as presented in NCASI (2007).
Barium	7440-39-3	Metal	Yes	Present in sludge analyzed from a similar Kraft pulp mill with AST treatment; release from power boilers combusting biosludge. Present in Northern Pulp's boiler stack testing results while combusting biomass.
Beryllium and Beryllium compounds	7440-41-7	Metal	Yes	Present in Northern Pulp's boiler stack testing results while combusting biomass.
Boron	7440-42-8	Metal	Yes	Present in sludge analyzed from a similar Kraft pulp mill with AST treatment; release from power boilers combusting biosludge.
Cadmium	7440-43-9	Metal	Yes	Present in sludge analyzed from a similar Kraft pulp mill with AST treatment. Present in power boiler stack analysis from an alternative similar pulp mill combusting biomass and biosludge. Also released from power boilers combusting biomass (i.e. hog fuel), as presented in NCASI (2007). Present in Northern Pulp's biomass boiler stack testing results while combusting biomass.
Chromium	7440-47-3	Metal	Yes	Present in sludge analyzed from a similar Kraft pulp mill with AST treatment. Present in power boiler stack analysis from an alternative similar pulp mill combusting biomass and biosludge. Also released from power boilers combusting biomass (i.e. hog fuel), as presented in NCASI (2007). Present in Northern Pulp's biomass boiler stack testing results while combusting biomass.
Hexavalent Chromium	18540-29-9	Metal	Yes	Released from power boilers combusting biomass (i.e. hog fuel), as presented in NCASI (2007).
Cobalt	7440-48-4	Metal	Yes	Present in sludge analyzed from a similar Kraft pulp mill with AST treatment. Present in power boiler stack analysis from an alternative similar pulp mill combusting biomass and biosludge. Also released from power boilers combusting biomass (i.e. hog fuel), as presented in NCASI (2007). Present in Northern Pulp's biomass boiler stack testing results while combusting biomass.
Copper	7440-50-8	Metal	Yes	Present in sludge analyzed from a similar Kraft pulp mill with AST treatment. Present in power boiler stack analysis from an alternative similar pulp mill combusting biomass and biosludge. Also released from power boilers combusting biomass (i.e. hog fuel), as presented in NCASI (2007). Present in Northern Pulp's biomass boiler stack testing results while combusting biomass.
Iron	7439-89-6	Metal	Yes	Present in sludge analyzed from a similar Kraft pulp mill with AST treatment; release from power boilers combusting biosludge.
Ferric Oxide	1309-37-1	Metal	Yes	Iron present in Northern Pulp's biomass boiler stack testing results while combusting biomass. Iron contained in site effluent analysis. Iron present in sludge analyzed from a similar Kraft pulp mill with AST treatment.
Lead	7439-92-1	Metal	Yes	Present in sludge analyzed from a similar Kraft pulp mill with AST treatment. Present in power boiler stack analysis from an alternative similar pulp mill combusting biomass and biosludge. Also released from power boilers combusting biomass (i.e. hog fuel), as presented in NCASI (2007). Present in Northern Pulp's biomass boiler stack testing results while combusting biomass.
Lithium	7439-93-2	Metal	Yes	Present in sludge analyzed from a similar Kraft pulp mill with AST treatment; release from power boilers combusting biosludge.
Magnesium	7439-95-4	Metal	Yes	Present in sludge analyzed from a similar Kraft pulp mill with AST treatment; release from power boilers combusting biosludge.
Magnesium Oxide	1309-48-4	Metal	Yes	Magnesium present in Northern Pulp's biomass boiler stack testing results while combusting biomass. Magnesium contained in site effluent analysis. Magnesium present in sludge analyzed from a similar Kraft pulp mill with AST treatment.
Manganese	7439-96-5	Metal	Yes	Present in sludge analyzed from a similar Kraft pulp mill with AST treatment. Present in power boiler stack analysis from an alternative similar pulp mill combusting biomass and biosludge. Also released from power boilers combusting biomass (i.e. hog fuel), as presented in NCASI (2007). Present in Northern Pulp's biomass boiler stack testing results while combusting biomass.
Mercury	7439-97-6	Metal	Yes	Present in sludge analyzed from a similar Kraft pulp mill with AST treatment. Present in power boiler stack analysis from an alternative similar pulp mill combusting biomass and biosludge. Also released from power boilers combusting biomass (i.e. hog fuel), as presented in NCASI (2007). Present in Northern Pulp's biomass boiler stack testing results while combusting biomass.
Nickel	7440-02-0	Metal	Yes	Present in sludge analyzed from a similar Kraft pulp mill with AST treatment. Present in power boiler stack analysis from an alternative similar pulp mill combusting biomass and biosludge. Also released from power boilers combusting biomass (i.e. hog fuel), as presented in NCASI (2007). Present in Northern Pulp's boiler stack testing results while combusting biomass.
Phosphorus	7723-14-0	Metal	Yes	Present in sludge analyzed from a similar Kraft pulp mill with AST treatment; release from power boilers combusting biosludge.
Selenium	7782-49-2	Metal	Yes	Released from power boilers combusting biomass (i.e. hog fuel), as presented in NCASI (2007). Present in Northern Pulp's biomass boiler stack testing results while combusting biomass.
Silver and Silver compounds	7782-49-2	Metal	Yes	Present in Northern Pulp's biomass boiler stack testing results while combusting biomass. Contained in site effluent analysis.
Strontium	7440-24-6	Metal	Yes	Present in sludge analyzed from a similar Kraft pulp mill with AST treatment; release from power boilers combusting biosludge. Present in Northern Pulp's biomass boiler stack testing results while combusting biomass.
Titanium	7440-32-6	Metal	Yes	Present in sludge analyzed from a similar Kraft pulp mill with AST treatment; release from power boilers combusting biosludge. Present in Northern Pulp's biomass boiler stack testing results while combusting biomass.
Vanadium	7440-62-2	Metal	Yes	Present in sludge analyzed from a similar Kraft pulp mill with AST treatment. Present in power boiler stack analysis from an alternative similar pulp mill combusting biomass and biosludge. Present in Northern Pulp's biomass boiler stack testing results while combusting biomass.
Zinc	7440-66-6	Metal	Yes	Present in sludge analyzed from a similar Kraft pulp mill with AST treatment. Present in power boiler stack analysis from an alternative similar pulp mill combusting biomass and biosludge. Also released from power boilers combusting biomass (i.e. hog fuel), as presented in NCASI (2007). Present in Northern Pulp's biomass boiler stack testing results while combusting biomass.
Carbon Monoxide	630-08-0	CACs	Yes	Released from power boilers combusting biomass (i.e. hog fuel), as presented in NCASI (2007). Present in biomass boiler stack analysis from Northern Pulp while only combusting biomass.

TPM	N/A	CACs	Yes	Released from power boilers combusting biomass (i.e. hog fuel), as presented in NCASI (2007). Present in biomass boiler stack analysis from Northern Pulp while only combusting biomass.
PM10	N/A	CACs	Yes	Released from power boilers combusting biomass (i.e. hog fuel), as presented in NCASI (2007).
PM2.5	N/A	CACs	Yes	Released from power boilers combusting biomass (i.e. hog fuel), as presented in NCASI (2007). Present in biomass boiler stack analysis from Northern Pulp while only combusting biomass.
Nitrogen oxides	N/A	CACs	Yes	Released from power boilers combusting biomass (i.e. hog fuel), as presented in NCASI (2007). Present in biomass boiler stack analysis from Northern Pulp while only combusting biomass.
Sulphur Dioxide	7446-09-5	CACs	Yes	Released from power boilers combusting biomass (i.e. hog fuel), as presented in NCASI (2007). Present in biomass boiler stack analysis from Northern Pulp while only combusting biomass.
Ammonia	7664-41-7	Other	Yes	Released from AST facilities, as presented in NCASI (2007). Contained in site effluent analysis. Not detected in Northern Pulp's biomass boiler stack testing results while combusting biomass.
Hydrochloric Acid	7647-01-0	Other	Yes	Released from power boilers combusting biomass (i.e. hog fuel), as presented in NCASI (2007). Present in biomass boiler stack analysis from Northern Pulp while only combusting biomass.
Dioxins and Furans	N/A	DnF	Yes	Present in power boiler stack analysis from an alternative similar pulp mill combusting biomass and biosludge. Also released from power boilers combusting biomass (i.e. hog fuel), as presented in NCASI (2007). Present in biomass boiler stack analysis from Northern Pulp while only combusting biomass.
Acetaldehyde	75-07-0	VOC	Yes	Released from power boilers combusting biomass and from AST facilities, as presented in NCASI (2007). Contained in site effluent analysis.
Acetone	67-64-1	VOC	Yes	Present in Northern Pulp's biomass boiler stack testing results while combusting biomass.
Acrolein	107-02-8	VOC	Yes	Released from power boilers combusting biomass (i.e. hog fuel), as presented in NCASI (2007).
Benzene	71-43-2	VOC	Yes	Released from power boilers combusting biomass and from AST facilities, as presented in NCASI (2007). Present in biomass boiler stack analysis from Northern Pulp while only combusting biomass.
1,3-Butadiene	106-99-0	VOC	Yes	Released from AST facilities, as presented in NCASI (2007).
Butanol, n	71-36-3	VOC	Yes	Released from effluent treatment (AST), as presented in NCASI (2007)
Chloroform	67-66-3	VOC	Yes	Released from power boilers combusting biomass and from AST facilities, as presented in NCASI (2007). Contained in site effluent analysis. Present in biomass boiler stack analysis from Northern Pulp while only combusting biomass.
Chloromethane	74-87-3	VOC	Yes	Released from power boilers combusting biomass and from AST facilities, as presented in NCASI (2007). Present in biomass boiler stack analysis from Northern Pulp while only combusting biomass.
Cyclohexane	110-82-7	VOC	Yes	Present in Northern Pulp's biomass boiler stack testing results while combusting biomass.
Dichloromethane	75-09-2	VOC	Yes	Released from power boilers combusting biomass (i.e. hog fuel) and from AST facilities, as presented in NCASI (2007). Contained in site effluent analysis. Present in Northern Pulp's biomass boiler stack testing results while combusting biomass.
Ethyl Benzene	100-41-4	VOC	Yes	Present in Northern Pulp's biomass boiler stack testing results while combusting biomass. Not included from AST as non-detect in site effluent analysis.
Ethylene Dichloride (1,2-Dichloroethane)	107-06-2	VOC	Yes	Present in Northern Pulp's biomass boiler stack testing results while combusting biomass. Not included from AST as non-detect in site effluent analysis.
Formaldehyde	50-00-0	VOC	Yes	Released from power boilers combusting biomass and from AST facilities, as presented in NCASI (2007).
Hexane, n	110-54-3	VOC	Yes	Present in Northern Pulp's biomass boiler stack testing results while combusting biomass. Released from effluent treatment (AST), as presented in NCASI (2007)
Methanol	67-56-1	VOC	Yes	Released from power boilers combusting biomass (i.e. hog fuel) and from AST facilities, as presented in NCASI (2007).
Methyl Ethyl Ketone	78-93-3	VOC	Yes	Released from power boilers combusting biomass and from AST facilities, as presented in NCASI (2007). Present in Northern Pulp's biomass boiler stack testing results while combusting biomass.
Methyl Isobutyl Ketone	108-10-1	VOC	Yes	Released from AST facilities, as presented in NCASI (2007). Not included in power boiler emissions as ND from stack testing with biomass.
Phenol	108-95-2	VOC	Yes	Released from power boilers combusting biomass (i.e. hog fuel), as presented in NCASI (2007).
Propionaldehyde	123-38-6	VOC	Yes	Released from power boilers combusting biomass (i.e. hog fuel), as presented in NCASI (2007).
Terpenes (a-pinene and b-pinene)	(80-56-8 and 127-91-3)	VOC	Yes	Released from AST facilities, as presented in NCASI (2007).
Toluene	108-88-3	VOC	Yes	Released from power boilers combusting biomass (i.e. hog fuel) and from AST facilities, as presented in NCASI (2007). Present in biomass boiler stack analysis from Northern Pulp while only combusting biomass.
Xylenes	1330-20-7	VOC	Yes	Released from power boilers combusting biomass (i.e. hog fuel) and from AST facilities, as presented in NCASI (2007). Present in biomass boiler stack analysis from Northern Pulp while only combusting biomass.
Acenaphthene ¹	83-32-9	PAHs	Yes	Despite not being present in power boiler stack analysis from an alternative similar pulp mill combusting biomass (i.e. hog fuel) and biosludge, NCASI (2007) shows releases from power boilers combusting biomass (i.e. hog fuel). Present in biomass boiler stack analysis from Northern Pulp while only combusting biomass.
Acenaphthylene ¹	208-96-8	PAHs	Yes	Present in power boiler stack analysis from an alternative similar pulp mill combusting biomass and biosludge. Also released from power boilers combusting biomass (i.e. hog fuel), as presented in NCASI (2007). Present in biomass boiler stack analysis from Northern Pulp while only combusting biomass.
Benz(a)anthracene ¹	56-55-3	PAHs	Yes	Present in power boiler stack analysis from an alternative similar pulp mill combusting biomass and biosludge. Also released from power boilers combusting biomass (i.e. hog fuel), as presented in NCASI (2007). Present in biomass boiler stack analysis from Northern Pulp while only combusting biomass.
Benzo(a)phenanthrene (Chrysene) ¹	218-01-9	PAHs	Yes	Present in power boiler stack analysis from an alternative similar pulp mill combusting biomass and biosludge. Also released from power boilers combusting biomass (i.e. hog fuel), as presented in NCASI (2007).
Benzo(a)pyrene	50-32-8	PAHs	Yes	Released from power boilers combusting biomass (i.e. hog fuel), as presented in NCASI (2007).
Benzo(b)fluoranthene ¹	205-99-2	PAHs	Yes	Released from power boilers combusting biomass (i.e. hog fuel), as presented in NCASI (2007). Present in biomass boiler stack analysis from Northern Pulp while only combusting biomass.
Benzo(b,j) fluoranthene ¹	205-82-3	PAHs	Yes	Present in power boiler stack analysis from an alternative similar pulp mill combusting biomass and biosludge.
Benzo(e)pyrene ¹	192-97-2	PAHs	Yes	Present in power boiler stack analysis from an alternative similar pulp mill combusting biomass and biosludge. Also released from power boilers combusting biomass (i.e. hog fuel), as presented in NCASI (2007).
Benzo(g,h,i)perylene ¹	191-24-2	PAHs	Yes	Present in power boiler stack analysis from an alternative similar pulp mill combusting biomass and biosludge. Also released from power boilers combusting biomass (i.e. hog fuel), as presented in NCASI (2007). Present in biomass boiler stack analysis from Northern Pulp while only combusting biomass.
Benzo(j)fluoranthene ¹	191-24-2	PAHs	Yes	Released from power boilers combusting biomass (i.e. hog fuel), as presented in NCASI (2007).

Benzo(k)fluoranthene ¹	207-08-9	PAHs	Yes	Despite not being present in power boiler stack analysis from an alternative similar pulp mill combusting biomass and biosludge, NCASI (2007) shows releases from power boilers combusting biomass (i.e. hog fuel). Present in biomass boiler stack analysis from Northern Pulp while only combusting biomass.
Dibenz(a,j)acridine	224-42-0	PAHs	Yes	Present in biomass boiler stack analysis from Northern Pulp while only combusting biomass.
Fluoranthene ¹	206-44-0	PAH/VOC	Yes	Present in power boiler stack analysis from an alternative similar pulp mill combusting biomass and biosludge. Also released from power boilers combusting biomass (i.e. hog fuel), as presented in NCASI (2007).
Fluorene ¹	86-73-7	PAHs	Yes	Present in power boiler stack analysis from an alternative similar pulp mill combusting biomass and biosludge. Also released from power boilers combusting biomass (i.e. hog fuel), as presented in NCASI (2007). Present in biomass boiler stack analysis from Northern Pulp while only combusting biomass.
Hexachlorobenzene	118-74-1	PAHs	Yes	Present in power boiler stack analysis from an alternative similar pulp mill combusting biomass and biosludge.
Indeno(1,2,3-c,d)pyrene ¹	193-39-5	PAHs	Yes	Present in power boiler stack analysis from an alternative similar pulp mill combusting biomass and biosludge. Also released from power boilers combusting biomass (i.e. hog fuel), as presented in NCASI (2007). Present in biomass boiler stack analysis from Northern Pulp while only combusting biomass.
Naphthalene	91-20-3	PAH/VOC	Yes	Released from power boilers combusting biomass (i.e. hog fuel), as presented in NCASI (2007). Present in biomass boiler stack analysis from Northern Pulp while only combusting biomass.
Perylene ¹	198-55-0	PAHs	Yes	Despite not being present in power boiler stack analysis from an alternative similar pulp mill combusting biomass and biosludge, NCASI (2007) shows releases from power boilers combusting biomass (i.e. hog fuel).
Phenanthrene ¹	85-01-8	PAHs	Yes	Despite not being present in power boiler stack analysis from an alternative similar pulp mill combusting biomass and biosludge, NCASI (2007) shows releases from power boilers combusting biomass (i.e. hog fuel).
Pyrene ¹	129-00-0	PAHs	Yes	Present in power boiler stack analysis from an alternative similar pulp mill combusting biomass and biosludge. Also released from power boilers combusting biomass (i.e. hog fuel), as presented in NCASI (2007). Present in biomass boiler stack analysis from Northern Pulp while only combusting biomass.
Quinoline	91-22-5	PAHs	Yes	Present in power boiler stack analysis from an alternative similar pulp mill combusting biomass and biosludge. Present in biomass boiler stack analysis from Northern Pulp while only combusting biomass.
Total Reduced Sulphur ²	NA	TRS	Yes	Released from AST facilities, as presented in NCASI (2007). Contained in site effluent analysis. Present in biomass boiler stack analysis from Northern Pulp while only combusting biomass.
Carbon Disulphide ²	75-15-0	TRS	Yes	Released from power boilers combusting biomass, as presented in NCASI (2007).
Dimethyl sulphide ²	75-18-3	TRS	Yes	Released from AST facilities, as presented in NCASI (2007). Contained in site effluent analysis.
Dimethyl Disulphide ²	624-92-0	TRS	Yes	Released from AST facilities, as presented in NCASI (2007). Contained in site effluent analysis.
Hydrogen Sulphide ²	7783-06-4	TRS	Yes	Released from AST facilities, as presented in NCASI (2007). Contained in site effluent analysis. Present in biomass boiler stack analysis from Northern Pulp while only combusting biomass.
Methyl Mercaptan ²	74-93-1	TRS	Yes	Released from AST facilities, as presented in NCASI (2007). Contained in site effluent analysis.
Vinyl Chloride	75-01-4	VOC	No	NPRI reportable substance but not presented in NCASI (2006) as a contaminant released from pulp and paper mills. Non-detect in site effluent analysis. Non-detect in Northern Pulp's boiler stack testing results while combusting biomass.
Chlorine dioxide	10049-04-4	Other	No	Not presented in NCASI from power boilers or from AST. No effluent or sludge data presented in NCASI.
Chlorine	7782-50-5	Other	No	Not presented in NCASI from power boilers. NCASI states only expected in effluent if used in water treatment, which it will not be, hence will also not be present in sludge.
Sulphuric acid	7664-93-9	Other	No	Not presented in NCASI from power boilers (biomass) or from AST. Low vapour pressure - will not be released from effluent treatment.
Carbonyl Sulphide	463-58-1	TRS	No	Not presented in NCASI from power boilers. Only expected to be in AST if used by mill, which it is not (NCASI).
Dibenzo(a,i)pyrene	189-55-9	PAHs	No	Not presented in NCASI from power boilers or from AST. Non-detect in power boiler stack analysis from an alternative similar pulp mill combusting biomass and biosludge. Not presented in NCASI effluent data. No sludge data in NCASI.
5-Methylchrysene	3697-24-3	PAHs	No	Not presented in NCASI (2007) from power boilers or from AST. Non-detect in power boiler stack analysis from an alternative similar pulp mill combusting biomass and biosludge. Not presented in NCASI effluent data. No sludge data in NCASI 2007.
Dibenzo(a,e)pyrene	192-65-4	PAHs	No	Not presented in NCASI (2007) from power boilers or from AST. Non-detect in power boiler stack analysis from an alternative similar pulp mill combusting biomass and biosludge. Not presented in NCASI (2007) effluent data. No sludge data in NCASI (2007).
Dibenzo(a,h)pyrene	189-64-0	PAHs	No	Not presented in NCASI (2007) from power boilers or from AST. Non-detect in power boiler stack analysis from an alternative similar pulp mill combusting biomass and biosludge. Not presented in NCASI (2007) effluent data. No sludge data in NCASI (2007).
Dibenzo(a,h)acridene	226-36-8	PAHs	No	Not presented in NCASI (2007) from power boilers or from AST. Non-detect in power boiler stack analysis from an alternative similar pulp mill combusting biomass and biosludge. Not presented in NCASI (2007) effluent data. No sludge data in NCASI (2007).
7H-dibenzo(c,g)carbazole	194-59-2	PAHs	No	Not presented in NCASI (2007) from power boilers or from AST. Non-detect in power boiler stack analysis from an alternative similar pulp mill combusting biomass and biosludge. Not presented in NCASI (2007) effluent data. No sludge data in NCASI (2007).
Dibenzo(a,e) fluoranthene	5385-75-1	PAHs	No	Not presented in NCASI (2007) from power boilers or from AST. Non-detect in power boiler stack analysis from an alternative similar pulp mill combusting biomass and biosludge. Not presented in NCASI (2007) effluent data. No sludge data in NCASI (2007).
3-Methylcholanthrene	56-49-5	PAHs	No	Not presented in NCASI (2007) from power boilers or from AST. Non-detect in power boiler stack analysis from an alternative similar pulp mill combusting biomass and biosludge. Not presented in NCASI (2007) effluent data. No sludge data in NCASI (2007).
1-Nitropyrene	5522-43-0	PAHs	No	Not presented in NCASI (2007) from power boilers or from AST. Non-detect in power boiler stack analysis from an alternative similar pulp mill combusting biomass and biosludge. Not presented in NCASI (2007) effluent data. No sludge data in NCASI (2007).
7,12-Dimethylbenz(a)anthracene	57-97-6	PAHs	No	Not presented in NCASI (2007) from power boilers or from AST. Non-detect in power boiler stack analysis from an alternative similar pulp mill combusting biomass and biosludge. Not presented in NCASI (2007) effluent data. No sludge data in NCASI (2007).
Dibenzo(a,i)pyrene	189-55-9	PAHs	No	Not presented in NCASI (2007) from power boilers or from AST. Non-detect in power boiler stack analysis from an alternative similar pulp mill combusting biomass and biosludge. Not presented in NCASI (2007) effluent data. No sludge data in NCASI (2007). Non-detect in Northern Pulp's boiler stack testing results while combusting biomass.
Pentachlorophenol	87-86-5	Other	No	Non-detect in site effluent analysis. Expected from boilers combusting treated wood (waste wood), Northern Pulp does not burn waste wood.
Calcium Oxide	1305-78-8	Metal	No	Calcium contained in site effluent analysis and calcium present in sludge analyzed from a similar Kraft pulp mill with AST treatment. Calcium in the effluent and sludge will not be in the form of an oxide as CaO is highly reactive with water and will make a hydroxide or a carbonate.
Carbon Dioxide	124-38-9	GHG	No	Carbon Dioxide is quantified and reported under the Federal Greenhouse Gas Reporting Program.

Trichloroethane	71-55-6	VOC	No	Non-detect in site effluent analysis. Non-detect in Northern Pulp's boiler stack testing results while combusting biomass. Not in Ontario ACB list.
Cresols	1319-77-3	Other	No	Not presented in NCASI from power boilers. Insignificant amount volatilized from AST (<1%), as presented in NCASI.
Chloroethane	75-00-3	VOC	No	Non-detect in site effluent analysis. Non-detect in Northern Pulp's boiler stack testing results while combusting biomass. Contaminant not presented in NCASI as released from pulp mills, despite being an NPRI reportable substance
Dichloroethane, 1,1-	75-34-3	VOC	No	Non-detect in site effluent analysis. Non-detect in Northern Pulp's boiler stack testing results while combusting biomass.
Carbon Tetrachloride	56-23-5	VOC	No	Non-detect in site effluent analysis. Non-detect in Northern Pulp's boiler stack testing results while combusting biomass.
Nitrilotriacetic Acid	139-13-9	Acid	No	As per NCASI (2007), only present if used in chelants in thermomechanical pulp mills. Not used on-site.
Acetic Acid	64-19-7	Acid	No	Not included in assessment as according to Ontario 419/05 standards, it has a high limit (2500 ug/m3) and the limiting effect is due to odour not human health.
Melamine	108-78-1	Other	No	Product used at some mills as an additive to strengthen paper. Northern Pulp does not use melamine, therefore, it is not expected to be released.
Formic Acid	64-18-6	Acid	No	Formic acid is used at some pulp mills as a solvent to make lignin more soluble in cooking liquor. Northern Pulp does not use formic acid, therefore, it is not expected to be released.
Isopropyl Benzene (Cumene)	98-82-8	VOC	No	O. Reg. 419/05 has a Guideline with the limiting effect being odour - not a standard based on health. As per NCASI 2007, concentrations in effluent not expected to be significant.
Biphenyl	92-52-4	VOC	No	As per NCASI 2007, only present in trace amounts in effluent if the mill uses the substance. O. Reg. 419/05 has a Guideline with the limiting effect being odour - not a standard based on health.
Styrene	100-42-5	VOC	No	Non-detect in site effluent analysis. Non-detect in Northern Pulp's boiler stack testing results while combusting biomass.
Dibenzo(a,h)anthracene ¹	53-70-3	PAHs	No	Not being present in power boiler stack analysis from an alternative similar pulp mill combusting biomass and biosludge. Not present in biomass boiler stack analysis from Northern Pulp while only combusting biomass.
Carbon tetrachloride	75-73-0	VOC	No	Non-detect in site effluent analysis. Non-detect in Northern Pulp's boiler stack testing results while combusting biomass.
Trichloroethylene	79-01-6	VOC	No	Non-detect in site effluent analysis. Non-detect in Northern Pulp's boiler stack testing results while combusting biomass.
Tetrachloroethylene	127-18-4	VOC	No	Non-detect in site effluent analysis. Non-detect in Northern Pulp's boiler stack testing results while combusting biomass.
Ozone	10028-15-6	CAC	No	Secondary species, not directly emitted from emission sources.

¹PAHs without Ontario Regulation 419/05 (O. Reg. 419/05) standards. Following O. Reg. 419/05 (in the absence of Nova Scotia provincial standards), benzo[a]pyrene (B[a]P) is considered a surrogate for all PAHs that do not have individual Air Quality Standards. As per O. Reg. 419/05, if modelling of B[a]P complies with the air standard, all other PAHs that do not have an individual standard are considered to have negligible carcinogenic risk and no expected adverse effects. Only PAHs with specific Benchmark 1 Standards under O. Reg. 419/05 will be modelled.

²Total Reduced Sulphur is a combination of hydrogen sulphide, dimethyl disulphide, dimethyl sulphide, methyl mercaptan, and carbon disulphide. As per O. Reg. 419/05, if a mixture of TRS compounds are released, only TRS is required to be modelled and assessed, individual limits do not apply. Hydrogen sulphide was assessed as part of TRS and separately due to the Nova Scotia Provincial limit.

APPENDIX B

Project Emissions Inventory

Table B1 Emission Rates - Project (AST and Sludge in Power Boiler)

Contaminant	CAS No.	Emission Rate (g/s)															Total				
		ETF (AST)	Biomass Boiler	Recovery Boiler	Lime Kiln	Smelt Dissolving Tank	HLRV	Bleach Pulp Dryer ²	Slacker/Cautsitizer ³	Slacker	Cautsitizer Only ⁴	Salt Cake Mix	Lime Mud Precoat	Precoat Filter Exhaust	White liquor	Dregs Filter		Green Liquor Clarifier ⁵	Steam stripper		
Aluminum	7429-90-5		7.9E-02																		7.85E-02
Antimony	7440-36-0		3.8E-05	1.3E-05			2.8E-05	6.7E-06													8.59E-05
Arsenic	7440-38-2		2.9E-04	2.3E-07	6.6E-07		1.2E-07														2.90E-04
Barium	7440-39-3		2.07E-03																		2.07E-03
Beryllium	7440-41-7		3.2E-06																		3.22E-06
Boron	7440-42-8		5.32E-04																		5.32E-04
Cadmium	7440-43-9		1.9E-04	6.4E-05	1.4E-05		8.8E-06														2.81E-04
Chromium	7440-47-3		5.2E-04	4.4E-05	1.9E-04		2.7E-06														7.66E-04
Hexavalent Chromium	18540-29-9		2.2E-04	1.2E-04	1.9E-05		3.0E-05														3.90E-04
Cobalt	7440-48-4		4.1E-05	2.5E-05	1.07E-05		3.4E-06														7.99E-05
Copper	7440-50-8		9.524E-04	1.947E-04	1.071E-04		1.062E-04														1.36E-03
Iron	7439-89-6		7.98E-02																		7.98E-02
Ferric Oxide	1309-37-1		1.1E-01																		1.14E-01
Lead	7439-92-1		8.39E-04	1.06E-04	1.71E-04		3.01E-05														1.15E-03
Lithium	7439-93-2		2.53E-05																		2.53E-05
Magnesium	7439-95-4		3.58E-01																		3.58E-01
Magnesium Oxide	1309-48-4		5.93E-01																		5.93E-01
Manganese	7439-96-5		2.01E-02	4.60E-04	3.21E-04		9.73E-05														2.10E-02
Mercury	7439-97-6		4.42E-05	3.26E-06	9.64E-09		6.07E-05														4.74E-05
Nickel	7440-02-0		4.27E-04	2.83E-04	1.03E-04		4.07E-05														8.53E-04
Phosphorus	7723-14-0		1.91E-01	1.77E-03	1.82E-03		1.59E-04														1.95E-01
Selenium	7782-49-2		2.24E-05	7.08E-06	2.30E-05		2.30E-05		2.71E-06												5.52E-05
Silver	7440-22-4		3.92E-04	3.72E-05	1.67E-06		1.95E-05														4.50E-04
Strontium	7440-24-6		2.37E-03																		2.37E-03
Titanium	7440-32-6		6.00E-03																		6.00E-03
Vanadium	7440-62-2		3.28E-04																		3.28E-04
Zinc	7440-66-6		5.29E-02	5.13E-04	8.99E-05		9.73E-04														5.45E-02
TPM			3.96E+00	3.22E-01	2.36E+00		3.06E+00														9.71E+00
PM10			2.32E+00	2.40E+00	1.24E+00		1.33E+00		4.42E-02												7.33E+00
PM2.5			1.10E+00	9.26E-03	5.28E-01		4.86E-01														2.12E+00
Carbon Monoxide			1.30E+01	7.98E+01	2.40E-02		4.61E+00														9.74E+01
Nitrogen oxides (expressed as Nitrogen dioxide)	10102-44-0		3.60E+00	5.82E+00	2.57E+00		5.65E-02		7.40E-01												1.28E+01
Sulphur Dioxide	7446-09-5		8.13E-02	4.60E+00			1.38E+00		4.02E-01												1.86E+00
Ammonia	7664-41-7	1.48E+00					0.00E+00		7.43E-01	4.60E-01	1.61E-02	1.39E-01			6.42E-03					7.76E+00	
Hydrochloric Acid	7647-01-0		1.82E-02	7.62E-01			1.09E-01														8.89E-01
VOC ¹			1.90E-01	7.97E-01	2.57E-02		8.85E-02		2.31E+00	3.17E-01	4.71E-02		1.15E-02	4.71E-03	1.93E-02			7.07E-02		3.88E+00	
Acetaldehyde	75-07-0	3.52E-02		8.24E-03	9.76E-03	9.21E-03	9.73E-03	4.22E-01	8.14E-02	4.50E-03		1.03E-03	9.56E-04	1.48E-03	8.14E-03	1.93E-03	3.85E-04	1.07E-04	2.39E-03	6.24E-01	
Acetone	67-64-1	3.37E+00		4.20E-01	5.14E-02	1.66E-03	5.71E-03	1.49E-01	2.04E-02	3.04E-03	0.00E+00		7.43E-04	3.04E-04	1.24E-03			4.56E-03		4.03E+00	
Acrolein	107-02-8		2.81E-03	2.30E-03	6.00E-06	4.78E-04	1.52E-04	1.18E-03	1.82E-05	3.00E-06	3.64E-06		5.31E-05	1.46E-05	1.93E-04	6.42E-05	4.71E-06		4.13E-05	7.39E-03	
Cyclohexane	110-82-7	1.18E-01		2.11E-04	1.30E-03	4.20E-05	1.45E-04	3.78E-03	5.18E-04	7.71E-05	0.00E+00		1.88E-05	7.71E-06	3.15E-05		1.16E-04			1.24E-01	
Benzene	71-43-2	1.13E-04		1.29E-03	1.59E-02	2.57E-04	6.73E-06	1.28E-04	1.45E-03	8.35E-06	3.96E-07	1.50E-05	2.83E-06	2.36E-06	1.76E-06	6.64E-05	6.85E-06	3.00E-05	1.35E-05	1.93E-02	
1,3-Butadiene	106-99-0	6.94E-04		Below DL	1.44E-04	9.85E-06	2.48E-05	1.32E-04	3.80E-05		4.18E-08	2.03E-05		4.92E-06	1.71E-06					1.08E-03	
Butanol, n	71-36-3	5.34E-01																			5.34E-01
Chloroform	67-66-3	9.33E-03		5.85E-04	8.28E-06	1.07E-05	8.49E-07	2.29E-02	1.63E-05	1.56E-04	3.75E-08		1.56E-08	3.01E-06	1.76E-06	2.36E-05	3.21E-04	1.03E-05	3.00E-05	3.48E-05	
Chloromethane	74-87-3	3.13E-05		3.96E-05	2.83E-03	1.82E-03	9.73E-04	8.91E-03													1.46E-02
Dichloromethane	75-09-2	7.06E-04		1.02E-03	4.44E-04	1.43E-05	3.36E-06	4.85E-04	8.60E-03	8.35E-05	2.03E-04	3.43E-06	7.79E-05	3.64E-06	5.35E-06	1.71E-04	2.78E-05	1.61E-05	8.69E-07	1.59E-02	
Ethyl Benzene	100-41-4		4.61E-05																		4.61E-05
Ethylene Dichloride (1,2-Dichloroethane)	107-06-2	5.47E-05		1.31E-04	2.66E-04	1.56E-05	8.85E-07	1.13E-04	7.06E-05	4.28E-05	1.61E-05	1.71E-08		1.93E-06	1.28E-06		8.56E-06			1.04E-03	
Formaldehyde	50-00-0	3.82E-04		2.98E-02	7.28E-02	3.43E-03	3.36E-03	2.64E-02	3.53E-04	1.43E-04	9.64E-06	4.28E-06	6.37E-05	1.88E-04	1.50E-05	2.03E-04	1.50E-04		2.61E-06	1.38E-01	
n-hexane	110-54-3	2.84E+00		7.35E-02	9.79E-05	1.37E-05	2.12E-05	7.72E-04	1.99E-04	1.46E-05	1.71E-07	3.64E-07	8.32E-07	1.56E-05	7.28E-05	2.78E-05	2.78E-05			2.91E+00	
Methanol	67-56-1	7.21E-02		3.06E-02	1.66E-01	1.37E-02	9.73E-02	8.12E+00	1.45E-01	1.33E-01	2.89E-03	6.00E-04	8.67E-03	1.28E-02	3.85E-02	3.64E-02	1.05E-02	1.39E-01	2.26E-01	9.31E+00	
Methyl Ethyl Ketone	78-93-3	4.17E-03		2.58E-03	6.51E-03	6.64E-05	3.19E-05	1.50E-01	1.09E-03	8.35E-04	6.42E-05	1.39E-06	3.19E-04	1.50E-04	1.05E-03	2.03E-04	5.57E-04	2.14E-04	9.56E-04	1.70E-01	
Methyl Isobutyl Ketone	108-10-1	1.53E-03		2.71E-06	1.61E-04	1.69E-05	8.32E-06	1.07E-03	7.87E-04	6.21E-05	8.56E-06	3.43E-07	1.50E-05	1.18E-05	1.50E-04	4.28E-05	3.64E-04	1.18E-05	3.17E-05	4.44E-03	
Phenol	108-95-2		3.81E-04	1.19E-02	6.21E-03	1.24E-02	1.72E-03	1.09E-01	1.22E-03	6.10E-05	2.08E-05	3.19E-04	8.14E-04	2.78E-04	7.49E-04					1.46E-01	
Propionaldehyde	123-38-6		2.15E-03	4.79E-03	1.76E-04	5.84E-04	2.52E-02	4.80E-03	7.71E-05	1.02E-05	7.71E-05	3.36E-04	8.14E-04	3.64E-04	2.14E-04					3.98E-02	
a-pinene	80-56-8	3.54E+00		3.21E-02	4.92E-07	8.14E-05	3.52E-02	1.27E-01	1.61E-05	1.35E-04	6.90E-04	2.14E-03	8.56E-03		1.18E-05					3.74E+00	
b-pinene	127-91-3	8.95E-01		6.13E-03	4.71E-07	6.55E-05	9.47E-02	8.14E-05	1.28E-05	1.16E-04	4.78E-04	1.50E-03	6.21E-03	1.18E-05						1.00E+00	
Toluene	108-88-3	5.47E-05		3.14E-04	8.81E-04	4.50E-05	1.04E-04	6.33E-03	1.54E-03	1.05E-04	9.96E-06	1.99E-07	4.25E-05	2.57E-05	1.07E-05	1.61E-05	4.28E-05	1.07E-05	1.17E-04	9.84E-03	
Xylenes	1330-20-7	9.24E-05		2.94E-04	4.36E-05	8.35E-06	9.31E-07	4.78E-02	4.16E-04	7.92E-05	2.25E-08	1.50E-06	6.19E-06	3.64E-05	1.11E-05	9.21E-05	1.88E-06	2.14E-04	4.13E-05	4.49E-02	
Acenaphthene	83-32-9		1.44E-06		3.04E-06																4.49E-06
Acenaphthylene	208-96-8		5.91E-06		8.57E-05																9.16E-05
Benz(a)anthracene	56-55-3		2.32E-07	4.12E-06	5.60E-06	4.00E-05															5.00E-05
Benzo(a)phenanthrene (Chrysene)	218-01-9		1.77E-06	1.08E-04	5.60E-06	9.42E-05															2.10E-04
Benzo(a)pyrene	50-32-8		1.90E-07	5.38E-07	5.60E-06	3.19E-06															9.51E-06
Benzo(b)fluoranthene	205-99-2		4.99E-07	5.40E-06	5.60E-06	8.12E-06															1.96E-05
Benzo(b,j)fluoranthene	205-82-3		1.12E-07																		1.12E-07
Benzo(e)pyrene	192-97-2		4.43E-08	2.55E-06		4.19E-06															6.79E-06
Benzo(g,h,i)perylene	191-24-2		4.24E-07	5.77E-07	5.60E-06	5.10E-07															7.11E-06
Benzo(j)fluoranthene	191-24-2		4.24E-07																		4.24E-07
Benzo(k)fluoranthene	207-09-9		2.39E-07		1.11E-06	5.60E-06	7.11E-06				</										

1,2,3,7,8-Penta CDD	40321-76-4		3.01E-10																	3.01E-10
1,2,3,4,7,8-Hexa CDD	39227-28-6		3.06E-11																	3.06E-11
1,2,3,6,7,8-Hexa CDD	57653-85-7		4.05E-11																	4.05E-11
1,2,3,7,8,9-Hexa CDD	19408-74-3		3.07E-11																	3.07E-11
1,2,3,4,6,7,8-Hepta CDD	35822-46-9		1.53E-11																	1.53E-11
Ocla CDD	3268-87-9		1.20E-12																	1.20E-12
2,3,7,8-Tetra CDF	51207-31-9		2.89E-11																	2.89E-11
1,2,3,7,8-Penta CDF	57117-41-6		3.17E-11																	3.17E-11
2,3,4,7,8-Penta CDF	57117-31-4		5.42E-10																	5.42E-10
1,2,3,4,7,8-Hexa CDF	70648-26-9		3.66E-11																	3.66E-11
1,2,3,6,7,8-Hexa CDF	57117-44-9		4.00E-11																	4.00E-11
2,3,4,6,7,8-Hexa CDF	67562-39-4		6.08E-11																	6.08E-11
1,2,3,7,8,9-Hexa CDF	72918-21-9		2.04E-11																	2.04E-11
1,2,3,4,6,7,8-Hepta CDF	67562-39-4		4.20E-12																	4.20E-12
1,2,3,4,7,8,9-Hepta CDF	55673-89-7		1.23E-12																	1.23E-12
Ocla CDF	39001-02-0		3.74E-14																	3.74E-14
Total Dioxins and Furans			1.20E-09	2.30E-12																1.20E-09
Contaminant	CAS No.	Primary Clarifier	AST	Secondary Clarifier⁶	Biomass Boiler	Recovery Boiler	Lime Kiln	Smelt Dissolving Tank	HLRV	Bleach Pulp Dryer²	Slacker Only	Causticizer Only	Salt Cake Mix	Lime Mud Precoat	Precoat filter exhaust	White liquor	Dregs Filter	Steam stripper	Total	
Hydrogen Sulphide	7783-06-4	3.07E-03	4.76E-03	2.96E-03	0.00E+00	2.39E-01	2.30E-03	3.52E-04	1.34E+00							8.78E-03		2.00E-02	1.63E+00	
Methyl Mercaptan	74-93-1	1.24E-03	5.10E-02	0.00E+00		6.16E-01	3.29E-01	8.22E-02	1.64E-01										1.24E+00	
Dimethyl sulphide	75-18-3	5.87E-03	1.28E-01	0.00E+00		6.16E-01	3.29E-01	8.22E-02	1.64E-01										1.33E+00	
Dimethyl Disulphide	624-92-0	1.74E-03	3.14E-01	0.00E+00		6.16E-01	3.29E-01	8.22E-02	1.64E-01										1.51E+00	
Carbon Disulphide	75-15-0				1.24E-03		1.01E-03	4.60E-04	3.61E-02	3.30E-02	2.57E-06	2.57E-06	4.96E-05	1.50E-05	4.07E-05		3.00E-05		1.05E-01	
Total Reduced Sulphur	N/A	8.43E-03	3.39E-01	2.96E-03	1.11E-03	1.46E+00	6.54E-01	1.63E-01	1.70E+00	3.00E-02	2.30E-06	2.30E-06	4.44E-05	1.34E-05	3.64E-05	8.78E-03	2.68E-05	2.00E-02	5.81E+00	

¹Units are all "kg C/ s"

²In the model, emission rate presented is equally divided between the 3 drier vents

³Used in the case that specific slaker/caustizer emission rates are not available

⁴In the model, emission rate presented is equally divided between the 5 causticizer vents

⁵In the model, emission rate presented is equally divided between the 4 green liquid clarifier vents

⁶In the model, emission rate presented is equally divided between the 2 secondary clarifiers.

APPENDIX C

Full List of Source Parameters

Table C1 List of Secondary Point Source Parameters

Point Sources	UTM Coordinates		Stack Parameters					
	Easting (m)	Northing (m)	Base Elevation (m)	Release Height (m)	Stack Diameter (m)	Gas Exit Flow Rate (m ³ /s)	Gas Exit Velocity (m/s)	Gas Exit Temp. (°C)
Pulp Dryer Vent	521989.7	5055611.3	10.75	16.68	0.15	0.02	1	323
Pulp Dryer Vent 2	521977.6	5055622.9	10.81	16.68	0.15	0.02	1	323
Pulp Dryer Vent 3	521969.0	5055630.9	11	16.68	0.15	0.02	1	323
Salt Cake Mix Tank Vent	522094.9	5055503.4	10	47.34	0.15	0.02	1	323
Stripper Vent 1	522239.4	5055462.7	10	24.69	0.15	0.02	1	323
Stripper Vent 2	522251.8	5055469.5	10	22.58	0.15	0.02	1	323
Precoat Filter Vent	522189.30	5055388.6	10	22.49	1.5	12.4	7	323
Dregs Filter Vent	522197.8	5055379.8	10	22.49	1.5	12.4	7	323
3 Compartment Causticizer Vent	522245.8	5055415.9	10.03	23.36	0.25	0.05	1	323
Slaker Vent	522245.5	5055405.9	10.09	15.72	0.25	0.05	1	323
Causticizer Vent 1	522249.1	5055401.0	10.19	14.34	0.15	0.02	1	323
Causticizer Vent 2	522239.7	5055404.6	10	15.72	0.15	0.02	1	323
Causticizer Vent 3	522236.1	5055409.5	10	15.72	0.15	0.02	1	323
Causticizer Vent 4	522230.6	5055413.6	10	15.72	0.15	0.02	1	323

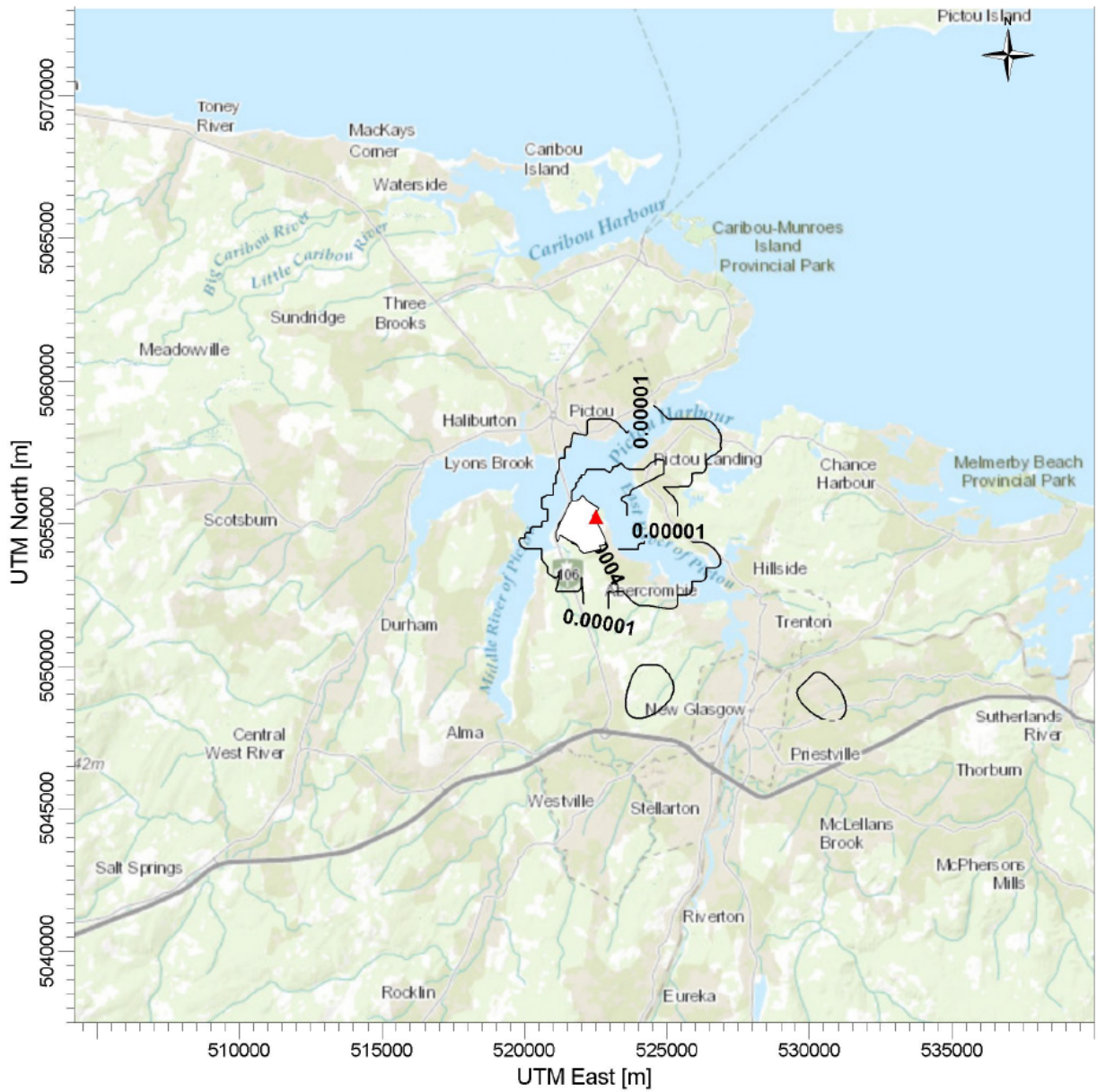
Table C2 List of Secondary Volume Sources

Volume Sources	UTM Coordinates		Volume Source Parameters			
	Easting (m)	Northing (m)	Base Elevation (m)	Release Height (m)	Sigma Y	Sigma Z
White Liquor Storage Tank	522112.5	5055557.4	11	13.17	0.23	5.66
Green Liquor Clarifier Vent 1	522219.6	5055420.5	10	15.15	0.23	6.58
Green Liquor Clarifier Vent 2	522215.5	5055416.7	10	15.15	0.12	6.58
Green Liquor Clarifier Vent 3	522211.9	5055412.3	10	15.15	0.12	6.58
Green Liquor Clarifier Vent 4	522207.8	5055408.7	10	15.15	0.12	6.58
Lime Mud Precoat	522201.3	5055382.8	10	20.94	0.23	9.27

APPENDIX D

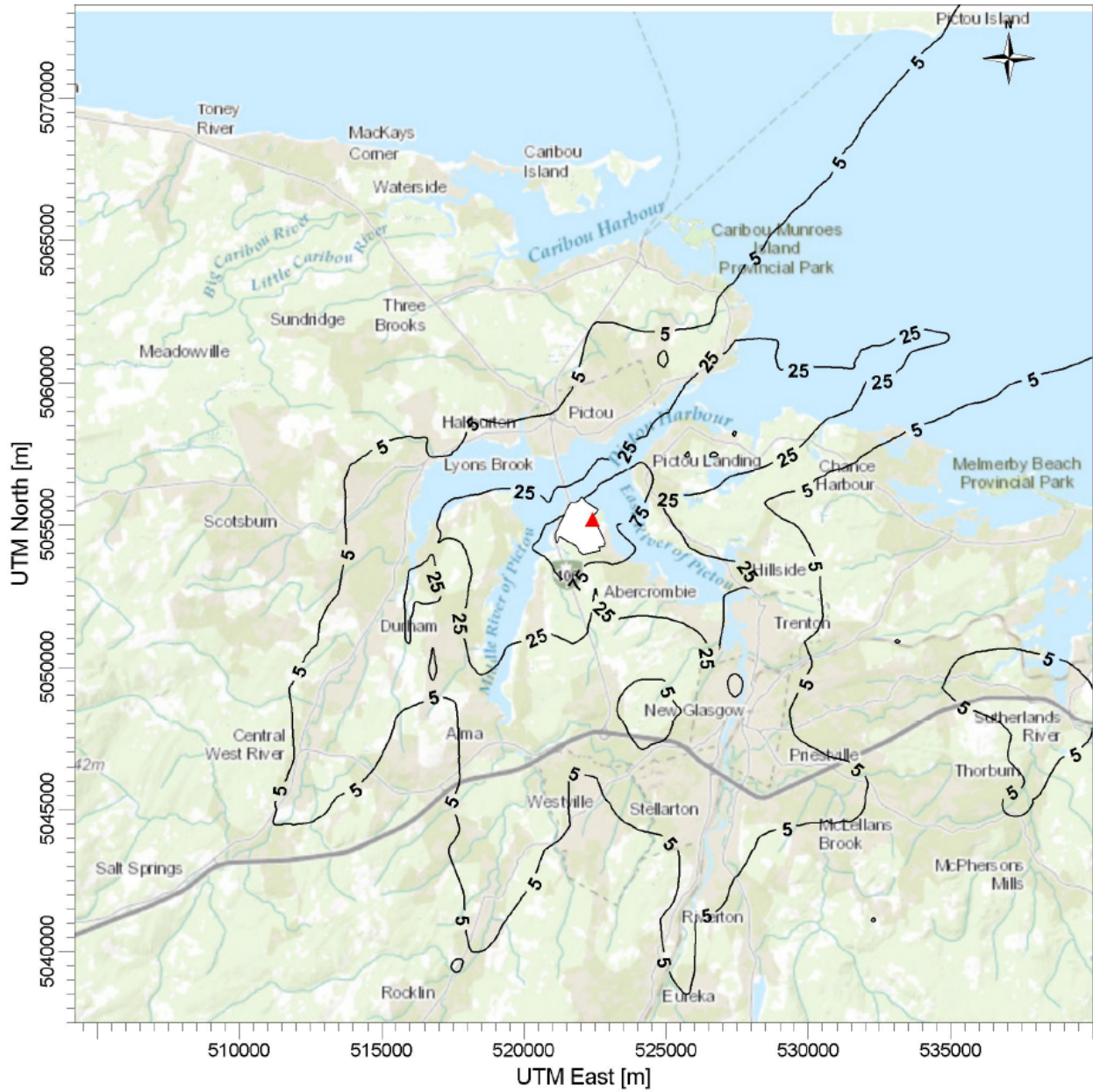
Air Dispersion Modelling Results – Concentration Contours

Figure D1 Maximum Predicted Annual Ground Level Concentration of Hexavalent Chromium



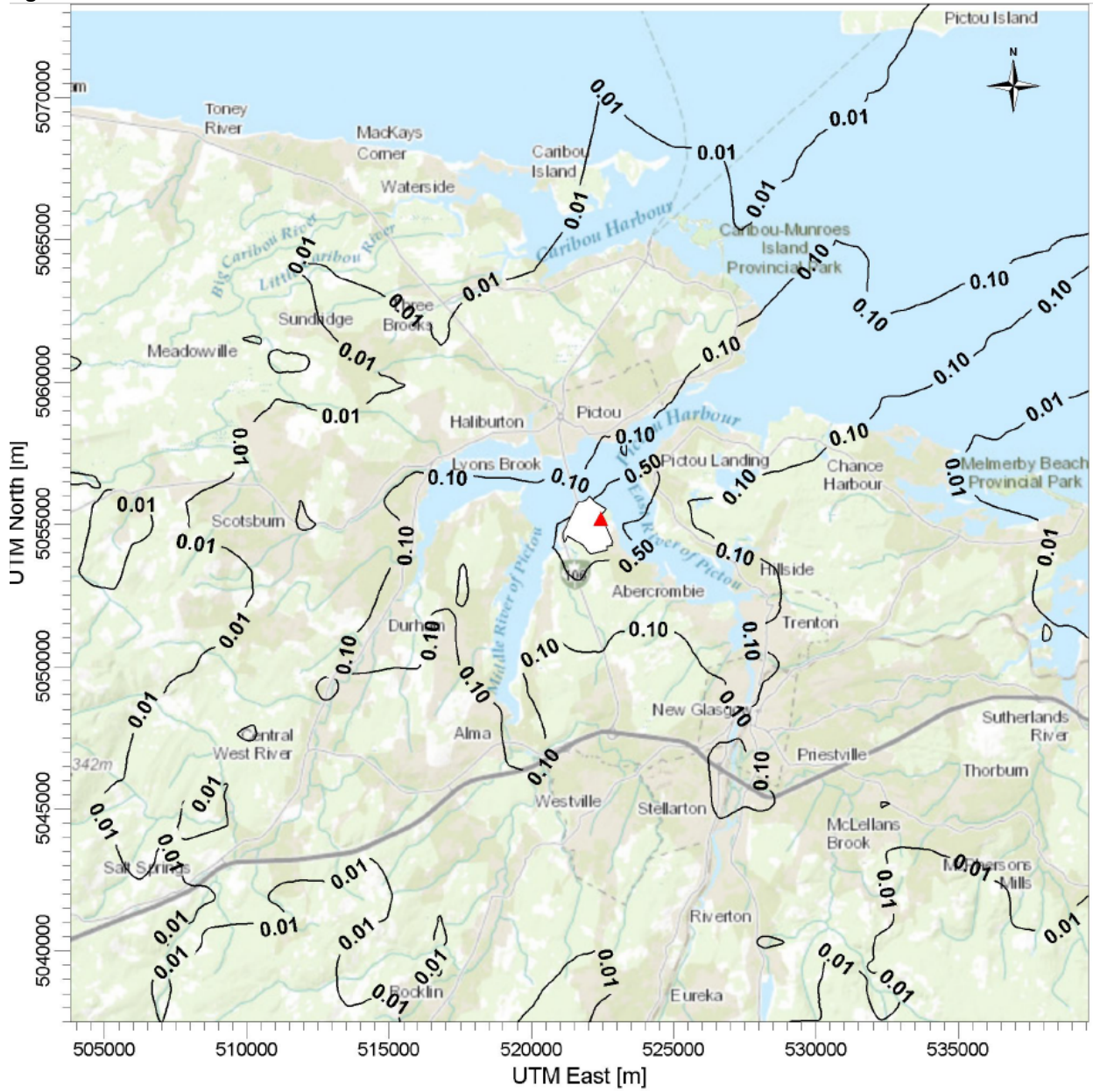
▲ Location of Maximum GLC ($2.20E-02 \mu\text{g}/\text{m}^3$)

Figure D2 Maximum Predicted 24-hour Ground Level Concentration of Ammonia



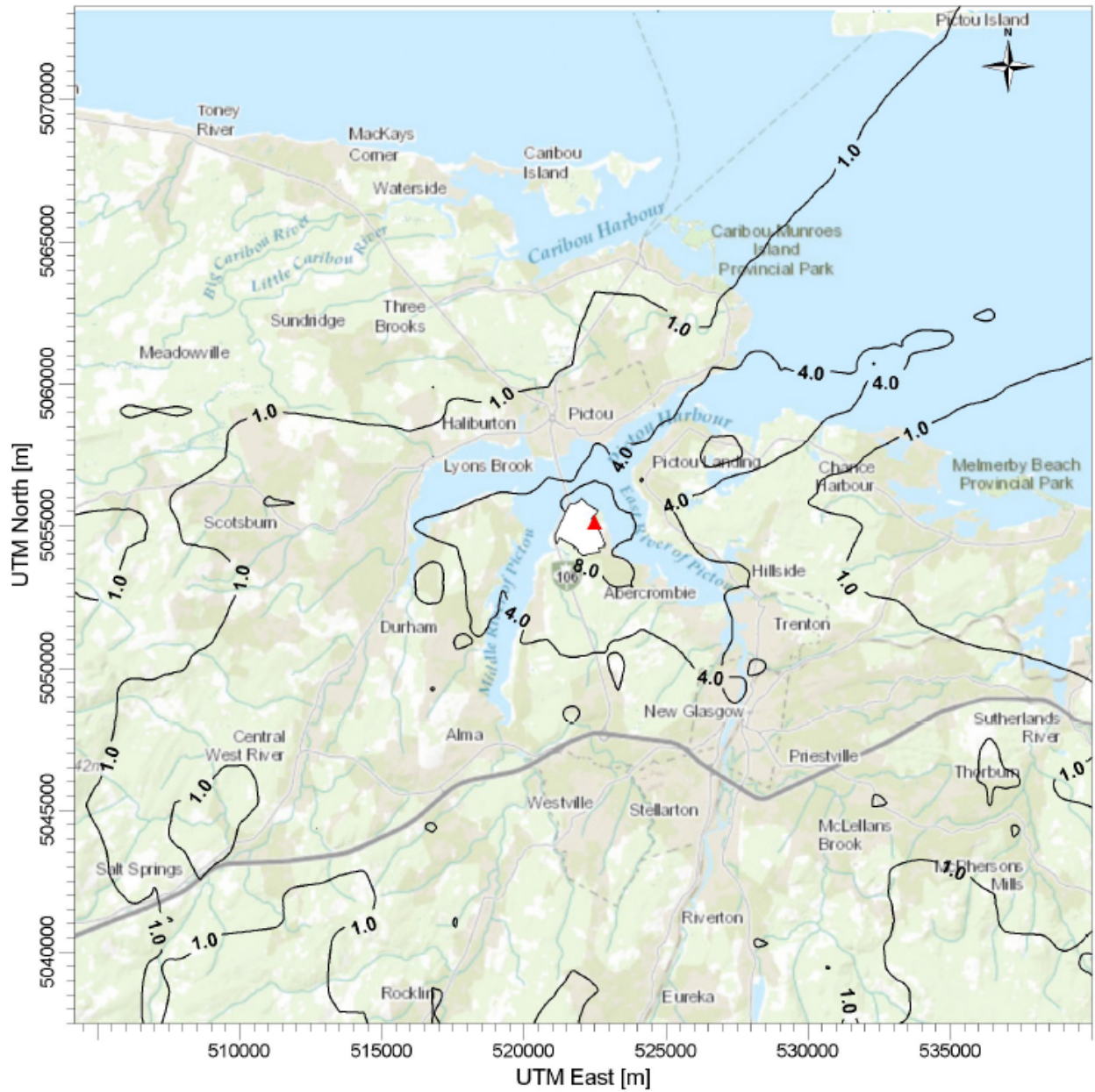
▲ Location of Maximum GLC (406 µg/m³)

Figure D3 Maximum Predicted 24-hour Ground Level Concentration of Chloroform



▲ Location of Maximum GLC (2.55 µg/m³)

Figure D4 Maximum Predicted 24-hour Ground Level Concentration of Total Reduced Sulphur (TRS)



▲ Location of Maximum GLC (64.5 µg/m³)