SENES Consultants Limited
Specialists in Energy, Nuclear and Environmental Sciences

CALIXTE Environmental Management

FINAL REPORT

CALPUFF AIR DISPERSION MODELLING SO_2, CO, NO_X, AND TSP EMISSIONS OF 2004 FOR THE HOLYROOD THERMAL GENERATING STATION

Prepared for:

Newfoundland and Labrador Hydro
Environmental Services and Properties Department
500 Columbus Drive
P.O. Box 12400
St. John's, NL
A1B 4K7

Prepared by:

SENES Consultants Limited
121 Granton Drive, Unit 12
Richmond Hill, Ontario
L4B 3N4

Calixte Environmental Management
6 Stoneyhouse Street
St. John's, NL
A1B 2T6

October 2005
Project 34113/NL05119

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Chris Marson, P.Eng.
Senior Environmental Engineer

Michel Wawrzkow, P.Eng. P.Geo
Senior Environmental Engineer

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EXECUTIVE SUMMARY

Calixte Environmental Management Inc and SENES Consultants Limited were retained by Newfoundland and Labrador Hydro to carry out air dispersion modelling of sulphur dioxide (SO_2), carbon monoxide (CO), nitrogen oxides (NO_x), and total suspended particulate matter (TSP) emissions from three stacks at the Holyrood Thermal Generating Station using 2004 emissions and meteorological data. The CALMET/CALPUFF modelling system was used in the analysis since this is the preferred system of the Newfoundland and Labrador Department of Environment and Conservation, and because it accounts for complex terrain and sea breeze effects that characterize the site. Maximum predicted time-averaged concentrations at receptors located within a 20 km by 20 km modelling domain were compared with Ambient Air Quality Standards (AAQS) of Newfoundland and Labrador's *Air Pollution Control Regulations, 2004*. In addition, maximum SO_2 concentrations were predicted at five discrete monitoring stations. At four of these stations, where continuous air quality monitoring has been carried out throughout 2004, comparisons were made between modelled and monitored values.

As a refinement from work of previous years, the National Centre for Environmental Predictions' (NCEP) Eta meso-scale analysis data were used in this study. In this region of Canada, Eta data is available on a 32 km by 32 km grid. Surface and upper air meteorological data from the nearest eight (8) Eta grid points were used to generate initial wind fields as input to the CALMET meteorological processor. Previously, data were obtained from three (3) surface and one (1) upper air weather stations that, located at St John's, Argentia and Gander, range from 30 to almost 300 km from the site. For this study, the CALMET three dimensional wind fields calculated with the Eta analysis fields produced more realistic wind flows near the facility.

A further refinement was in the use of hourly contaminant emission rates, which were derived for each of the three modelled sources using actual hourly process data obtained from the facility. In a previous study, daily emission rates, based on fuel consumption and composition, were used to derive hourly emission rates.

The CAPLUFF modelled results compared favourably with the concentrations monitored at the four nearby monitoring stations.

Maximum predicted concentrations for different averaging periods were computed and are presented in Tables ES.1 to ES.5 below. Also shown are the 99^{th}, 97^{th}, and 95^{th} percentile concentrations, and area and frequency of exceedance above the regulatory standards. The 99^{th} percentile indicates that a concentration at any point in the modelling domain will be lower than this percentile value for 99 percent of the time. SO_2 concentrations are predicted to exceed hourly, 3-hour and 24-hour AAQS for a very low percentage of the time in 2004. NO_x concentrations are predicted to exceed the hourly AAQS approximately once in 2004.

TABLE ES.1
STATISTICS OF MAXIMUM PREDICTED HOURLY AVERAGE OFF-PROPERTY CONTAMINANT CONCENTRATIONS

Contaminant	Max (μg/m³)	AAQS (μg/m³)	Area of Exceedance (km²)	Frequency of Exceeding AAQS (%)	Percentile Concentration (μg/m³)		
					99th	97th	95th
SO_2	3147	900	2.2	0.06	313	78	35
NO_x	405	400	~0.1	0.01	51	12	6
CO	323	35000	0	0	17	5	1

TABLE ES.2
STATISTICS OF MAXIMUM PREDICTED 3-HOUR AVERAGE OFF-PROPERTY CONTAMINANT CONCENTRATIONS

Contaminant	Max (μg/m³)	AAQS (μg/m³)	Area of Exceedance (km²)	Frequency of Exceeding AAQS (%)	Percentile Concentration (μg/m³)		
					99th	97th	95th
SO_2	1234	600	1.7	0.8	273	86	39

TABLE ES.3
STATISTICS OF MAXIMUM PREDICTED 8-HOUR AVERAGE OFF-PROPERTY CONTAMINANT CONCENTRATIONS

Contaminant	Max (μg/m³)	AAQS (μg/m³)	Area of Exceedance (km²)	Frequency of Exceeding AAQS (%)	Percentile Concentration (μg/m³)		
					99th	97th	95th
CO	120	15,000	0	0	13	5	3

TABLE ES.4
STATISTICS OF MAXIMUM PREDICTED DAILY AVERAGE OFF-PROPERTY CONTAMINANT CONCENTRATIONS

Contaminant	Max (μg/m^3)	AAQS (μg/m^3)	Area of Exceedance (km^2)	Frequency of Exceeding AAQS (%)	Percentile Concentration (μg/m^3)		
					99th	97th	95th
SO_2	309	300	~0.1	0.3	205	86	45
NO_x	50	200	0	0	33	14	7
TSP	28	120	0	0	17	7	4

TABLE ES.5
STATISTICS OF MAXIMUM PREDICTED ANNUAL AVERAGE OFF-PROPERTY CONTAMINANT CONCENTRATIONS

Contaminant	Maximum (μg/m^3)	AAQS (μg/m^3)	Area of Exceedance(km^2)
SO_2	8	60	0
NO_x	1.3	100	0
TSP	0.63	60	0

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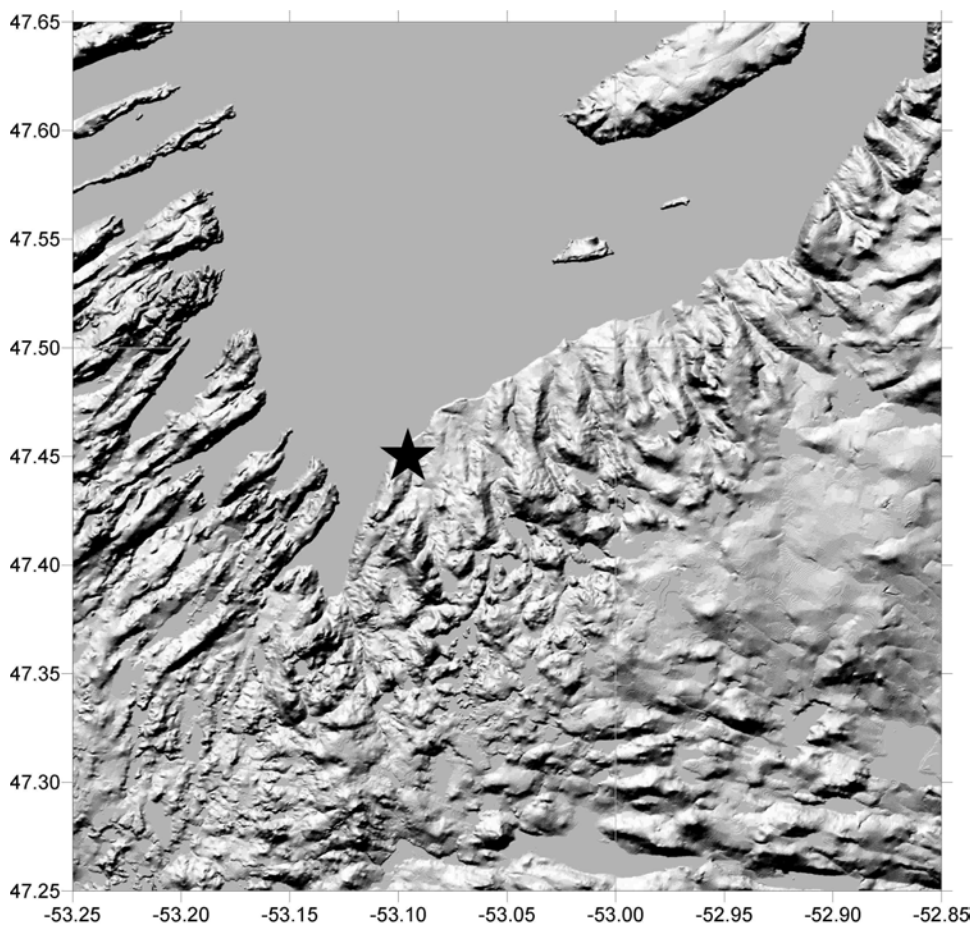
1.0 INTRODUCTION

Calixte Environmental Management (Calixte) and SENES Consultants Limited (SENES) were retained by the Environmental Services and Properties Department of Newfoundland and Labrador Hydro (NLH) to prepare this CALPUFF air dispersion modelling report for the Holyrood Thermal Generating Station (HTGS) in Holyrood. The results of this study will be used to fulfill NLH's agreement with the Newfoundland and Labrador Department of Environment and Conservation (DOEC) to complete annual air dispersion modelling of atmospheric emissions. This report is an analysis of the facility's air emissions that were produced during the 2004 calendar year.

NLH operates a 490 megawatt (MW) Bunker C fired thermal generating station in Holyrood, Newfoundland and Labrador, in the southwest corner of Conception Bay. Figure 1.1 is a relief map that shows the approximate location of the plant.

FIGURE 1.1
LOCATION OF HOLYROOD THERMAL GENERATING STATION



The facility is comprised of two 170 MW units (Units 1 & 2) and one 150 MW unit (Unit 3), each exhausting through its own independent stack. Emissions from each stack are directly related to the combustion of Bunker C fuel.

The DOEC has developed a plume dispersion modelling guideline, GD-PPD-19 entitled *Departmental Requirements for Plume Dispersion Modelling*. The guideline specifies that the preferred modelling approach is the CALMET / CALPUFF modelling system, and further defines the generic conditions under which the modelling will be undertaken. The modelling undertaken for this project generally followed this guideline. Any deviations in methodology from this guideline were discussed with and approved by DOEC (these are elaborated on later in relevant sections of this report).

As required under the DOEC modelling guideline (Table 8.1), this report deals with the emissions of:

- Sulphur dioxide (SO_2);
- Oxides of Nitrogen (NO_2);
- Carbon monoxide (CO); and
- Total Suspended Particulate (TSP).

Meteorology was developed using CALMET based on initial wind fields from the 32 by 32 km meso-scale Eta analysis data. This gives more realistic wind flow patterns than basing the generated wind fields on the meteorological data collected at the St John's Airport surface station.

1.1 ASSESSMENT CRITERIA

Table 1.1 contains the applicable Air Quality assessment criteria for the contaminants that are emitted from the HTGS.

TABLE 1.1
AMBIENT AIR QUALITY STANDARDS

Contaminant	1-hr (µg/m^3)	3-hr (µg/m^3)	8-hr (µg/m^3)	24-hr (µg/m^3)	Annual (µg/m^3)
Sulphur Dioxide (SO_2)	900	600	-	300	60
Nitrogen Dioxide (NO_2)	400	-	-	200	100
Carbon Monoxide (CO)	35,000	-	15,000	-	-
Particulate Matter Total (PM)	-	-	-	120	60

Source: Schedule A of Air Pollution Control Regulation, 2004 (NLR 39/04)

2.0 ATMOSPHERIC EMISSIONS

2.1 METHODOLOGY

For this study, the methodology was refined from previous years. In previous years, the daily fuel consumption rate was used to scale the results from the most recent source testing. Since the dispersion model requires hourly inputs, it was necessary to assume that the rate of fuel consumption was constant throughout the day. This introduced uncertainties into the modelling results as atmospheric dispersion characteristics during the night are different than during the day. To improve modelling accuracy, the current study used hourly varying mass emission rates, exhaust temperatures and exhaust volumetric flow rates. A sample of the hourly operational data log file is included in Appendix A.

Hourly operational data for each of the three units was supplied by NLH. The hourly data used for this report consisted of power generation rate, east and west gas outlet temperatures and flue gas mass flow rate. The use of hourly data matches the rate of emissions with the meteorology at the time of release resulting in a more accurate prediction of ambient concentrations.

The amount of fuel burned controls the power output of the units. As the units' rate of fuel varies not only does the mass emission rate of contaminants vary but so do the exhaust temperatures and the exhaust gas flowrates. This will change the dispersion characteristics as the momentum and plume rise vary.

Temperature

The east and west temperatures were averaged together for each hour. Data supplied by NLH of average temperatures for the year 2004 were compared with average temperatures measured by Air Testing Services during their 2005 testing for each of the units. These values were essentially the same confirming that the NLH supplied temperatures were representative of final exhaust temperatures.

Flue Gas Flow

The flue gas flow was supplied as an hourly mass flow rate in kilograms per second. The CALPUFF model requires stack exit velocity as input. The hourly mass flow rates were converted to equivalent volumetric flows by assuming the exhaust gases behave as an ideal gas where the relationship between temperature, pressure, and volume is expressed by the Ideal Gas Law, as follows:

$$V = \frac{mRT}{MW \bullet P}$$

where:

m = mass (kg);
V = volume (m^3);
MW = molecular weight (kg/mole);
R = ideal gas law constant (8.314);
T = absolute temperature (K);
P = atmospheric pressure (assumed constant at 101325 Pa).

This calculated volume was comparable to the volume measured during source testing.

Velocity

The velocity was calculated hourly based on the volumetric flow rate calculated above and the stack exit diameter.

Contaminant Mass Emission Rate

In deriving an equation for calculating hourly contaminant mass emission rates, it was assumed that mass emission rate varied linearly with power generation rate (expressed in MW). The expression used in determining the emission rate at any given hour (ER_{hour}) is as follows:

$$ER_{hour} = \frac{Gen_{hour}}{Gen_{test}} \times ER_{test}$$

Where *Gen* is the generation rate, and the subscript "*test*" refers to parameters measured during Air Testing Services' 2005 source testing campaign.

2.2 2005 SOURCE TESTING RESULTS

Air Testing Services Inc conducted a series of source tests in April of 2005. NLH staff provided a copy of Air Testing Services' report to Calixte/SENES for review, and emission rates measured during these tests were used to derive hourly emission rates for each of the three stacks. Tables 2.1, 2.2 and 2.3 contain a summary of the 2005 source testing results for Units 1, 2 and 3, respectively. Note that the data in these tables represent the average of three source tests. Appendix B contains the results from the 2005 source testing campaign.

TABLE 2.1
UNIT 1 SUMMARY SOURCE TESTING RESULTS

Contaminant	Temp (°C)	Generation (MW)	Emission Rate (g/s)
Average SO_2	182.3	165	404.0
Average NO_x	182.3	165	72.03
Average CO	182.3	165	0.964
Average TSP	180.0	165	44.7

TABLE 2.2
UNIT 2 SUMMARY SOURCE TESTING RESULTS

Contaminant	Temp (°C)	Generation (MW)	Emission Rate (g/s)
Average SO_2	172.7	165	440.0
Average NO_x	172.7	165	56.6
Average CO	172.7	165	6.95
Average TSP	172.7	157	18.20

TABLE 2.3
UNIT 3 SUMMARY SOURCE TESTING RESULTS

Test	Temp (°C)	Generation (MW)	Emission Rate (g/s)
Average SO_2	172.7	130	297.3
Average NO_x	172.7	130	52.87
Average CO	172.7	130	45.5
Average TSP	172	130	29.2

Note that Unit 1 and Unit 2 are identical in design and similar in operation. Emission rates of SO_2 and NO_x are similar for these two units. Comate, an abrasive additive, was used in Unit 1 during testing. This inert compound is designed to reduce buildup in the unit and results in an increase in particulate emissions.

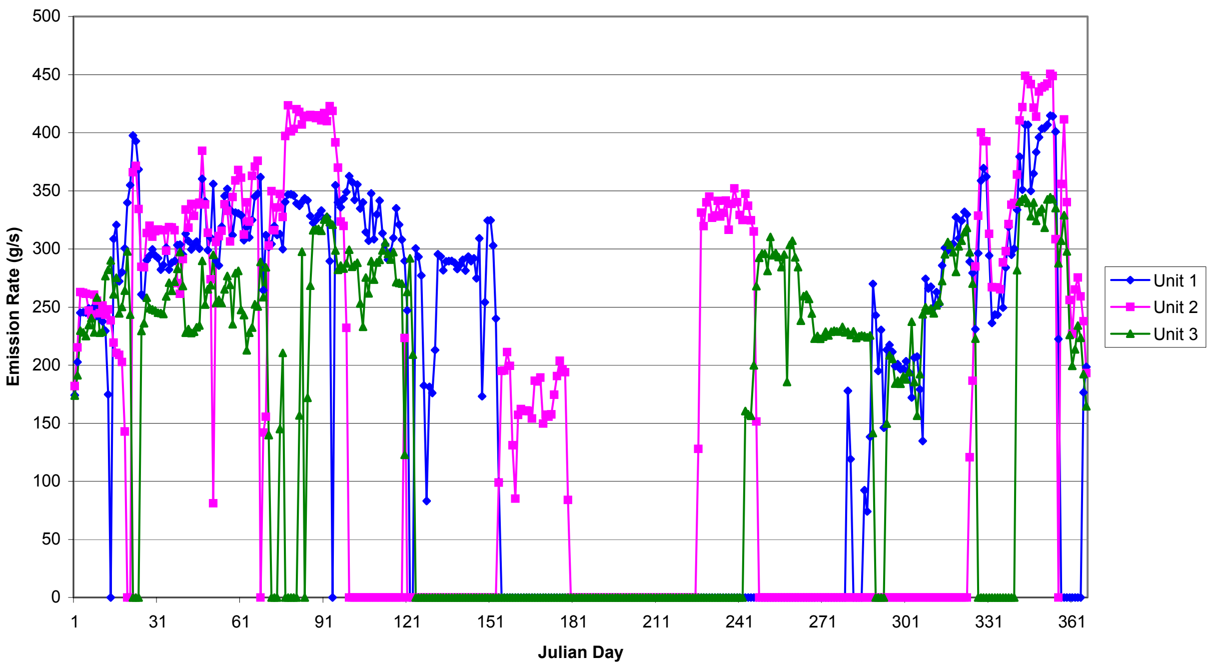
Since Unit 3 has a lower firing rate of 130 MW compared to the firing rate of 165 MW for Units 1 and 2, the SO_2 emission rate is lower from Unit 3.

2.3 HOURLY CONTAMINANT EMISSION RATES

Using the methodology described in Section 2.1 with the 2005 source testing results presented in Section 2.2, hour by hour emission rates were determined for each of the contaminants for each of the three units. Appendix A contains a sample of the hourly data supplied by NLH.

Figure 2.1 is a graphical representation of the derived SO_2 emission rates for the three units for the year 2004. Appendix C contains similar graphs for the other contaminants.

FIGURE 2.1
DERIVED SO_2 EMISSION RATES FOR 2004



These derived emission rates are combined with the hourly varying temperatures and flowrates supplied by NLH as input into the CALPUFF model. A sample CALPUFF input file is supplied on a CD in Appendix E.

3.0 MODELLING METHODOLOGY

3.1 MODEL SELECTION

The CALMET/CALPUFF modelling system is a regulatory model in Newfoundland and Labrador. For this study, the modelling has been undertaken using the Version 5.711 pf the CALMET/CALPUFF modelling system. CALMET is a meteorological model that produces hourly, three dimensional gridded wind fields from available meteorological, terrain and land use data. CALPUFF is a non-steady state puff dispersion model that utilizes the CALMET wind fields and accounts for spatial changes in meteorology, variable surface conditions, and plume interactions with terrain. CALPUFF can handle both simple and complex terrain.

The HTGS site is on the shore of a narrow inlet (Holyrood Bay) in complex terrain and thus ocean effects and terrain will be important at this site emphasising the need for a model such as CALPUFF.

3.2 CALMET

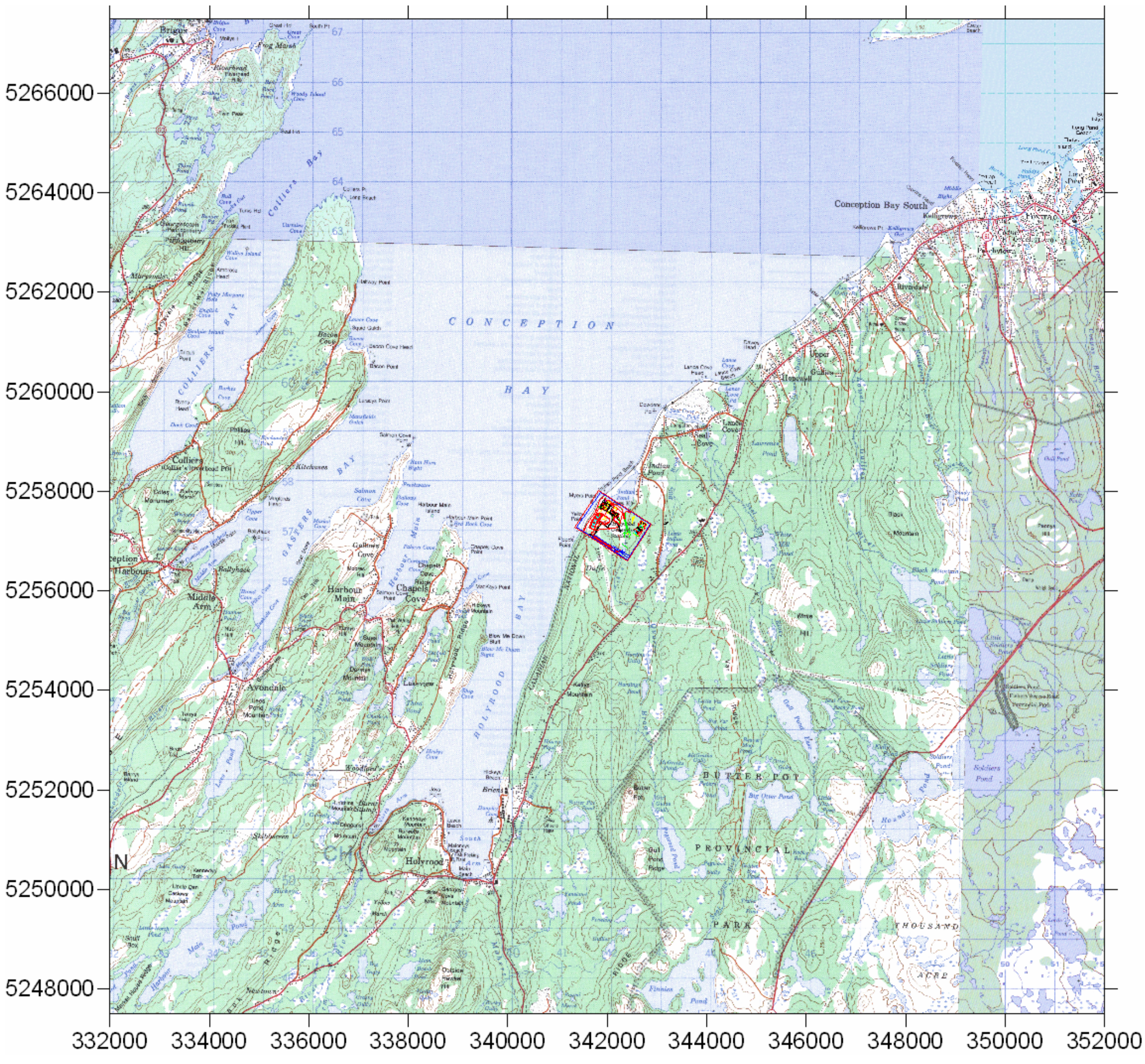
The CALMET metrological model was used to develop a one-year data set of hourly wind fields for use by the CALPUFF dispersion model for the year 2004. The CALMET model was run for a large modelling domain of 20 km in east-west direction and 20 km in south-north direction with a grid spacing of 0.1 km. This domain covers the area around Conception Bay and nearby land with all terrain features. Initial wind fields were based on the 32 by 32 km meso-scale Eta analysis data that is available in this region of Canada. The closest eight (8) grid points selected from the mesoscale model that were used are presented in Figure 3.1. The CALMET modelling domain is also shown.

FIGURE 3.1
LOCATION OF ETA GRID POINTS NEAR HOLYROOD

Note: + 32 x 32 km Eta grid points used
— CALMET modelling domain

Figure 3.2 shows the extent of the CALMET modelling domain and the location of the HTGS within that domain.

FIGURE 3.2
TOPOGRAPHICAL MAP OF CALMET DOMAIN



Processing the available data through the CALMET meteorological processor model captures the regional flow patterns. Nine vertical layers were included for the wind field. The layer heights are shown in Table 3.1.

TABLE 3.1
CALMET WIND FIELD LAYER HEIGHTS

Vertical Height of Layer (m)	Layer Height of Top (m)	Notes
20	20	10-meter meteorology
30	50	30-meter meteorology
25	75	
25	100	
100	200	
300	500	
500	1000	
1000	2000	
1300	3300	

The mixing heights in "A Mixing Heights Study for North America (1987–1991)" from St. Johns (Torbay) were reviewed to insure that the top of the grid is well above the climatological mixing heights (774 m). This pattern of rising layers follows the guidance from the CALMET user's manual in terms of gradually increasing layer depth with height.

The CALMET model requires as input, a control file that defines the wind field grid parameters and model option switches, meteorological data, land use data and terrain data. A description of the data used in this study is provided below.

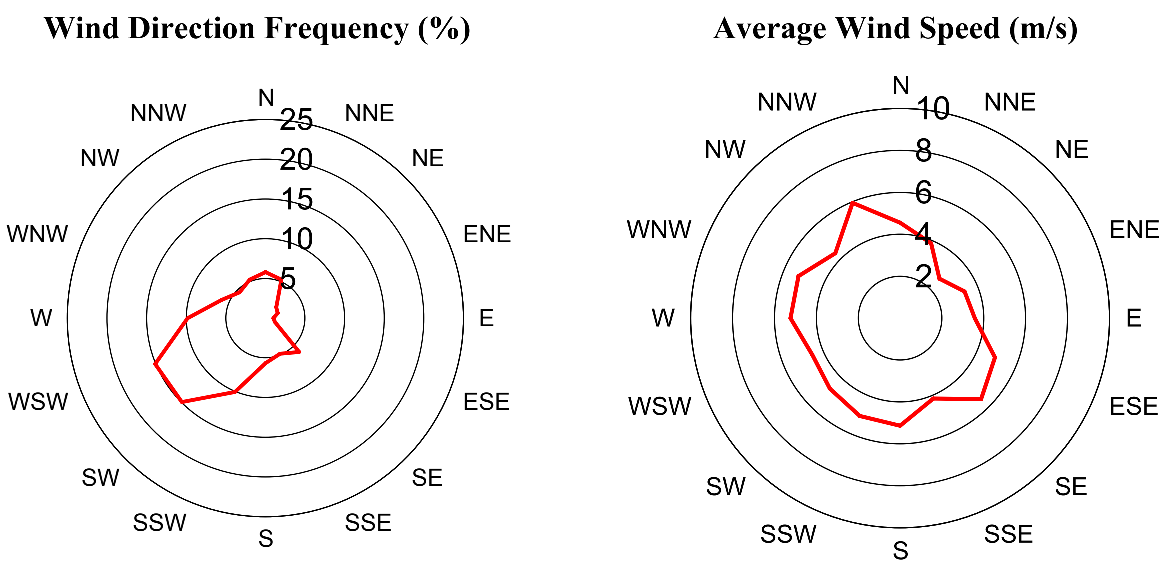
3.2.1 Meteorology

The CALMET model uses all available meteorology data within a defined modelling domain to compute gridded wind fields. CALMET requires, at a minimum, one surface station and one upper air (sounding) station. The wind fields can alternatively be created based on the National Center for Environmental Predictions (NCEP) Eta meso-scale analysis wind fields. The Eta initialization fields are available for every 6 hours. This methodology for developing the wind fields was discussed with and accepted by the DOEC as being superior to using available surface data.

For this study the St John's Airport surface data was not used as it shows predominant westerly winds (i.e. winds from the west) due to its exposure while at the HTGS site the winds should be predominantly from the southwest, being strongly influenced by the northeast-southwest orientated shoreline. CALMET creates hourly fields based on the meteorology, the terrain and land use files. For this study, a complete year of metrological data (1 January 2004 – 31 December 2004) was prepared.

Data was extracted from the three dimensional CALMET output file for the grid point nearest the location of the HTGS site at a height of 10 m. The wind rose presented in Figure 3.3 shows a predominance of winds from the southwest which confirms that the use of the Eta analysis data results in winds that roughly follow the shoreline as expected.

FIGURE 3.3
WIND ROSE FROM NEAREST CALMET GRID POINT – 2004



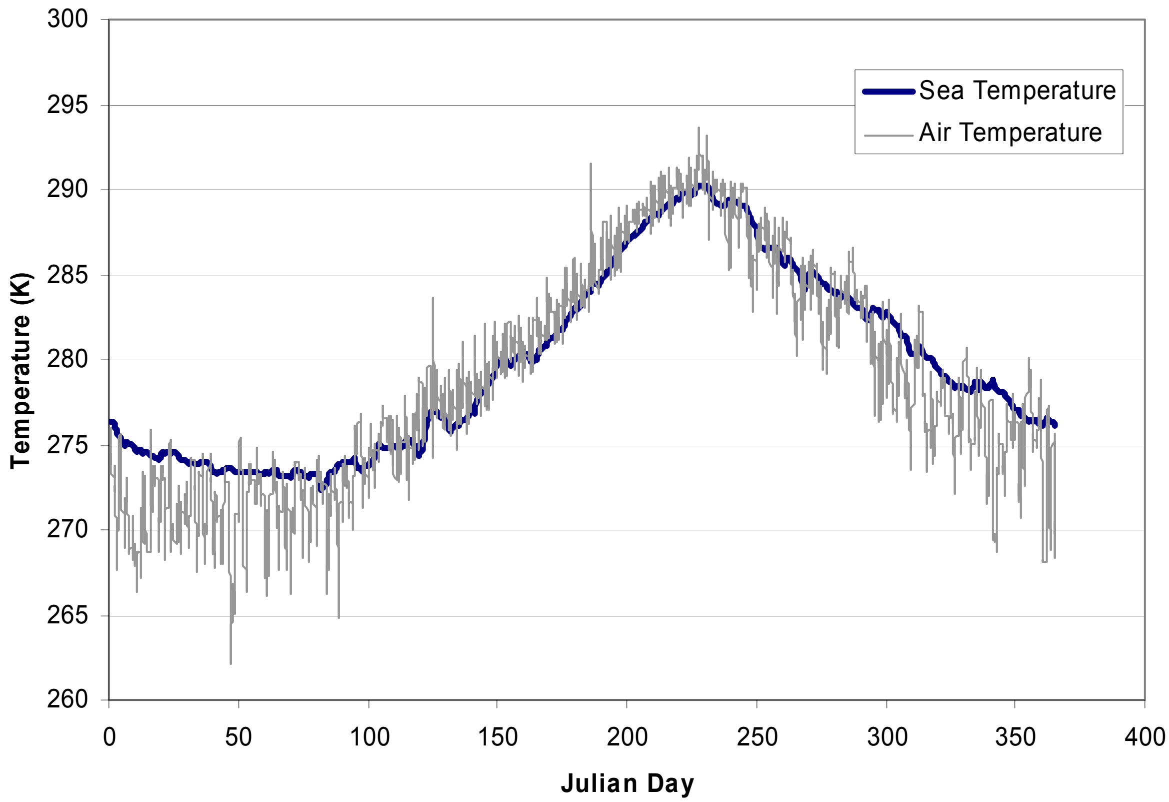
Note: This is direction wind blows **from**

Percentage Calms = 2.32%

3.2.2 Sea Temperature

A file (SEA.DAT) was developed based on daily sea surface temperatures from the Eta meso-scale fields at the grid point above the water closest to the HTGS site. Air temperatures and temperature differences between air and water were developed for the same grid point. The sea surface temperatures were kept constant over 24 hours. The air temperatures used were interpolated between the 6 hour Eta analysis fields. This method results in a better representation of water temperatures than the measurements taken from a remote buoy. Figure 3.4 presents the sea surface temperature (dark blue line) and the air temperature just above the sea at that point (light grey line).

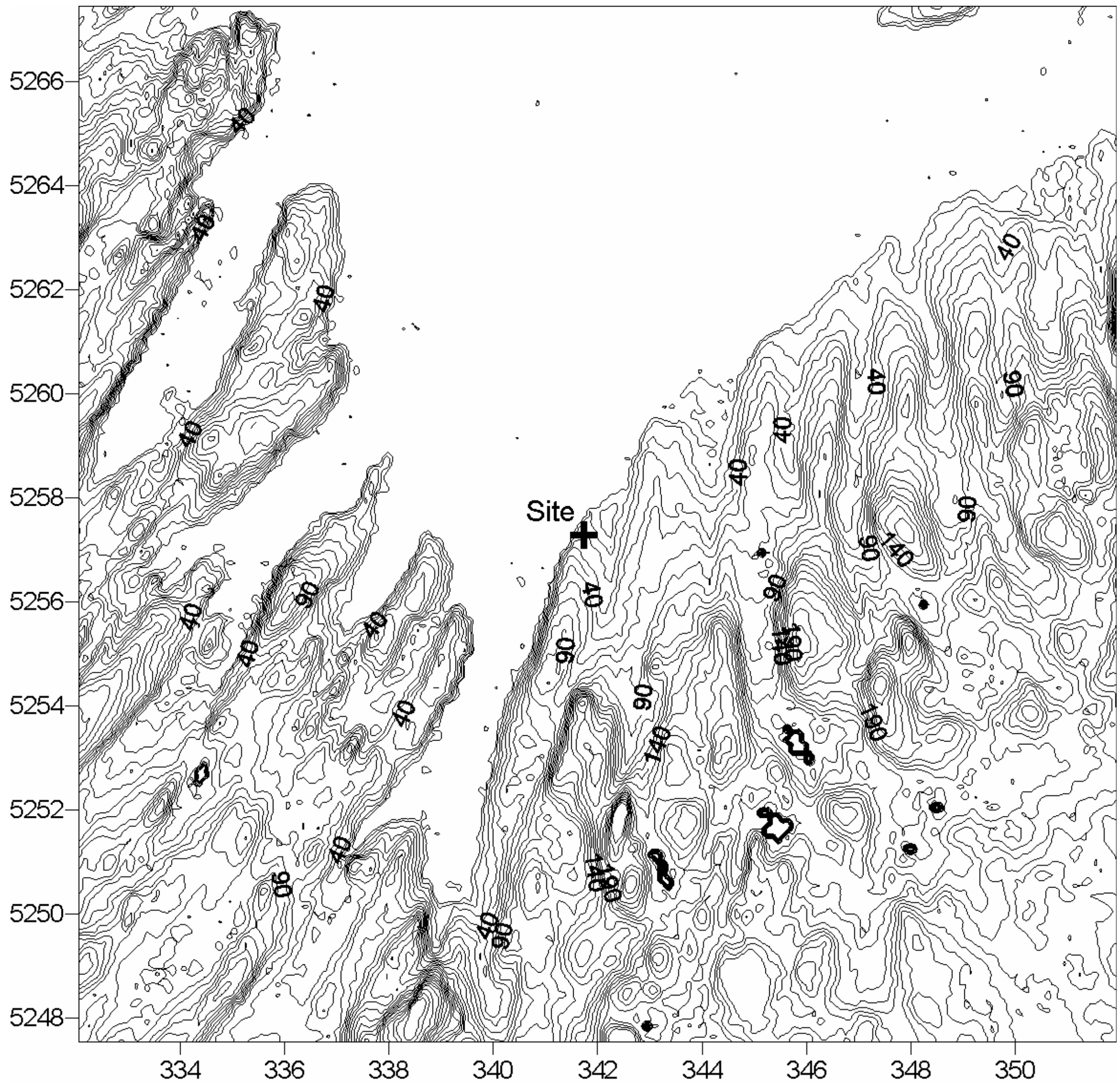
FIGURE 3.4
SEA SURFACE AND AIR TEMPERATURES – 2004



3.2.3 Terrain Data

Terrain data for the modelling domain were processed through TERREL CALMET preprocessor and prepared for the CALMET GEO file through MAKEGEO pre-processors. The terrain processing program TERREL, which is provided with the CALMET/CALPUFF modelling system, was designed to process SRTM satellite data. (ftp://e0mss21u.ecs.nasa.gov/srtm/). All North American data above 15 deg north latitude are processed by the SRTM global processor and sampled at 3 arcseconds (~90 m resolution). The results from CALMET processed QATER.GRD data file was used to generate Figure 3.5. This methodology was approved by DOEC and has been used on several other projects in Newfoundland and Labrador.

FIGURE 3.5
TERRAIN DATA USED IN CALMET/CALPUFF MODELLING

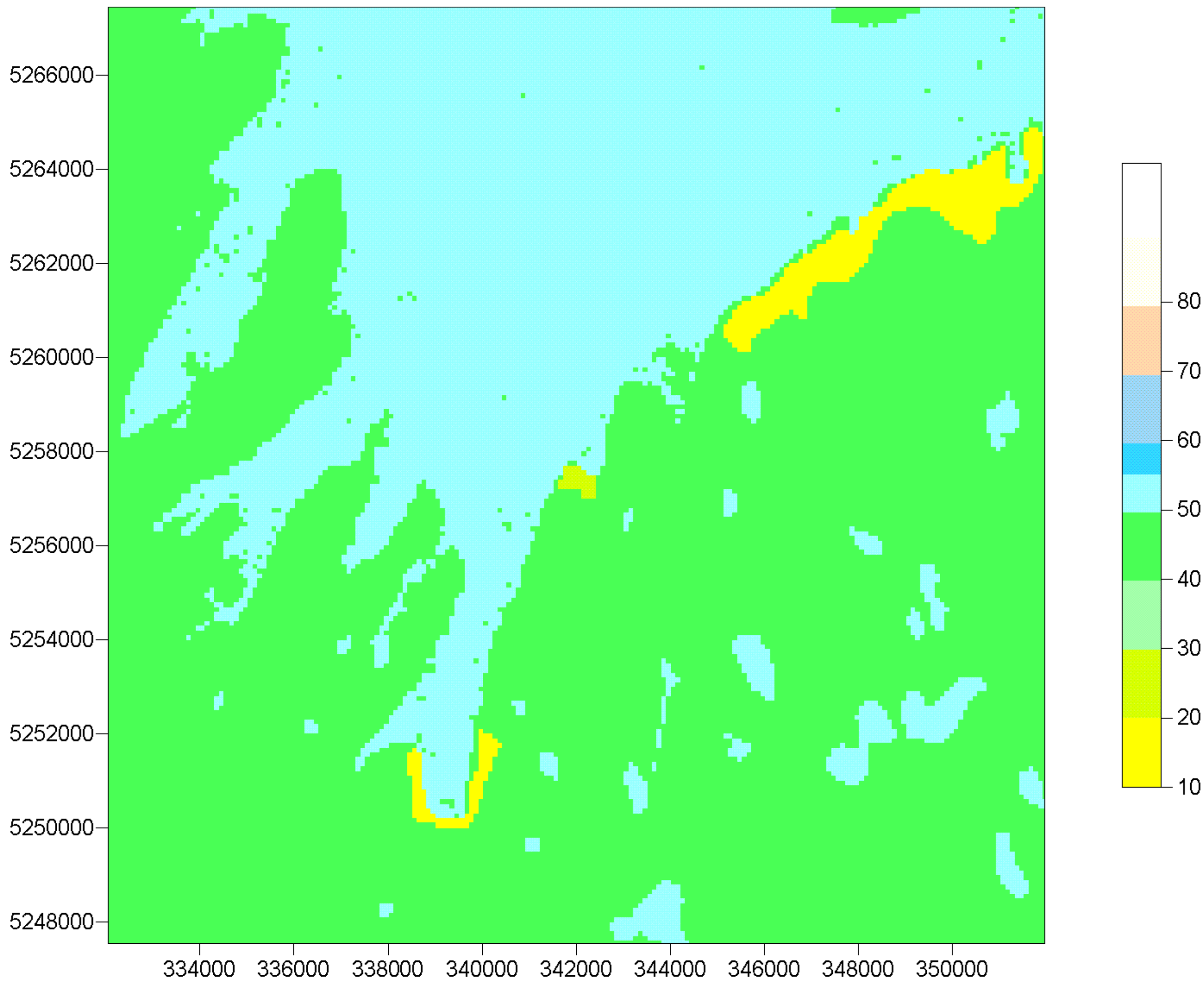


3.2.4 Land Use Data

Canadian Government 1:250000 scale land use data is available for this area from GeoGratis. However, the ArcView files for this area did not represent the land use very well requiring alternative processing to prepare the land use data as follows. The terrain data was used to determine the water/land interface. Except for small areas along the shore where there is some urban development, all of the land was assigned to the forest land use category of 40. The water was assigned as land use category 50. This approach has been used on other recent applications and was approved by the DOEC.

After processing input through CALMET, the QALANDUSE gridded file was used to generate the land use data shown in Figure 3.6.

FIGURE 3.6
LAND USE DATA USED BY CALMET



3.2.5 CALMET Switches

A sample CALMET input file is included on the enclosed CD in Appendix E. The switches in Input Groups 1 - 4 are set as required for the nature of the run, the grid sizes, and the outputs desired. Input Group 5 contains the wind field options. Those that do not follow the default recommendations are:

- INPUT Group 1 Defaults + Data Entry
- INPUT Group 2 Defaults + Data Entry

- INPUT Group 3 Defaults + Output Options
- INPUT Group 4 Defaults
- INPUT Group 5
  - 1KINE = 0 which is the correct default
  - RMIN2 set to –1.0, which allows surface winds at all stations to be extrapolated.
  - RMAX1 was set to 30 km; RMAX2 was set to 30 km.
  - TERRAD was set at 12 kilometres; the terrain does not have an influence in this application.
  - R1 and R2 are set at 1 km in order to enhance the effect of the upper layer wind field.
  - NINTR2 was set at 3 to limit the number of stations used in each layer of the interpolation to a grid point.
- INPUT Group 6
  - MNMDAV was set to 10 kilometres to enhance the special averaging of windy heights.
  - ZIMIN and ZIMINW were set to 50 metres - the default value.
  - SIGMAP was set to 50 kilometres although precipitation is not being used.
- INPUT Group 7 Station Variables
- INPUT Group 8 Upper Air Stations
- INPUT Group 9 Precipitation Stations

Terrain adjustment method switch option 2 and option 3.

Some investigation was undertaken for the recommended setting of the terrain adjustment switch. The choices are shown below.

Terrain adjustment method
(MCTADJ) Default: 3 ! MCTADJ = 3 !
0 = no adjustment
1 = ISC-type of terrain adjustment
2 = simple, CALPUFF-type of terrain adjustment
3 = partial plume path adjustment

David Strimaitus, the CALPUFF developer in charge of the terrain algorithms was contacted. He stated that option 2 “simple CALPUFF type of terrain” is actually a far more complicated algorithm that has not been tested very extensively. It has only been tested for the case of a single hill in the middle of a flat area. The option 3 “partial plume path adjustment” is the complex terrain adjustment algorithm that is more frequently used in other more tested/verified models. The option 3 switch setting was used as to best compare to other complex terrain models. The selection of these switches was discussed with staff from the DOEC.

3.3 CALPUFF

3.3.1 Modelling Domains and Grids

Figure 3.7 shows the CALPUFF modelling domain, which defines a 20 km by 20 km area with axes oriented north-south and east-west. The HTGS site is centred within this area.

A variable spaced receptor grid was used to supply detail where needed close to facility but still maintain reasonable computer run times. The following grid receptor spacing was used:

- 0 – 1 km 100 m x 100 m;
- 1 – 2 km 200 m x 200 m;
- 2 – 3 km 500 m x 500 m; and
- 3 – 10 km 1 km x 1 km.

In consultation with DOEC, it was mutually recognized and agreed upon that though the receptor grid did not necessarily conform to departmental guidelines, the net impact of this deviation would have negligible impact on the predicted concentrations.

Figure 3.7 shows the grid used.

FIGURE 3.7
CALPUFF MODELLING DOMAIN GRID

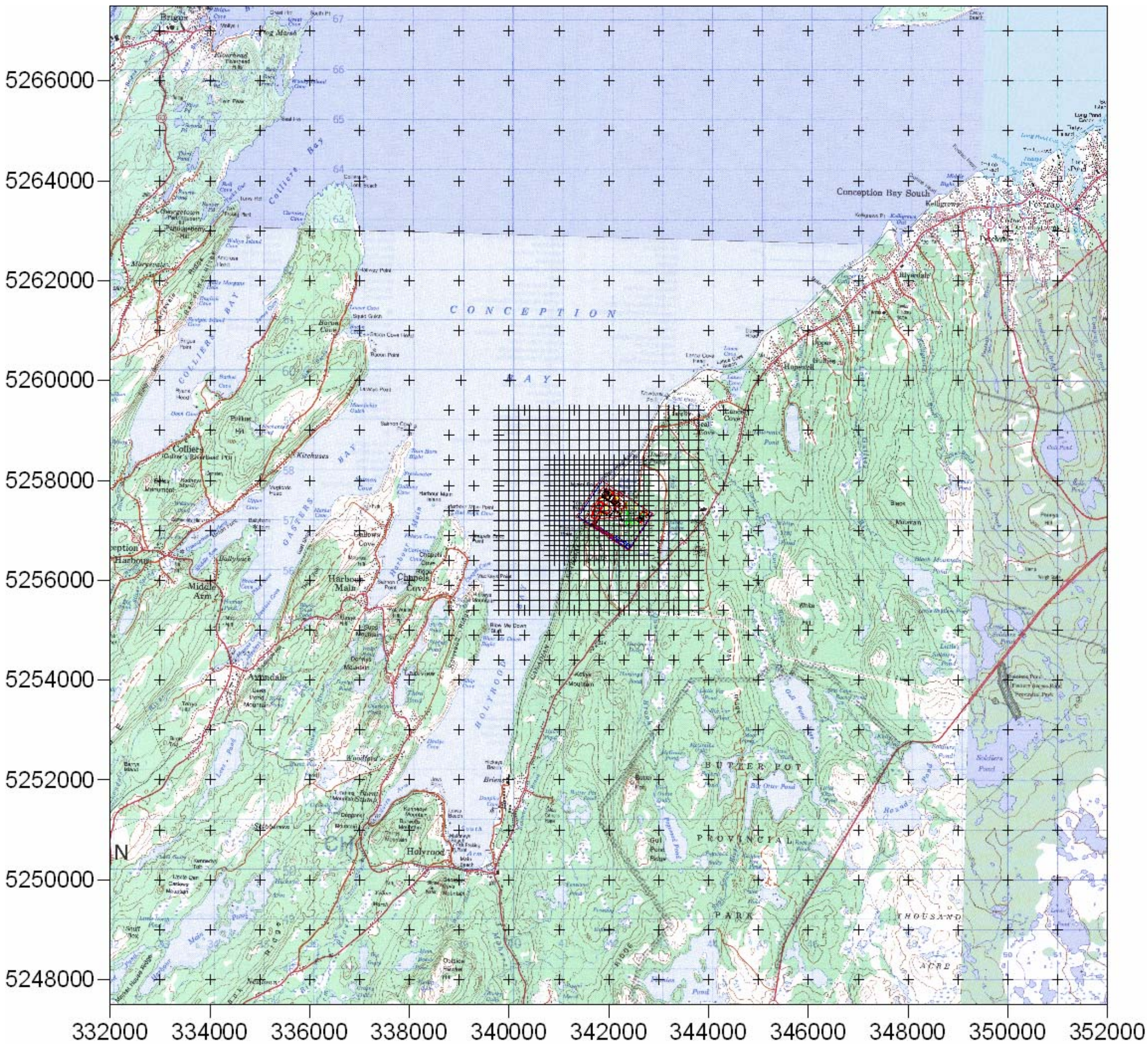
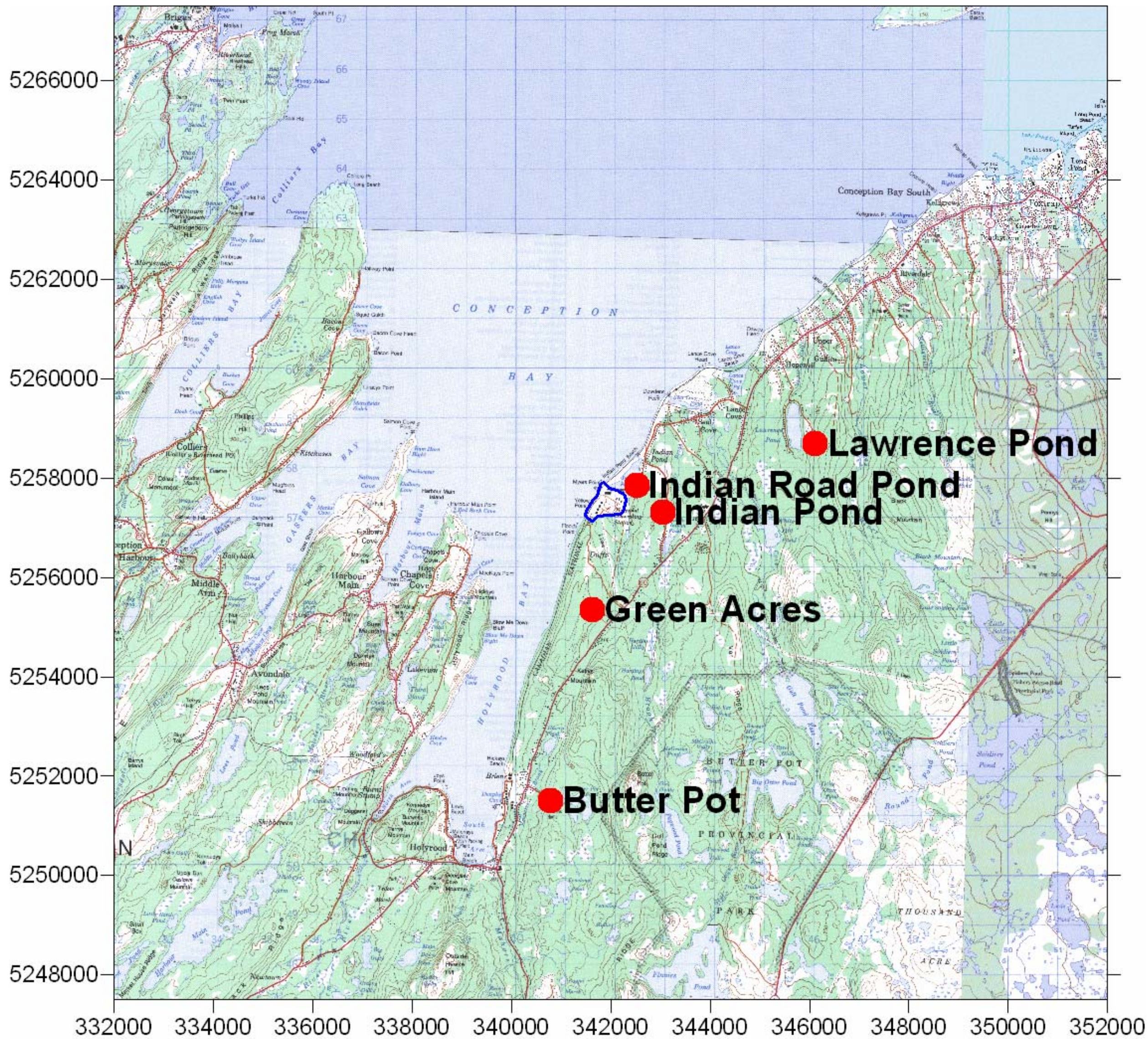


Figure 3.8 shows the location of the SO_2 monitoring stations, referred to as Lawrence Pond, Indian Pond, Green Acres, Butter Pot and Indian Pond Drive. Note that the monitoring station located at Indian Pond Drive, adjacent to the HTGS site, was commissioned in late 2004 and full auditing of the system was not complete until December 2004. Model results were output at these five discrete receptors, and compared with available measured values at four of these locations.

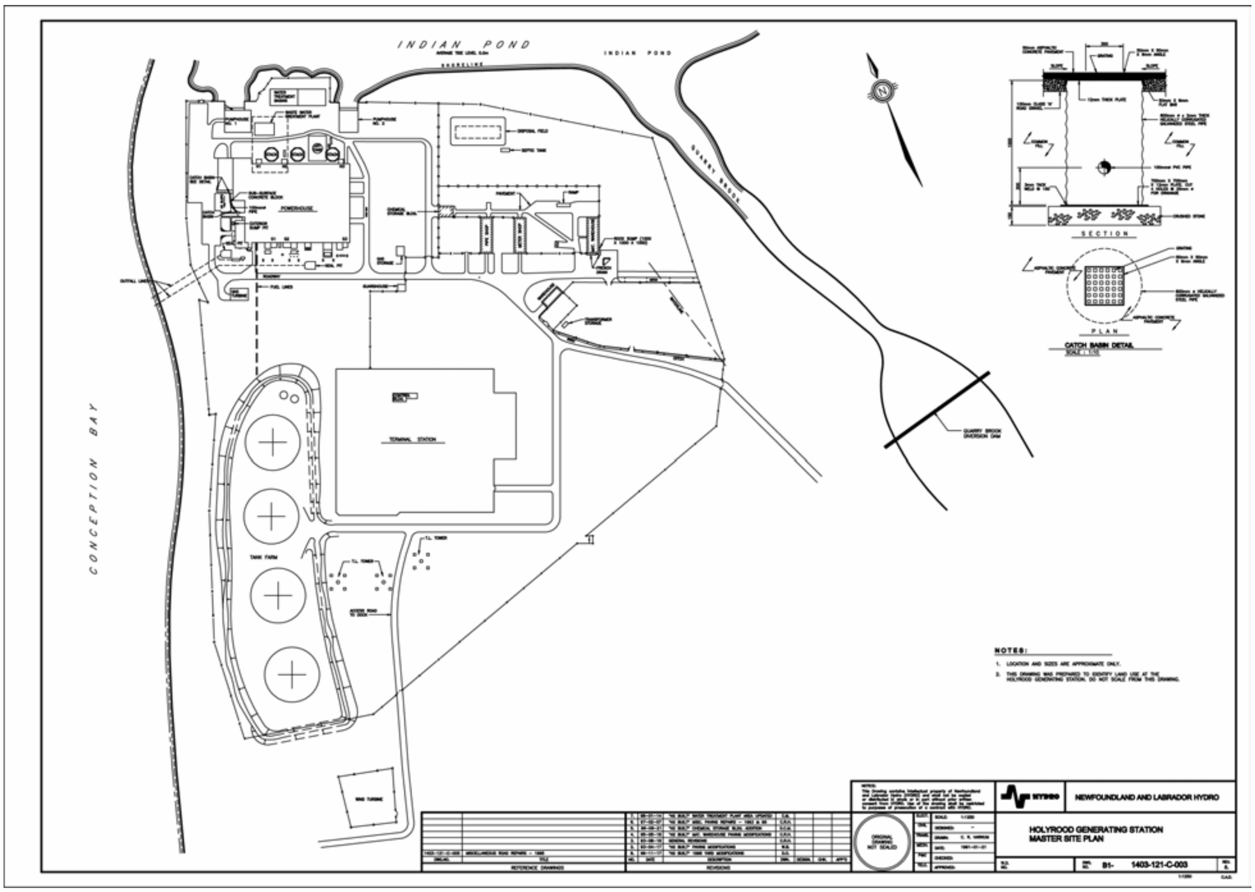
FIGURE 3.8
LOCATION OF SO_2 MONITORING STATIONS



3.3.2 Modelled Source Locations

Figure 3.9 is a site plan (not to scale).

FIGURE 3.9
SITE PLAN



Each of the three units exhaust to the atmosphere through its own independent stack. The coordinates of the stacks were supplied by NLH staff.

TABLE 3.2
PHYSICAL STACK PARAMETERS

Stack	Easting [UTM, NAD 83] (m)	Northing [UTM, NAD 83] (m)	Height (m)	Exit Diameter (m)	Base Elevation (m)
Unit 1	341887.5	5257702	91.44	4.1	10
Unit 2	341905.8	5257687	91.44	4.1	10
Unit 3	341939.5	5257666	109.80	3.0	10

The physical parameters of the main HTGS building were required for the calculation of building downwash parameters (Table 3.3). The height of the HTGS building is 44 m above grade. Downwash can be experienced for stacks less than 2.5 times the height of the building or 110 m. Very minor downwash can be expected for all three stacks.

TABLE 3.3
PHYSICAL BUILDING PARAMETERS

Corner	Easting [UTM, NAD 83] (m)	Northing [UTM, NAD 83] (m)
1	341845.5	5257711
2	341950.5	5257641
3	341913.5	5257591
4	341881.5	5257666

Note: For modelling purposes, building was considered to be at a single height of 44 m

The coordinates of the property line were estimated from the supplied drawing.

4.0 MODELLING RESULTS

4.1 GENERAL

This project was run using the standard BPIP downwash algorithm as there is a bug in this version of the CALPUFF model when using the PRIME downwash algorithm causing the CALPUFF model to crash. The DOEC are aware of this problem with PRIME and CALPUFF. With the heights of the stacks at HTGS only minor downwash is expected and the choice of standard or PRIME version of BPIP will have little impact on the predicted concentrations outside of the HTGS property line.

For the purposes of this assessment, the results presented are the maximum values predicted outside of the property line. Results within the property line were excluded to eliminate modelling artefacts and overpredicted concentrations.

Derived emission rates for these contaminants are presented in Appendix C, and maximum predicted concentration isopleths for SO_2, NO_x, TSP and CO at different time averaging periods, as listed in Table 1.1, are provided in Appendix D.

Appendix E contains the top 50 hourly maximum concentrations for SO_2, NO_x, TSP and CO (Tables E.1 to E.4, respectively). Each table also lists the date and time, receptor coordinates, and meteorological conditions associated with each concentration.

Appendix F contains a CD with CALMET/CALPUFF modelling files.

In the following sections which present the results for the studied averaging periods, there are summary tables which present the 99th, 97th, and 95th percentile concentrations, and area and frequency of exceedance above the regulatory standards. The 99th percentile indicates that actual concentration at any point in the modelling domain will be lower than this value for 99 percent of the time. These statistics were calculated by writing a program that sorted all of the predicted hourly concentrations for each grid point. The 99th percentile is the 88th ([100%-99%] x 8760 hr) highest hourly concentration for that grid point. The maximum of all of the 99th percentiles is presented in the tables.

Where concentrations are predicted to exceed a standard, the area which was predicted to have concentrations above that standard was determined by digitizing the isopleth for the standard and calculating the area within.

4.2 1-HOUR AVERAGE RESULTS

Hourly concentrations were modelled for SO_2, NO_x, and CO.

Emission rates of SO_2, NO_x, and CO vary over the yearly period in accordance with the operation of Units 1, 2 and 3. The maximum corresponds to increased emission rates, when all three units are in operation. All of the maximum tend to occur approximately 700 metres from the property boundary to the northeast of the site which is in the direction of the predominant winds.

SO_2

The maximum 1-hour concentration of 3,147 µg/m^3 exceeds the AAQS criteria of 900 µg/m^3. Figure 4.1 presents the maximum SO_2 1-hour concentration isopleths. Plots for all other contaminants and averaging periods are contained in Appendix D.

FIGURE 4.1
MAXIMUM PREDICTED 1-HR SO_2 CONCENTRATIONS (µg/m^3)

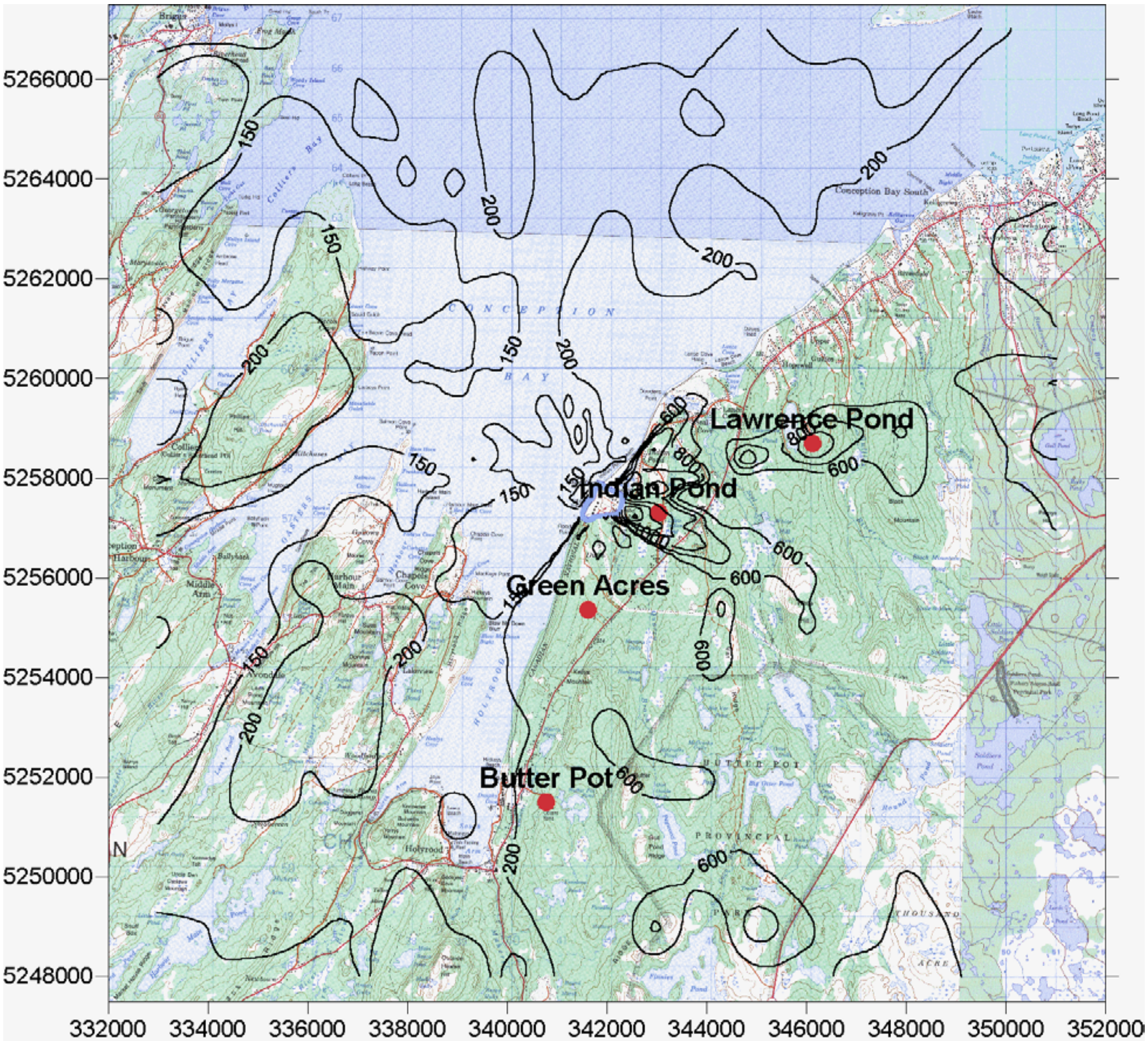
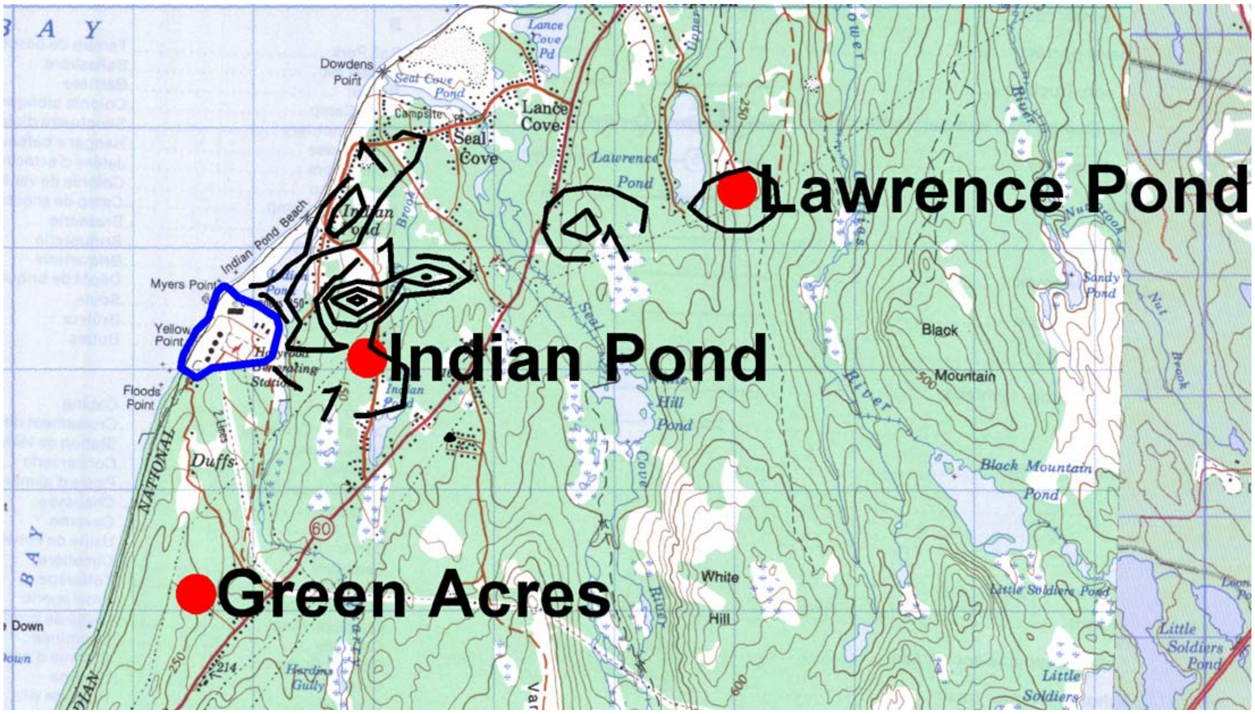


Figure 4.2 presents hours of exceedance of the 1-hour SO_2 AAQS of 900µg/m^3. At the maximum location the standard is predicted to be exceeded 5 times in 2004. Note that the graphic is zoomed in to be able to see the areas of exceedance. The total area where the 1-hour SO_2 AAQS is predicted to be exceeded at least once in 2004 is 2.2 km^2.

FIGURE 4.2
CONTOURS OF ISO-EXCEEDANCE OF 1-HR SO_2 AAQS (hr/yr)



NO_x

The maximum 1-hour concentration of 405 µg/m^3 marginally exceeds the AAQS criteria of 400 µg/m^3. This occurs at 1 grid point once in 2004.

CO

The maximum 1-hour concentration of 323 µg/m^3 is well below the AAQS criteria of 35,000 µg/m^3.

Emission rates of CO are higher for Unit 3, than Unit 1 and 2 over the entire year, corresponding to differences in the combustion mechanisms of the three Units.

STATISTICS

Table 4.1 contains maximum predicted hourly average concentrations. This table also contains the 99th, 97th, and 95th percentile concentrations, and area and frequency of exceedance above the regulatory standards. The 99th percentile indicates that the actual concentration at any point in the modelling domain will be lower than this value for 99 percent of the time.

TABLE 4.1
STATISTICS OF MAXIMUM PREDICTED HOURLY AVERAGE OFF-PROPERTY CONTAMINANT CONCENTRATIONS

Contaminant	Max ($\mu g/m^3$)	AAQS ($\mu g/m^3$)	Area of Exceedance (km^2)	Frequency of Exceeding AAQS (%)	Percentile Concentration ($\mu g/m^3$)		
					99^{th}	97^{th}	95^{th}
SO_2	3147	900	2.2	0.06	313	78	35
NO_x	405	400	~0.1	0.01	51	12	6
CO	323	35000	0	0	17	5	1

SO_2 is predicted to exceed the hourly AAQS 0.06% of the time (~5h/yr). There is an area of approximately 2.2 km^2 where the SO_2 hourly AAQS is predicted to be exceeded at least once in 2004. NO_x is also predicted to exceed its hourly AAQS approximately once in 2004. Table 4.1 shows that for SO_2, only 1% of the time will the predicted hourly concentration be above 313 $\mu g/m^3$ (34% of AAQS).

4.3 3-HOUR AVERAGE RESULTS

3-hour concentrations were modelled for SO_2.

The maximum 3-hour concentration of 1,234 $\mu g/m^3$ exceeds the AAQS criteria of 600 $\mu g/m^3$. This is predicted to occur 0.8% of the time as shown in Table 4.2.

TABLE 4.2
STATISTICS OF MAXIMUM PREDICTED 3-HOUR AVERAGE OFF-PROPERTY CONTAMINANT CONCENTRATIONS

Contaminant	Max ($\mu g/m^3$)	AAQS ($\mu g/m^3$)	Area of Exceedance (km^2)	Frequency of Exceeding AAQS (%)	Percentile Concentration ($\mu g/m^3$)		
					99^{th}	97^{th}	95^{th}
SO_2	1234	600	1.7	0.8	273	86	39

4.4 8-HOUR AVERAGE RESULTS

8-hour concentrations were modelled for CO. No exceedance above the AAQS criteria was predicted as shown in Table 4.3.

TABLE 4.3
STATISTICS OF MAXIMUM PREDICTED 8-HOUR AVERAGE OFF-PROPERTY CONTAMINANT CONCENTRATIONS

Contaminant	Max (µg/m^3)	AAQS (µg/m^3)	Area of Exceedance (km^2)	Frequency of Exceeding AAQS (%)	Percentile Concentration (µg/m^3)		
					99th	97th	95th
CO	120	15,000	0	0	13	5	3

4.5 24-HOUR AVERAGE RESULTS

Daily concentrations were modelled for SO_2, NO_x, and TSP.

Exceedances were noted for SO_2, with a maximum 24-hour modelled concentration of 309 µg/m^3 marginally surpassing the AAQS criteria of 300 µg/m^3 once in 2004 as shown in Table 4.4.

Modelled 24-hour average concentrations of the remaining contaminants were found to well below their respective AAQS criteria.

TABLE 4.4
STATISTICS OF MAXIMUM PREDICTED DAILY AVERAGE OFF-PROPERTY CONTAMINANT CONCENTRATIONS

Contaminant	Max (µg/m^3)	AAQS (µg/m^3)	Area of Exceedance (km^2)	Frequency of Exceeding AAQS (%)	Percentile Concentration (µg/m^3)		
					99th	97th	95th
SO_2	309	300	~0.1	0.3	205	86	45
NO_x	50	200	0	0	33	14	7
TSP	28	120	0	0	17	7	4

4.6 ANNUAL RESULTS

Annual concentrations were modelled for SO_2, NO_x, and TSP.

All predicted concentrations were found to be below their AAQS criteria as shown in Table 4.5.

TABLE 4.5
STATISTICS OF MAXIMUM PREDICTED ANNUAL AVERAGE OFF-PROPERTY CONTAMINANT CONCENTRATIONS

Contaminant	Maximum ($\mu g/m^3$)	AAQS ($\mu g/m^3$)	Area of Exceedance (km^2)
SO_2	8	60	0
NO_x	1.3	100	0
TSP	0.63	60	0

4.7 COMPARISON OF PREDICTED AND MONITORED SO_2 CONCENTRATIONS

Table 4.6 presents the predicted and monitored SO_2 concentrations at five ambient air quality monitoring stations located off property[1].

TABLE 4.6
COMPARISON OF PREDICTED AND MONITORED SO_2 CONCENTRATIONS

Monitoring Station	Easting [UTM, NAD 83] (m)	Northing [UTM, NAD 83] (m)	Maximum 1-hr		Maximum 24-hr		Annual	
			Predicted	Observed	Predicted	Observed	Predicted	Observed
Lawrence Pond	346116	5258701	1481	289	201	61	6.8	11.2
Green Acres	341618	5255353	328	497	50	64	1.5	3.9
Butter Pot	340784	5251500	272	324	39	44	1.1	6.5
Indian Pond	343040	5257306	2195	514	151	119	4.8	8.3
Indian Pond Drive	342527	5257852	1030	-	103	-	2.1	-

Note: Indian Pond Drive Station was fully commissioned in late 2004 – insufficient data available

It can be seen that for the monitoring stations that are in the predominant wind direction (Lawrence Pond and Indian Pond) the model is overpredicting for the maximum 1 hour and 24 hr average concentrations. Especially in complex terrain situations and for short averaging periods, it is unrealistic to expect modelled concentrations to accurately reflect monitored data. During development, a model is calibrated to match measured concentrations anywhere along an equidistant arc from the source in an area without complex terrain. Thus, if the winds used by the model differ from actual winds experienced at the monitoring station by only a few degrees there is increased uncertainty in the modelled results (overpredict or underpredict) for short time averaging periods. For longer averaging periods, the model results tend to be closer to the measured concentrations.

[1] Note that the monitoring station at Indian Pond Drive was commissioned in late 2004 and full auditing of the system was not complete until December 2004. Insufficient monitoring data was available in 2004 for this station.

The other two monitoring stations that are not in the predominant wind direction (Green Acres and Butter Pot) show much better agreement of the predicted and monitored concentrations for the 1 hr and 24 hr averaging periods. For all time averaging periods the predicted concentrations at these stations are less than the observed. If a suitable background concentration was added to these predicted concentrations the agreement would improve.

On an annual basis, it would be expected that monitoring concentrations should always be higher than modelled concentrations as there are other sources that will contribute to the ambient SO_2 levels. Based on this modelling study, the modelled concentrations are less than the measured SO_2 concentrations by 2.4 to 5.4 $\mu g/m^3$ (or on average approximately 4 $\mu g/m^3$) which is likely contributable to the background.

5.0 CONCLUSIONS

Calixte and SENES were retained by Newfoundland and Labrador Hydro to carry out air dispersion modelling of sulphur dioxide (SO_2), carbon monoxide (CO), nitrogen oxides (NO_x), and total suspended particulate matter (TSP) emissions from three stacks at the Holyrood Thermal Generating Station using 2004 emissions and meteorological data. The CALMET/CALPUFF modelling system was used in the analysis since this is the preferred system of the Newfoundland and Labrador Department of Environment and Conservation, and because it accounts for complex terrain and sea breeze effects that characterize the site. Maximum predicted time-averaged concentrations at receptors located within a 20 km by 20 km modelling domain were compared with Ambient Air Quality Standards of Newfoundland and Labrador's Air Pollution Control Regulation (2004). In addition, maximum SO_2 concentrations were predicted at five discrete monitoring stations. At four of these stations, where continuous air quality monitoring has been carried out throughout 2004, predicted concentrations were compared with observed values.

Exceedances above regulatory standards at off-property receptors were predicted for SO_2 concentrations for the following averaging periods:

- 1-hour (at a frequency of 0.06% over a 2.2 km^2 area),
- 3-hour (at a frequency of 0.8% over a 1.7 km^2 area), and
- 24-hour (at a frequency of 0.3% over a ~0.1 km^2 area).

Exceedances above regulatory standards at off-property receptors were predicted for NO_x concentrations for a 1-hour averaging period (at a frequency of 0.01% over a ~0.1 km^2 area).

CO and TSP concentrations are not predicted to exceed provincial standards.

Comparisons of predicted concentrations with actual monitoring data for SO_2 show a very good agreement.

APPENDIX A

SAMPLE OPERATIONAL DATA LOGS

Sample of Hourly Operational Data file for Unit 1

Holyrood EtaPRO System - Holyrood EtaPRO System UNIT NO.1 HISTORICAL TRENDS REPORT
ALL SHIFTS: HOURLY AVERAGES
Newfoundland Daylight Time

DATE	TIME	AJT1807	ATE1224	ATE1225	AFT1200	C010AHAGOT	C010AHBGOT	C003AIR	C003GAS
		GROSS GENERATION	AH EAST GAS INLET TEMP	AH WEST GAS INLET TEMP	FUEL OIL FLOW TO BURNERS	AH EAST GAS OUTLET TEMP AVG	AH WEST GAS OUTLET TEMP AVG	AIR FLOW	FLUE GAS FLOW
		MW	°C	°C	kg/s	°C	°C	kg/s	kg/s
		H1.V.JT1807	H1.V.TE1224	H1.V.TE1225	H1.V.FT1200	H1.V.C010AHAGOT	H1.V.C010AHBGOT	H1.V.C003AIR	H1.V.C003GAS
01/01/2004	1:00:00	68.15	268	264	4.78	151	152	75.6	80.3
01/01/2004	2:00:00	67.75	268	264	4.74	151	151	75.1	79.8
01/01/2004	3:00:00	68.3	268	269	4.88	152	154	77.5	82.4
01/01/2004	4:00:00	68.01	266	268	4.82	151	153	77.1	81.9
01/01/2004	5:00:00	68.12	265	266	4.83	150	152	75.8	80.5
01/01/2004	6:00:00	68.21	266	267	4.81	150	152	75.9	80.6
01/01/2004	7:00:00	68.17	266	268	4.82	150	152	75.8	80.6
01/01/2004	8:00:00	68.1	266	268	4.81	150	152	75.8	80.5
01/01/2004	9:00:00	68.26	267	269	4.79	150	153	75.9	80.6
01/01/2004	10:00:00	67.05	266	268	4.63	150	152	75.1	79.8
01/01/2004	11:00:00	92.01	296	299	6.57	161	164	97.1	103.5
01/01/2004	12:00:00	97.91	306	309	6.87	165	168	103.5	110.3
01/01/2004	13:00:00	72.19	278	276	5	153	156	80.5	85.5
01/01/2004	14:00:00	69.96	275	268	4.9	153	153	79.4	84.4
01/01/2004	15:00:00	70.61	277	267	4.96	153	152	79.1	84
01/01/2004	16:00:00	69.98	277	267	4.89	154	153	78.3	83.3
01/01/2004	17:00:00	70.36	278	268	4.98	154	153	78.9	83.8
01/01/2004	18:00:00	67.5	276	266	4.81	153	152	77.1	81.9
01/01/2004	19:00:00	68.73	277	267	4.78	153	153	78.4	83.3
01/01/2004	20:00:00	70.03	277	269	5.06	154	154	80.1	85.1
01/01/2004	21:00:00	69.56	273	268	4.91	153	153	78.4	83.3
01/01/2004	22:00:00	70.12	273	268	4.98	153	153	78.5	83.4
01/01/2004	23:00:00	68.14	271	267	4.75	152	152	76.7	81.5
01/02/2004	0:00:00	69.57	274	269	4.76	153	153	78	82.8
01/02/2004	1:00:00	70.49	275	271	4.98	153	153	78.7	83.6
01/02/2004	2:00:00	70.17	275	273	5.04	154	155	79.9	84.9
01/02/2004	3:00:00	69.86	273	272	5.03	153	154	79.5	84.5
01/02/2004	4:00:00	69.67	271	270	4.93	151	153	78	82.9
01/02/2004	5:00:00	69.68	272	271	4.93	151	154	78.1	83
01/02/2004	6:00:00	69.56	272	272	4.88	152	154	78	82.9
01/02/2004	7:00:00	69.41	272	272	4.95	152	154	78.1	82.9
01/02/2004	8:00:00	69.72	273	273	4.9	152	154	78.4	83.4
01/02/2004	9:00:00	69.02	273	272	4.9	152	154	77.7	82.5
01/02/2004	10:00:00	67.65	273	270	4.89	152	153	77.1	81.9
01/02/2004	11:00:00	68.86	275	271	4.98	153	153	77.9	82.8
01/02/2004	12:00:00	68.75	273	276	4.82	152	154	77.8	82.7
01/02/2004	13:00:00	83.22	287	292	5.87	158	160	89.3	95.1
01/02/2004	14:00:00	100.08	312	314	6.99	167	169	104.5	111.5
01/02/2004	15:00:00	100.05	325	304	6.93	170	165	104	110.9
01/02/2004	16:00:00	100.06	325	305	6.97	170	165	103.8	110.7
01/02/2004	17:00:00	100.04	327	305	6.95	170	165	103.9	110.8
01/02/2004	18:00:00	100.14	327	306	6.98	171	166	104.1	111
01/02/2004	19:00:00	100.05	329	307	6.96	171	166	104.2	111.1
01/02/2004	20:00:00	100.13	329	308	6.96	172	166	104.2	111.2
01/02/2004	21:00:00	100.13	330	308	6.99	172	167	104.3	111.2
01/02/2004	22:00:00	100.13	331	310	7.04	173	166	105.4	112.4
01/02/2004	23:00:00	100.09	326	307	7.03	172	168	106.1	113.1
01/03/2004	0:00:00	100.07	318	300	6.98	169	165	105.2	112.2
01/03/2004	1:00:00	100.14	317	300	6.9	168	165	104.7	111.6
01/03/2004	2:00:00	100.07	317	302	6.97	169	166	106.2	113.2
01/03/2004	3:00:00	100.09	315	302	6.96	169	166	106	113
01/03/2004	4:00:00	100.11	314	300	6.98	167	165	104.5	111.4
01/03/2004	5:00:00	100.09	315	301	6.97	168	165	104.4	111.3
01/03/2004	6:00:00	100.08	316	302	6.9	169	166	104.6	111.5
01/03/2004	7:00:00	100.07	317	303	6.93	169	167	104.8	111.7
01/03/2004	8:00:00	100.09	318	304	6.93	170	167	104.5	111.5
01/03/2004	9:00:00	99.51	318	304	6.89	170	167	104.1	111
01/03/2004	10:00:00	99.14	318	304	6.93	170	167	103.7	110.6
01/03/2004	11:00:00	98.52	318	304	6.93	170	168	104.4	111.4
01/03/2004	12:00:00	99.28	317	303	6.92	170	167	105.4	112.4
01/03/2004	13:00:00	99.19	314	300	6.87	168	165	103.8	110.6
01/03/2004	14:00:00	98.99	314	300	6.86	168	165	103.3	110.1
01/03/2004	15:00:00	99.07	316	301	6.9	169	166	103.5	110.4

APPENDIX B

EXECUTIVE SUMMARY OF 2005 SOURCE TESTING REPORT

UNITS 1, 2 AND 3 EMISSIONS TEST 2005
HOLYROOD GENERATING STATION
NEWFOUNDLAND & LABRADOR HYDRO
FINAL REPORT

PROJECT P-504

Prepared for
Newfoundland & Labrador Hydro
500 Columbus Drive
P.O. Box 12400
St. John's, Newfoundland & Labrador
A1B 4K7

Prepared by
Air Testing Services Inc.
160 Glenwood Drive,
Head of St Margarets Bay, Nova Scotia
B3Z 2E8

August 2005

CONFIDENTIALITY

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In preparing this report, ATS has relied in good faith on information provided by others as noted in this report and has assumed the information provided by those individuals is both factual and accurate.

EXECUTIVE SUMMARY

Air Testing Services was retained to perform a Boiler Emissions Test Program at the Newfoundland and Labrador Hydro plant in Holyrood Newfoundland. The objective of the test program was to measure various air emissions from the three electrical generating station units to satisfy requirements of the Newfoundland and Labrador Department of Environment and Conservation.

Testing was completed for PM_{10}/$PM_{2.5}$, metals/Total Suspended Particulate, sulphates (including Sulphuric Acid Mist), SO_2, NO_x, CO, CO_2, and O_2 at the boiler stacks. The testing strategy was to complete triplicate tests for all compounds. Table I shows the scope of work for the project.

Table I-Scope of Work

Source	**TSP**	**PM_{10} $PM_{2.5}$**	**Trace Metals**	**Sulphates**	**O_2 CO_2**	**CO**	**SO_2**	**NO_X**
Unit #1	✓	✓	✓	✓	✓	✓	✓	✓
Unit #2	✓	✓	✓	✓	✓	✓	✓	✓
Unit #3	✓	✓	✓	✓	✓	✓	✓	✓

The tests were completed between April 9th and 30th, 2005. All testing was done using methodologies acceptable to Newfoundland and Labrador Hydro, and the Newfoundland and Labrador Department of Environment and Conservation. A description of the test program is provided in Section 1. Details on the testing and analytical methodologies can be found in Section 5. Section 6 discusses the QA/QC program used in the program. The results of the testing program are provided in Section 7. The appendices referenced throughout this report are provided at the back of this document

Tables II to IV present the metals, particulate and gaseous emissions. Figures I through III present the summary of the test data.

An abrasive additive, Comate, was used in Unit 1 during testing. This inert compound is designed to reduce buildup in the unit and resulted in an increase in particulate emissions (see Table III). As well, since a key component of the additive is Aluminum, these emissions are also increased in Unit 1 (see Table II).

Table II – Holyrood G.S. Metals Testing Results Summary 2005

Metal	**Unit 1**		**Unit 2**		**Unit 3**	
	Average mg/s	**Average ug/DSm3 c/o 3% O2**	**Average mg/s**	**Average ug/DSm3 c/o 3% O2**	**Average mg/s**	**Average ug/DSm3 c/o 3% O2**
Mercury	0.0248	0.179	0.0371	0.273	0.04170	0.3780
Aluminum	1085	7845	470	3406	488	4431
Antimony	16.3	118.0	14.50	106.0	18.00	164.0
Arsenic	1.60	11.6	0.93	6.8	0.842	7.65
Barium	20.7	149	11.7	85	12.3	112.0
Beryllium	0.045	0.33	0.015	0.11	0.000	0.000
Cadmium	0.374	2.70	0.242	1.76	0.238	2.16
Chromium	36.00	260.0	10.80	78.7	29.40	267.0
Cobalt	6.10	44.1	4.04	29.4	3.66	33.2
Copper	10.5	76	7.3	53	7.6	69
Iron	678	4904	434	3166	298	2705
Lead	12.4	90	7.9	58	10.4	94.2
Manganese	9.4	68	5	39	8.1	73
Molybdenum	46.0	332	30.9	225	29.6	269
Nickel	306	2216	185	1345	192	1745
Phosphorus	0	0	0	0	0	0
Selenium	0.964	6.97	0.740	5.38	0.491	4.46
Sulphur	219542	1587449	200107	1458803	164482	1496007
Sulphate	6512	46110	6403	44614	4485	41631
Sulphuric Acid Mist	7975	56476	7842	54643	5494	50990
Titanium	42.5	307.0	19.3	140	21.20	192.0
Vanadium	935	6761	631	4593	550	4998
Total	227705	1646478	206861	1508068	116699	1061359

Note: DS refers to dry, std. conditions (25°C and 101.3 kPa)
Note: The value of 0 was used if the analytical result was <DL.

Table III – Holyrood G.S. Particulate and $PM_{10}/PM_{2.5}$ Testing Summary 2005

Parameter	Units	Unit #1*	Unit #2	Unit #3
Particulate Concentration	mg/DSm^3	314	125	260
	mg/DSm^3 @ 3% O_2	327	126	297
TSP Emission Rate	g/s	44.7	18.2	29.2
PM<10 Emission Rate	g/s	10.6	7.34	6.48
PM<2.5 Emission Rate	g/s	4.91	5.39	4.64
Volumetric Flowrate	DSm^3/hr	511126	525355	405017
Temperature	deg. C	180	174	172
Moisture	%	10.4	9.62	9.59
Process Rate**	MW	165	157	130

Note: DS refers to dry standard conditions, at 25°C and 101.3 kPa.
* Additive Comate was present on Unit 1 during testing.
** Process rate is averaged over the three tests.

Units #1 and #2 are identical in design and similar in operation. Consequently, the gaseous emission data (see Table IV) are very similar for Units #1 and #2. Unit #3 is of a slightly different design and operation, and shows higher O_2 and lower CO_2, as well as higher CO. This is consistent with previous test programs. The SO_2 emission rate is slightly lower from Unit #3 (as compared to Units #1 and #2) due to lower a firing rate (130 MW versus approximately 160-165 MW) resulting in a lower flowrate. The oxygen-corrected SO_2 concentrations are very consistent across the three stacks which is expected since the three units burn the same fuel.

Table IV – Holyrood G.S. Gaseous Emissions Testing Summary 2005

Parameter	**Units**	**Unit #1**	**Unit #2**	**Unit #3**
O_2 Concentration	%	3.69	3.18	5.25
CO_2 Concentration	%	13.4	13.9	12.1
CO_2 Concentration	% @ 3% O_2	13.9	14.1	13.9
CO Concentration	ppm	5.93	41.6	354
CO Emission Rate	g/s	0.964	6.94	45.5
CO Concentration	ppm @ 3% O_2	6.16	42.0	404
SO_2 Concentration	ppm	1087	1153	1010
SO_2 Emission Rate	g/s	404	440	297
SO_2 Concentration	ppm @ 3% O_2	1130	1164	1154
NOx Concentration	ppm	270	206	250
NOx Emission Rate	g/s	72.0	56.6	52.9
NOx Concentration	ppm @ 3% O_2	281	209	286

Note: All concentrations were measured on a dry, volume basis

Figure I – Holyrood G.S. Particulate (TSP) & PM_{10}/$PM_{2.5}$ Test Results 2005

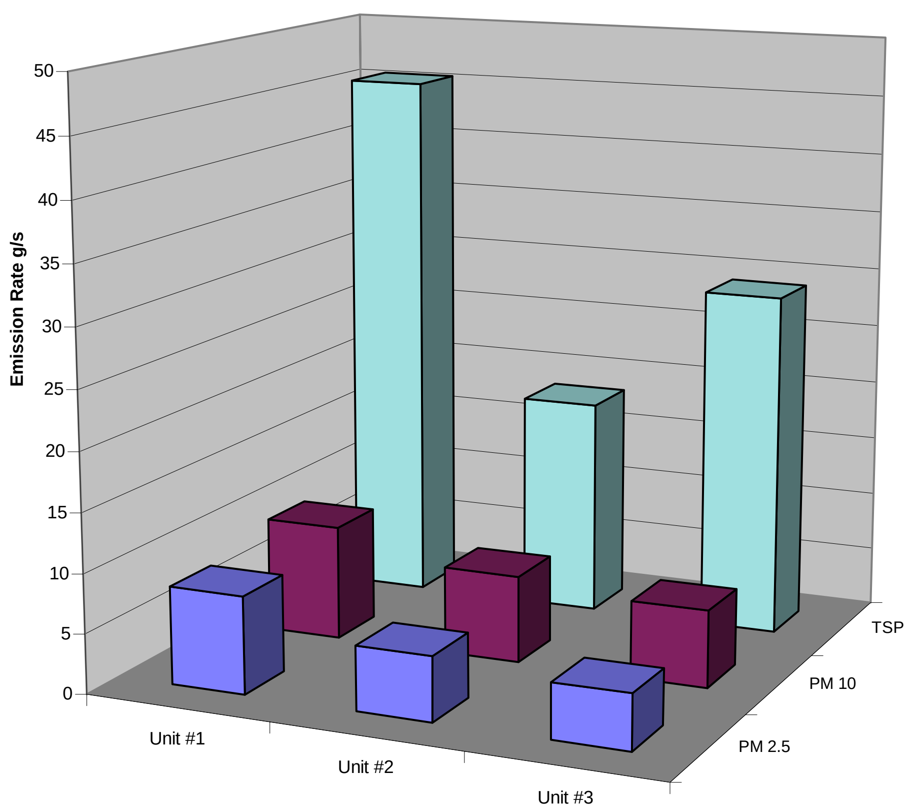
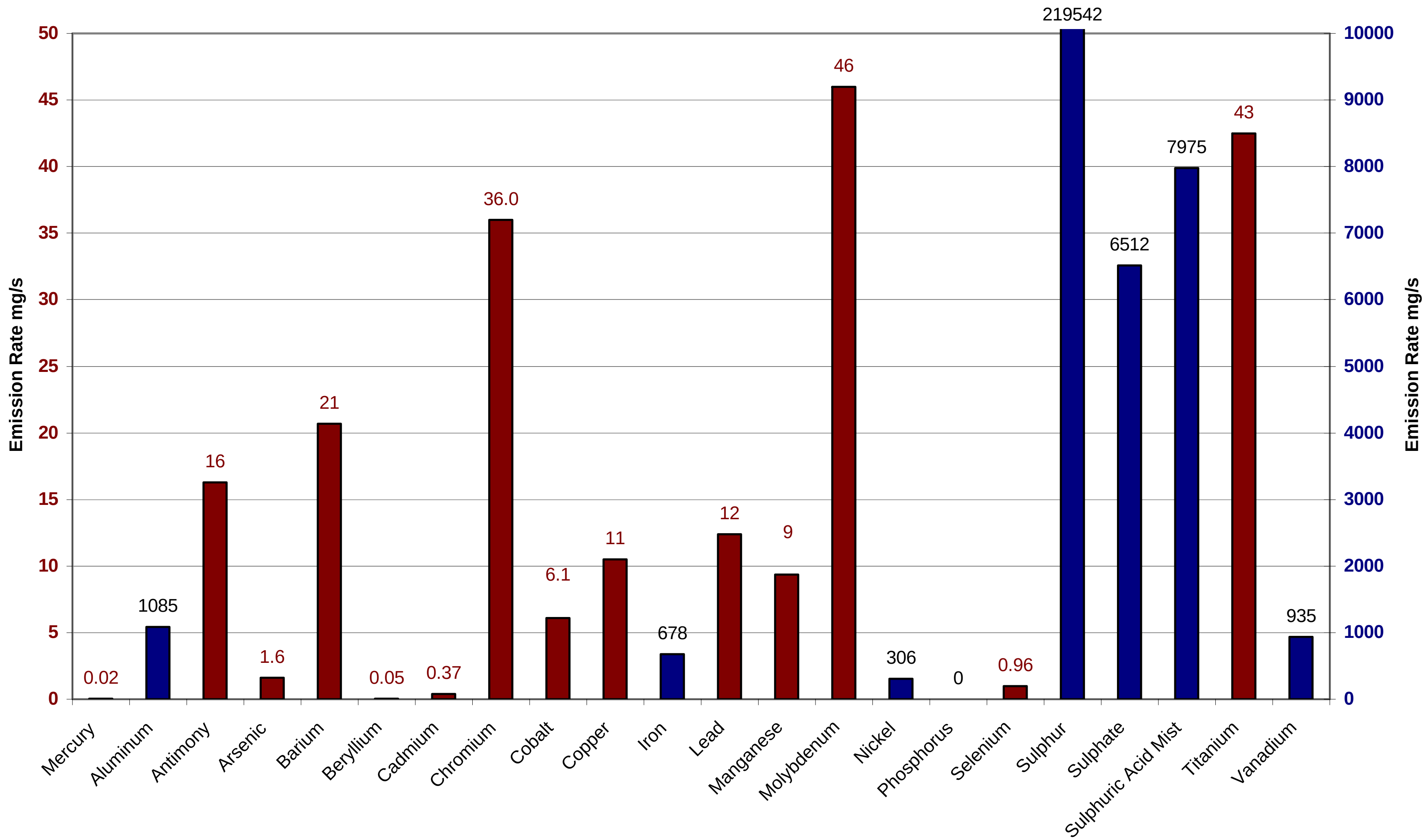


Figure II – Holyrood G.S. Summary of Metals Test Results 2005 (Unit 1 Typical)

(Note: Red data points are referenced against the left axis whereas blue data points are referenced against the right axis.)



AIR TESTING SERVICES INC.

APPENDIX C

HOURLY EMISSION DATA

FIGURE C.1
SO_2 EMISSION RATES

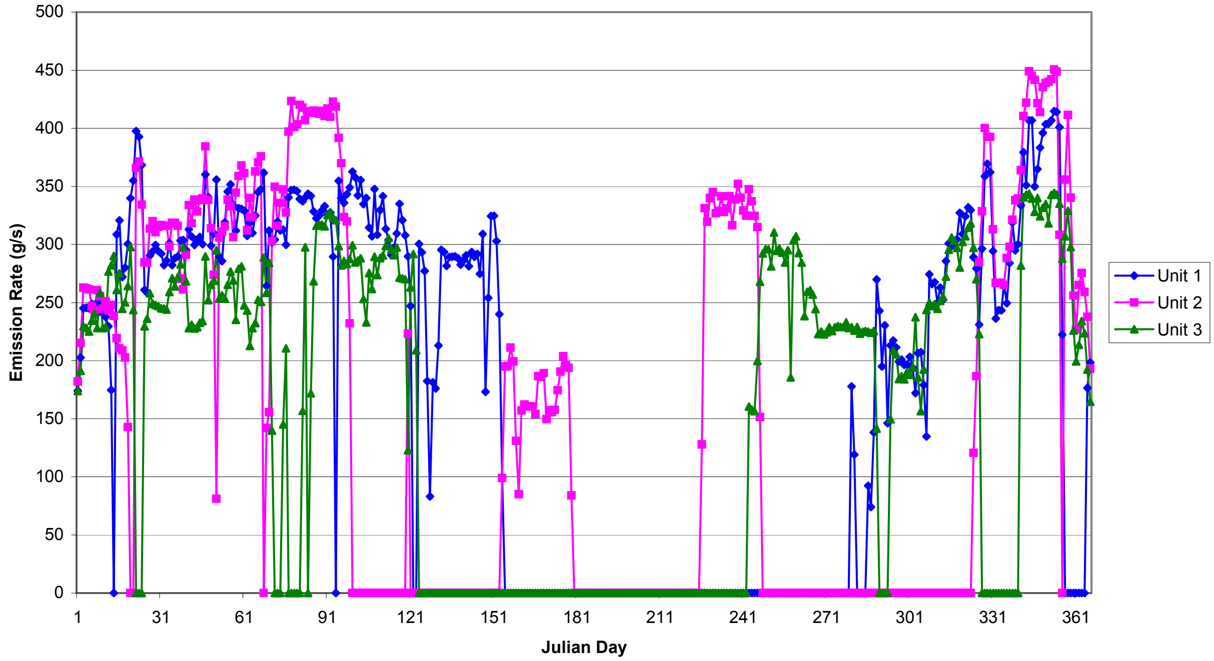


FIGURE C.2
NO_x EMISSION RATES

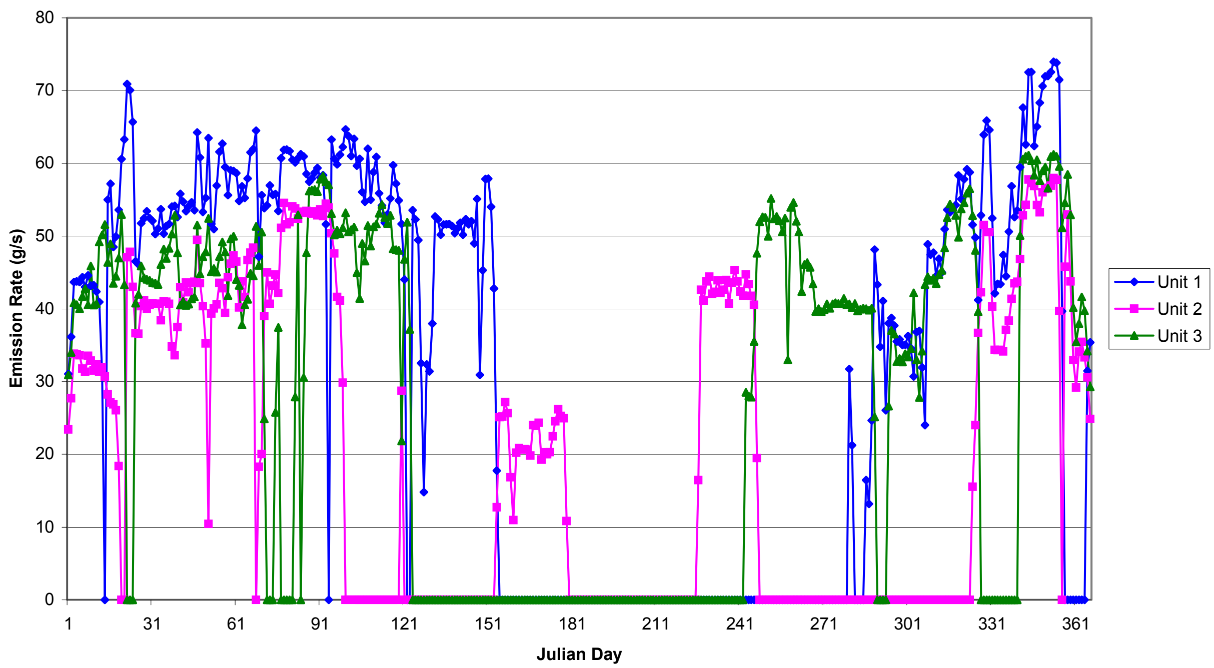


FIGURE C.3
CO EMISSION RATES

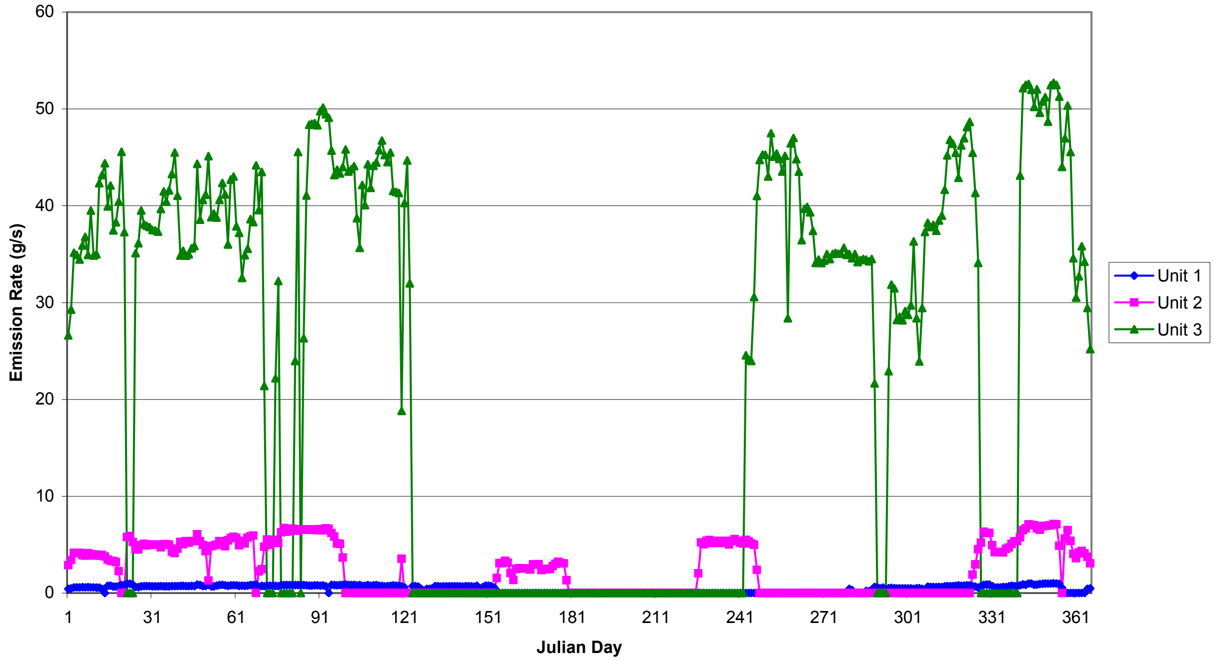
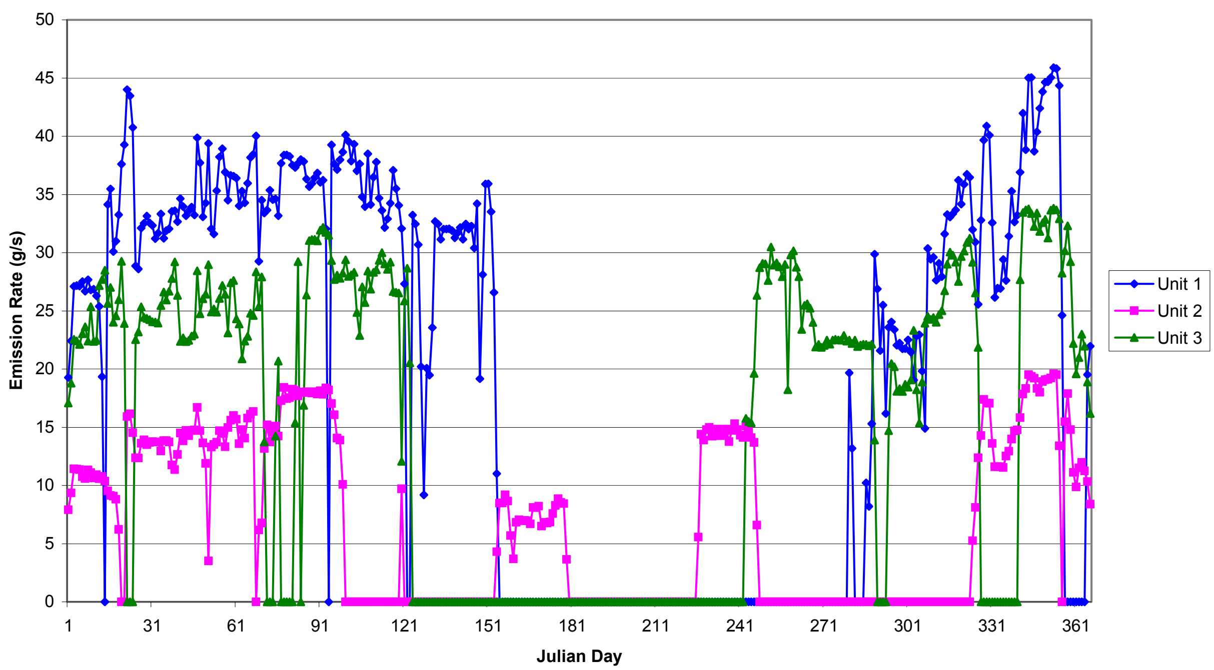


FIGURE C.4
TSP EMISSION RATES

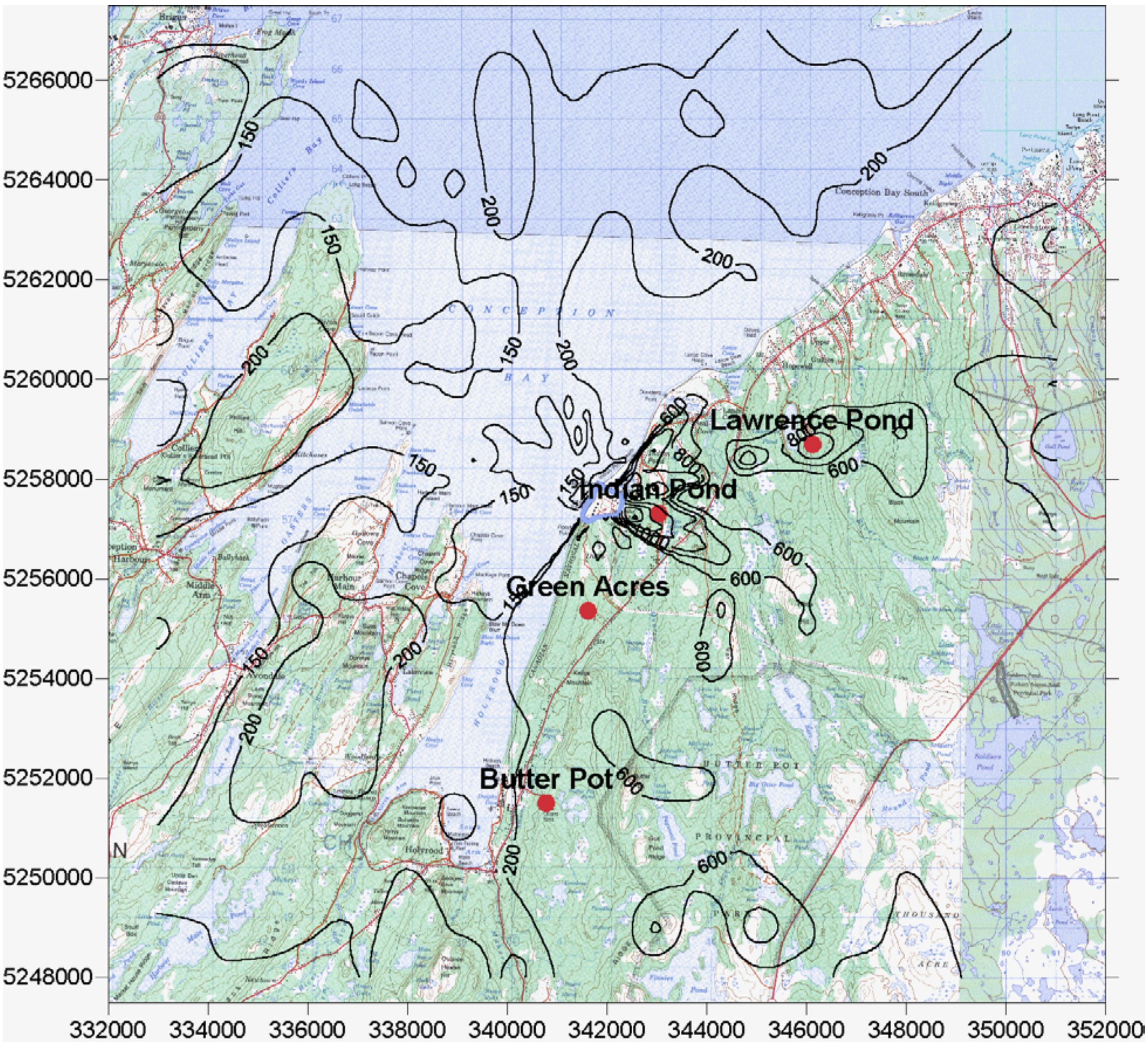


APPENDIX D

MAXIMUM PREDICTED CONCENTRATION ISOPLETHS

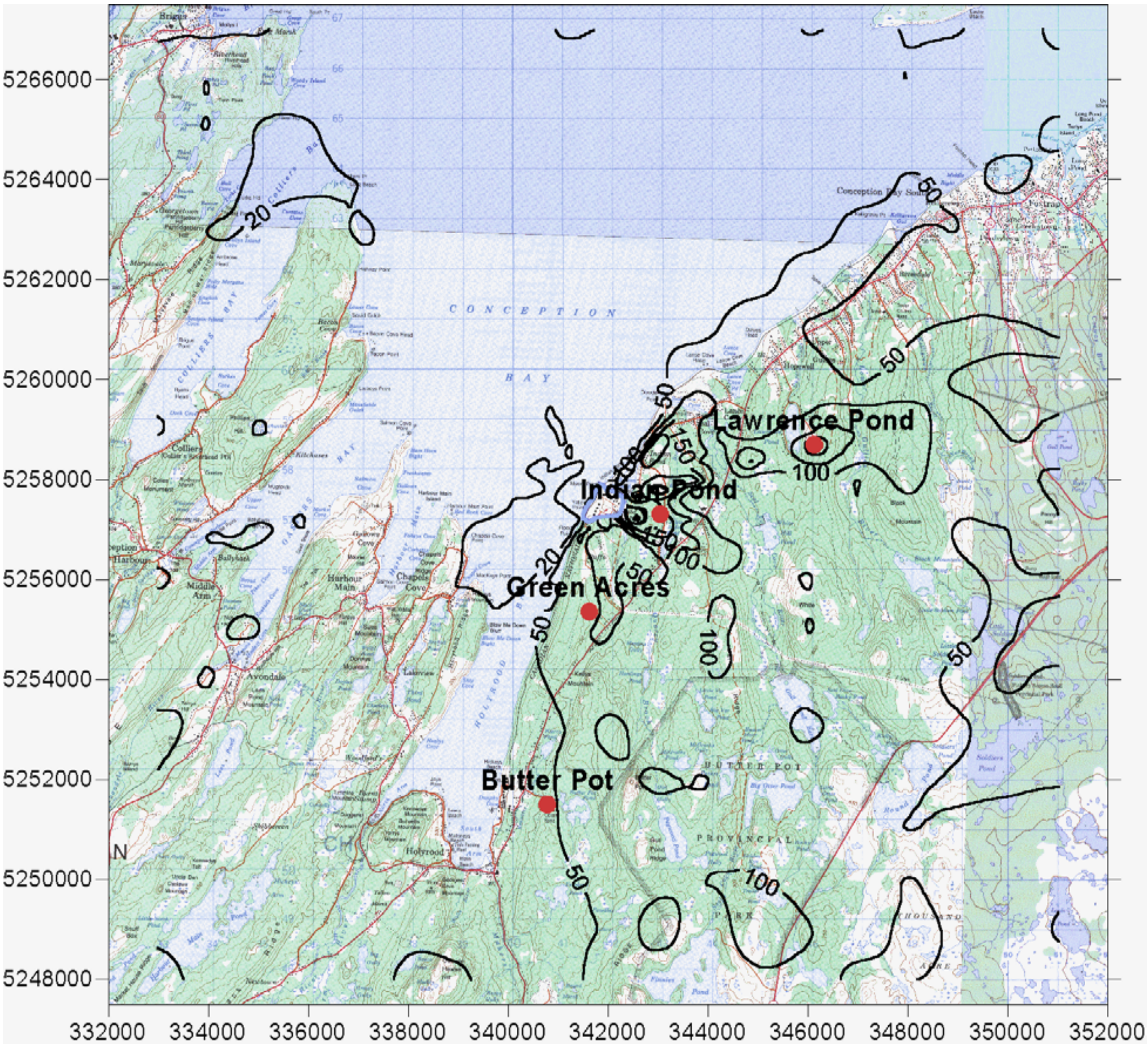
CONTAMINANTS WITH 1-HR AMBIENT AIR QUALITY STANDARDS

FIGURE D.1
MAXIMUM PREDICTED 1-HR SO_2 CONCENTRATION ($\mu g/m^3$)



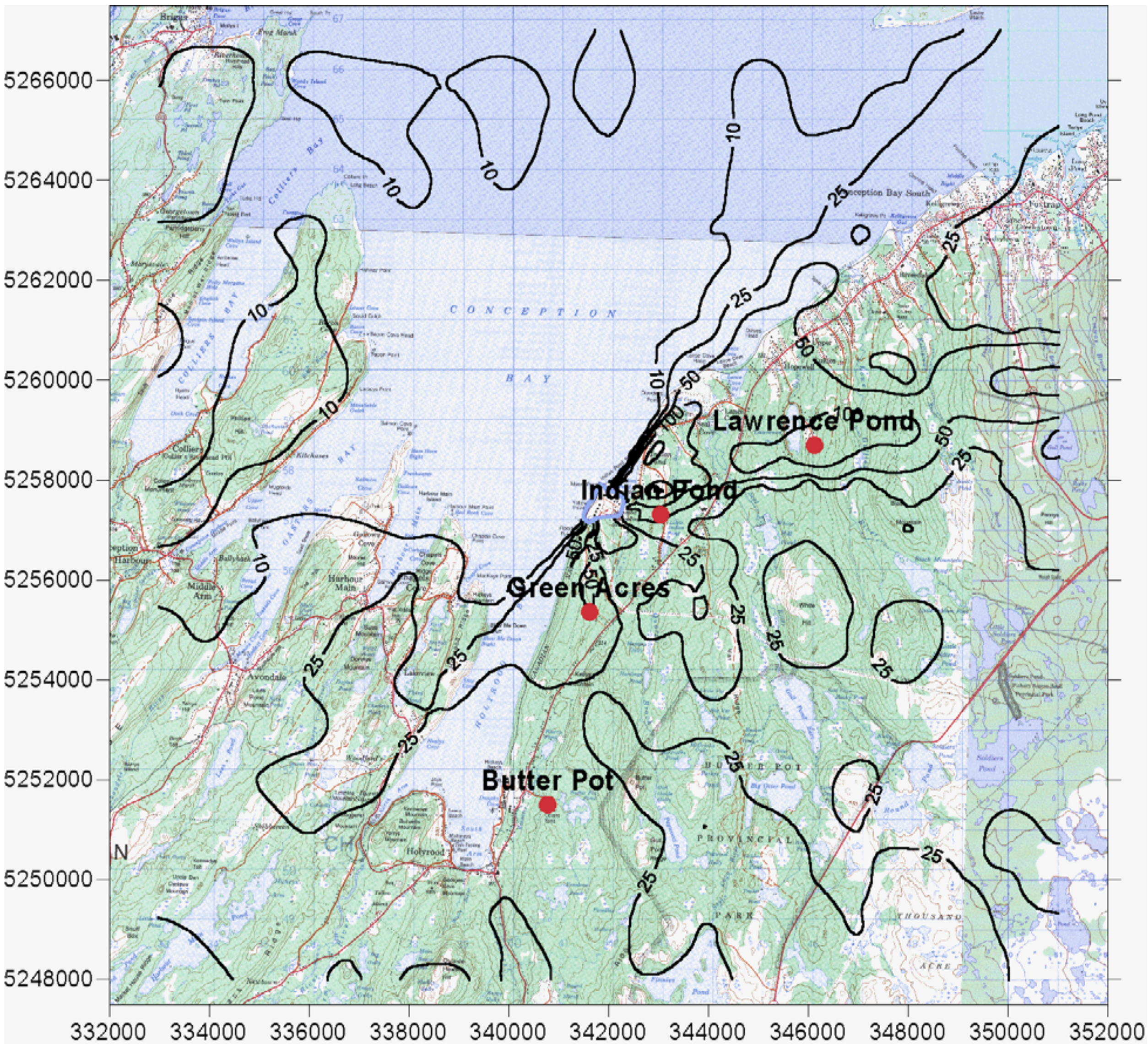
Note: 1-Hr Ambient Air Quality Standard for SO_2 = 900 $\mu g/m^3$

FIGURE D.2
MAXIMUM PREDICTED 1-HR NO_x CONCENTRATION ($\mu g/m^3$)



Note: 1-Hr Ambient Air Quality Standard for NO_x = 400 $\mu g/m^3$

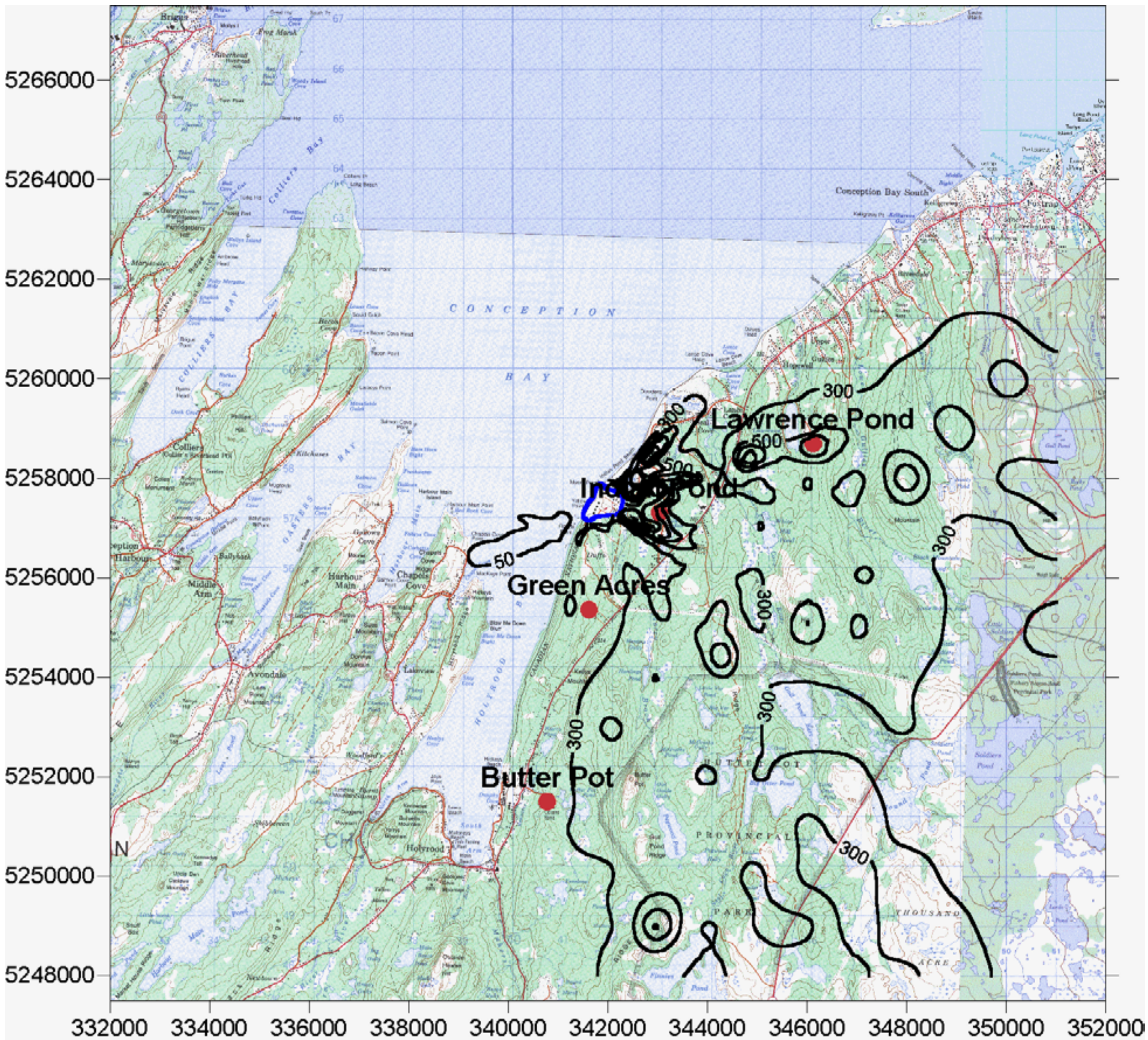
FIGURE D.3
MAXIMUM PREDICTED 1-HR CO CONCENTRATION (µg/m³)



Note: 1-Hr Ambient Air Quality Standard for CO = 35,000 µg/m³

CONTAMINANTS WITH 3-HR AMBIENT AIR QUALITY STANDARDS

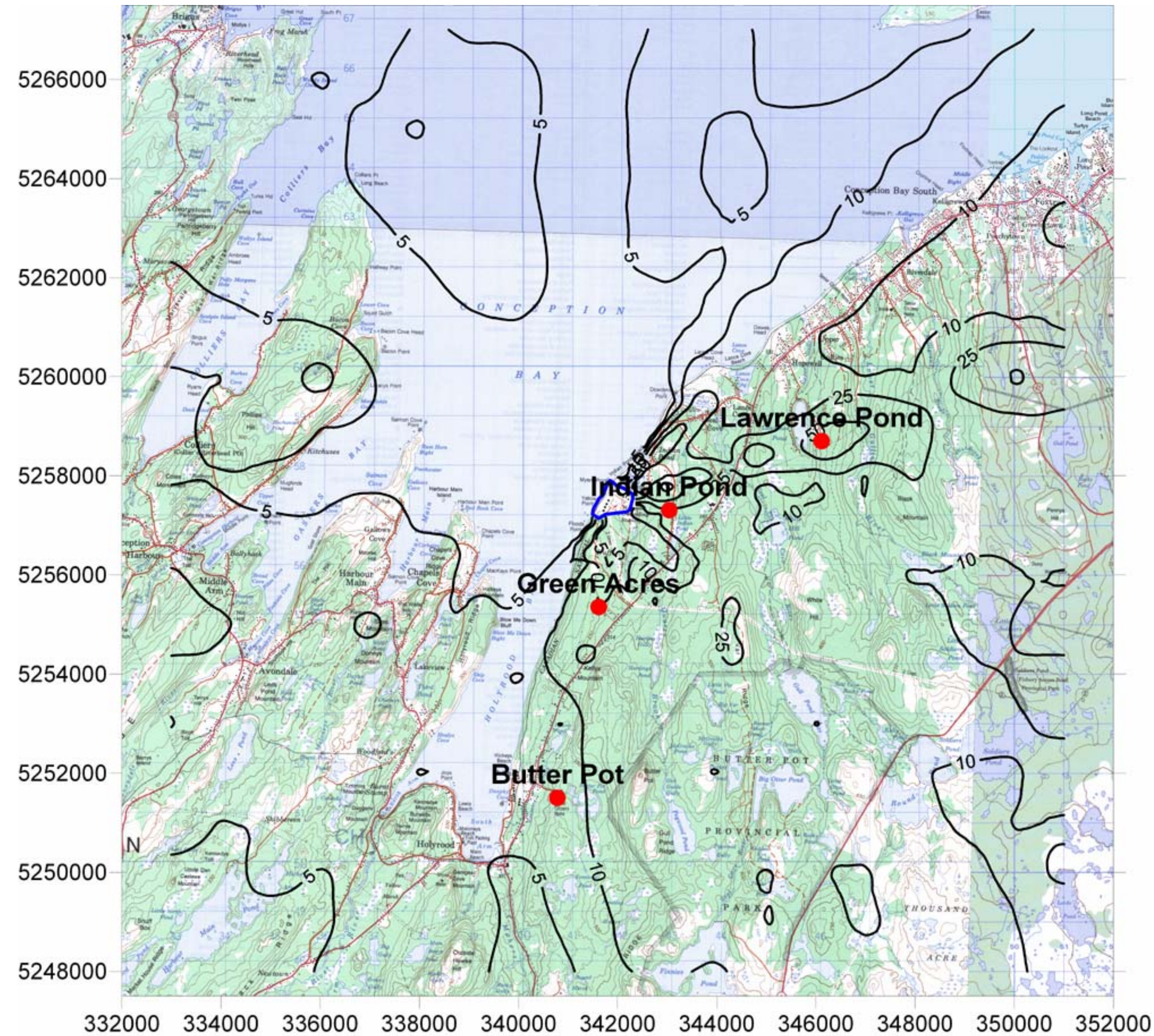
FIGURE D.4
MAXIMUM PREDICTED 3-HR SO_2 CONCENTRATION ($\mu g/m^3$)



Note: 3-Hr Ambient Air Quality Standard for SO_2 = 600 $\mu g/m^3$

CONTAMINANTS WITH 8-HR AMBIENT AIR QUALITY STANDARDS

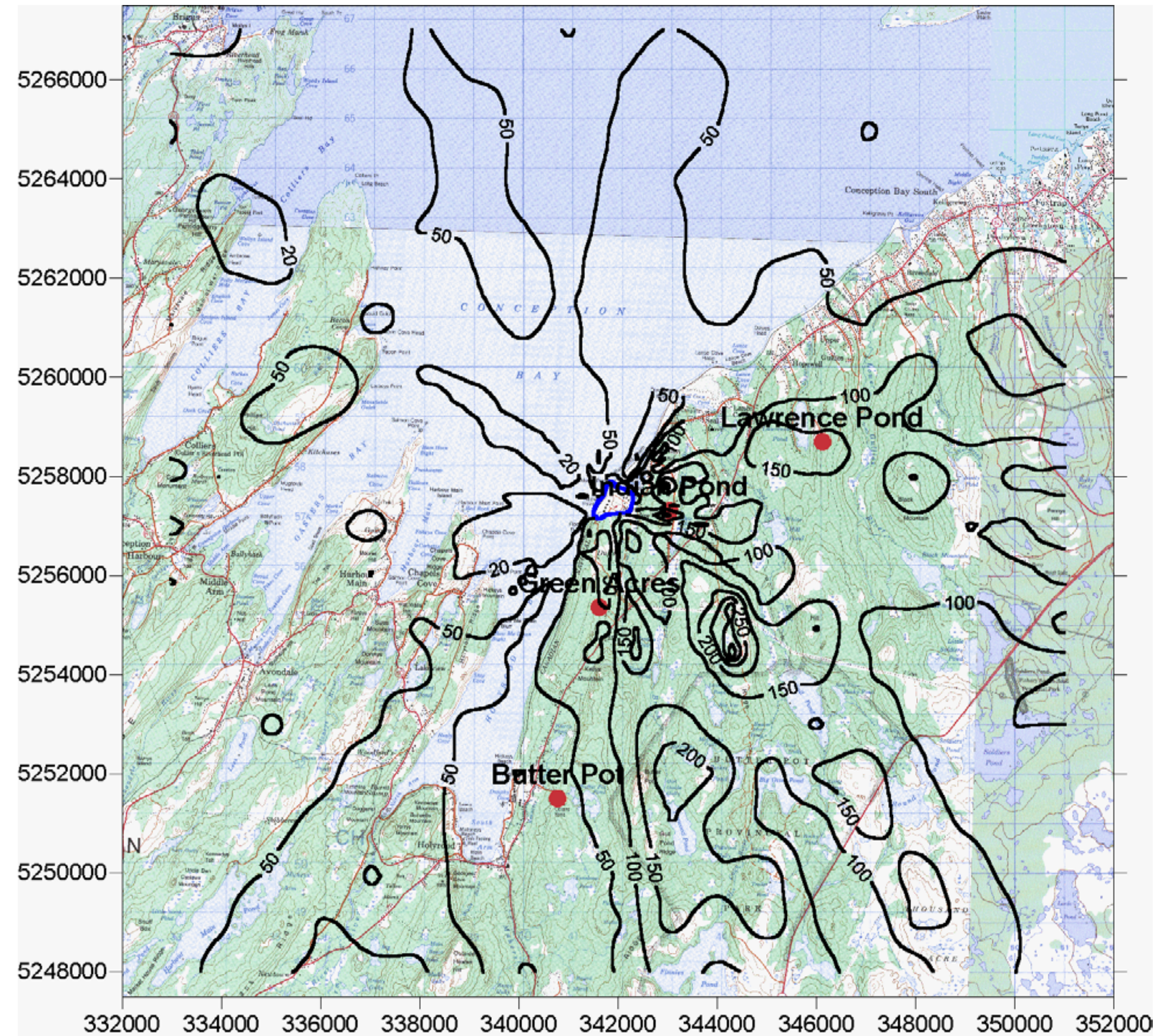
FIGURE D.5
MAXIMUM PREDICTED 8-HR CO CONCENTRATION (µg/m^3)



Note: 8-Hr Ambient Air Quality Standard for CO = 15,000 µg/m^3

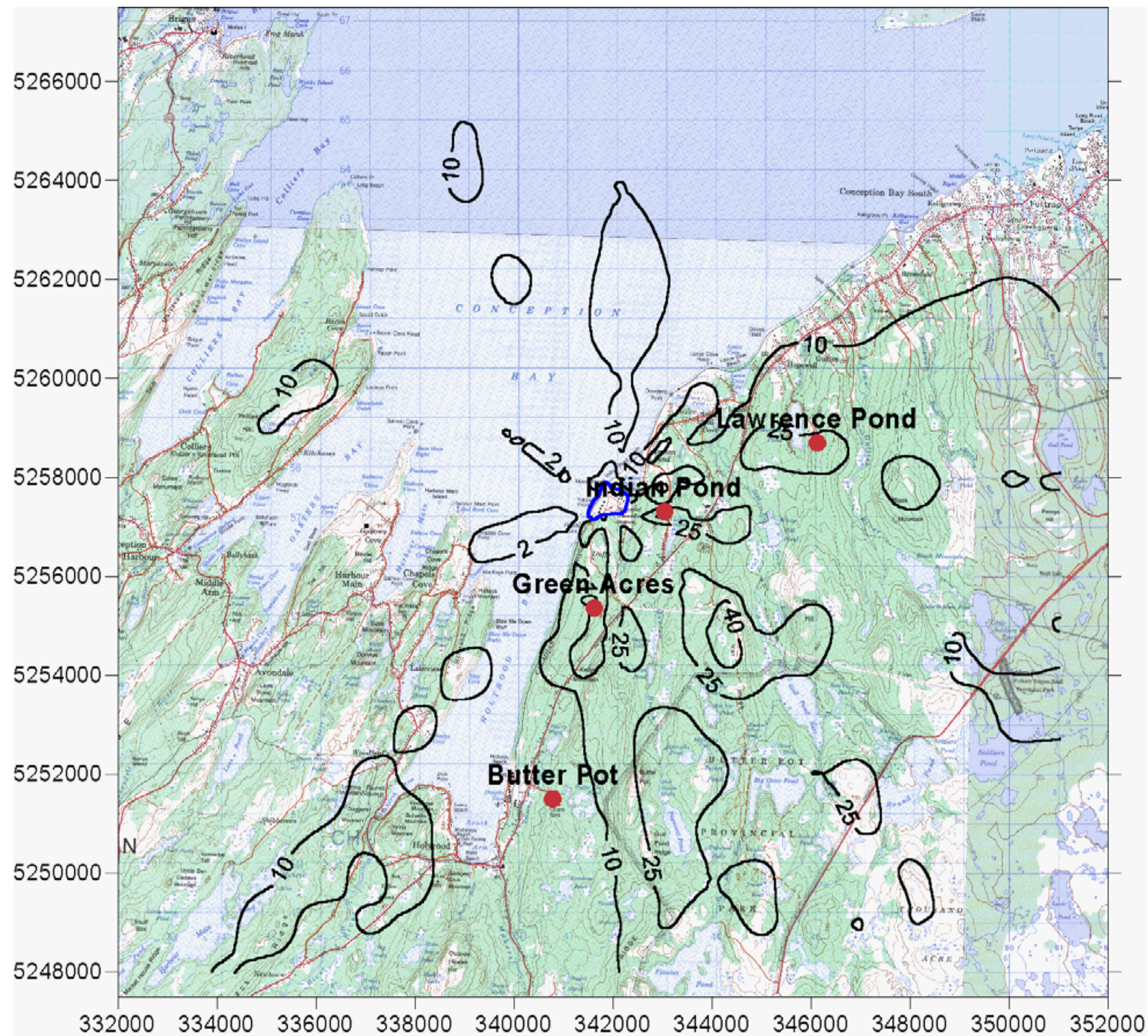
CONTAMINANTS WITH 24-HR AMBIENT AIR QUALITY STANDARDS

FIGURE D.6
MAXIMUM PREDICTED 24-HR SO_2 CONCENTRATION (µg/m^3)



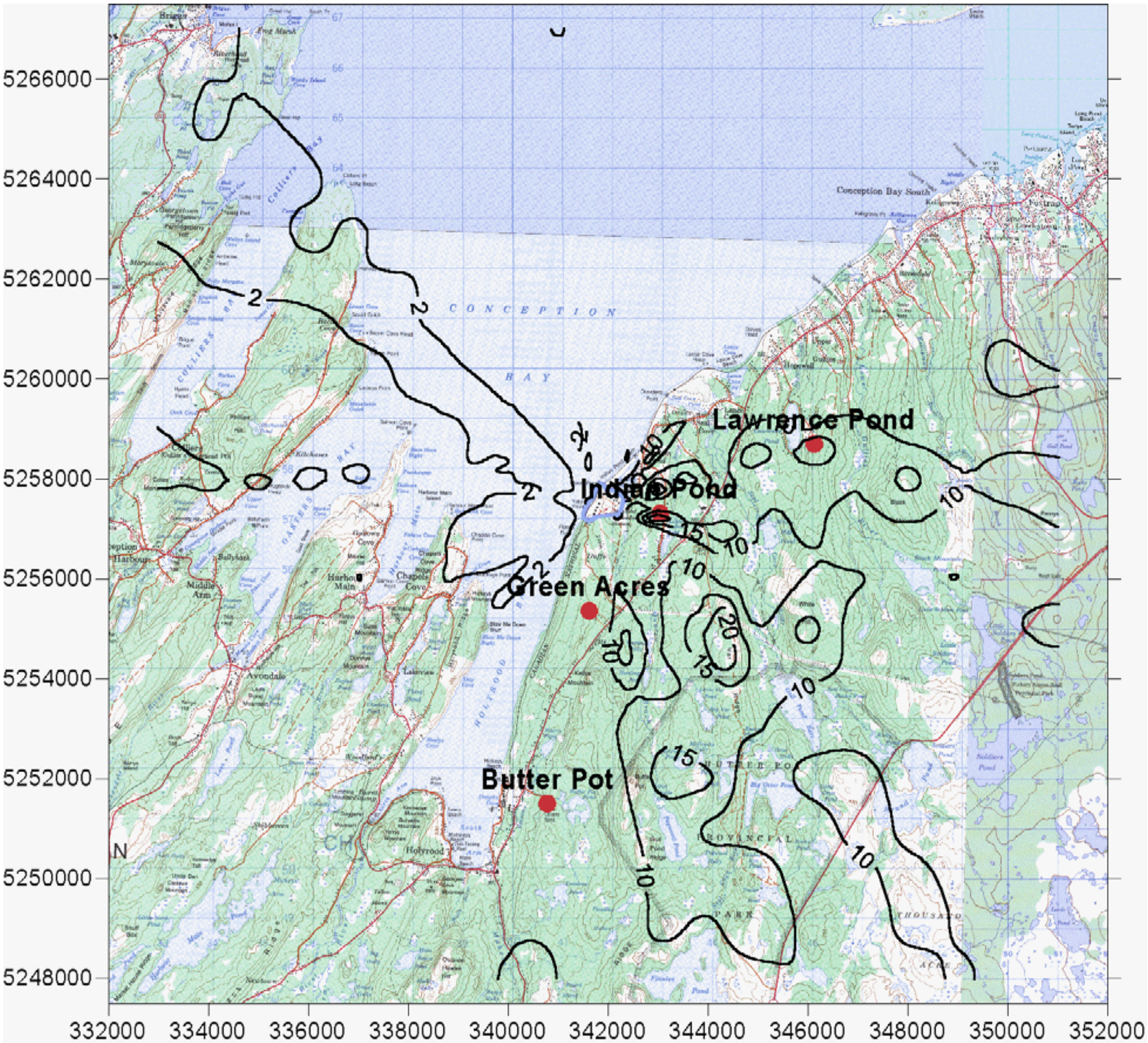
Note: 24-Hr Ambient Air Quality Standard for SO_2 = 300 µg/m^3

FIGURE D.7
MAXIMUM PREDICTED 24-HR NO_2 CONCENTRATION (μg/m^3)



Note: 24-Hr Ambient Air Quality Standard for NO_2 = 200 μg/m^3

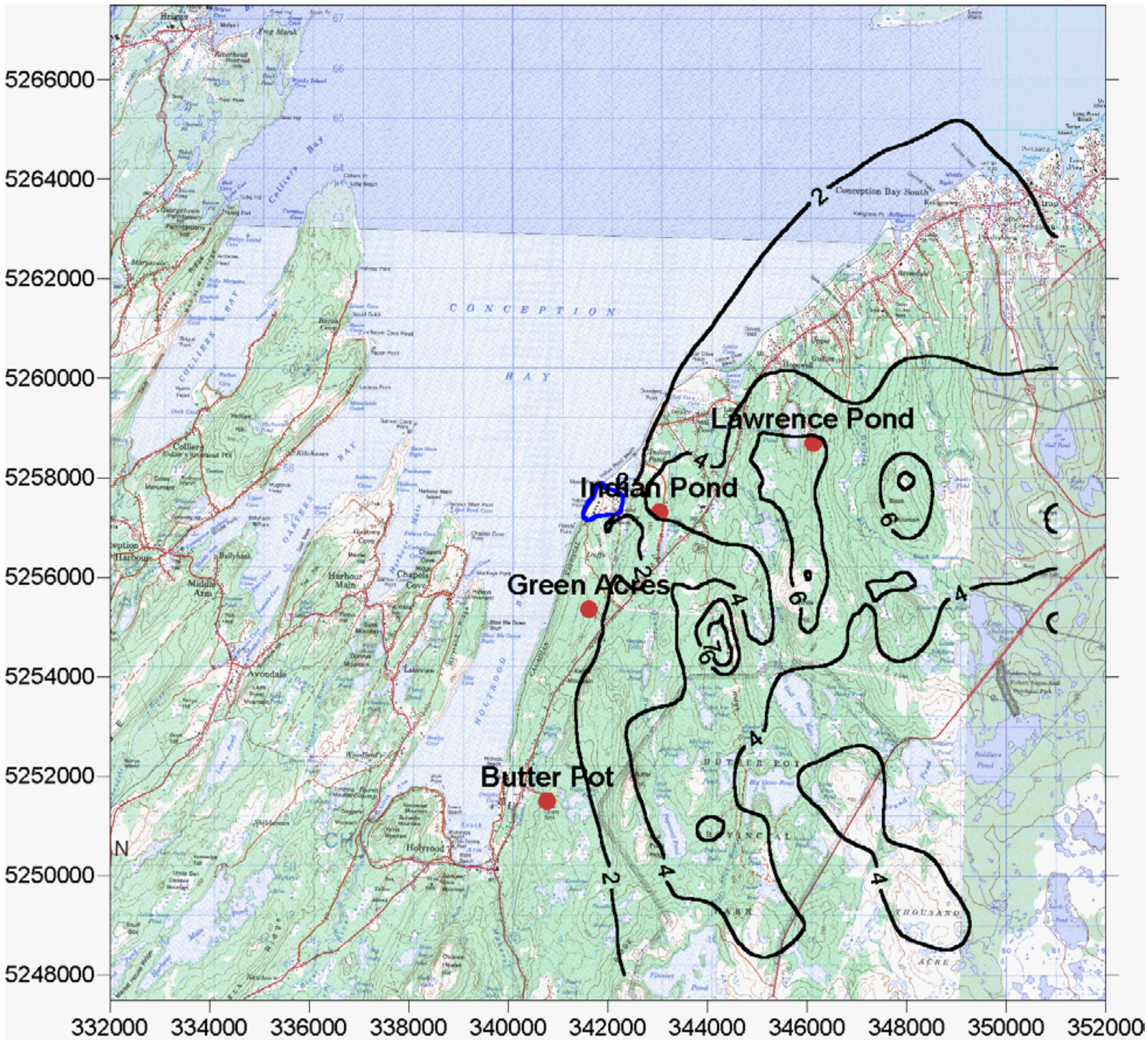
FIGURE D.8
MAXIMUM PREDICTED 24-HR TSP CONCENTRATION (µg/m³)



Note: 24-Hr Ambient Air Quality Standard for TSP = 120 µg/m³

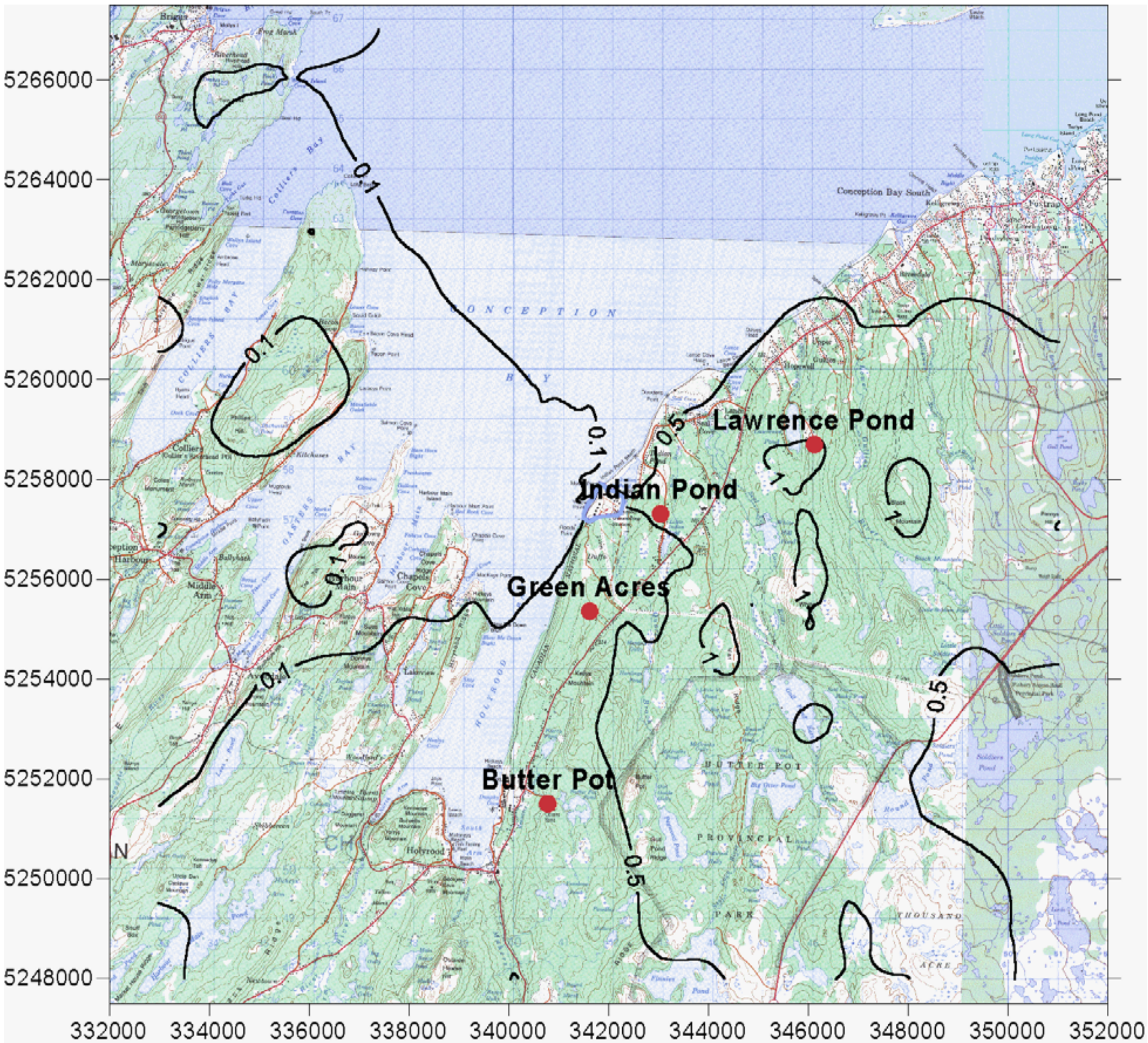
Contaminants with Annual Ambient Air Quality Standards

FIGURE D.9
MAXIMUM PREDICTED ANNUAL SO_2 CONCENTRATION (µg/m^3)



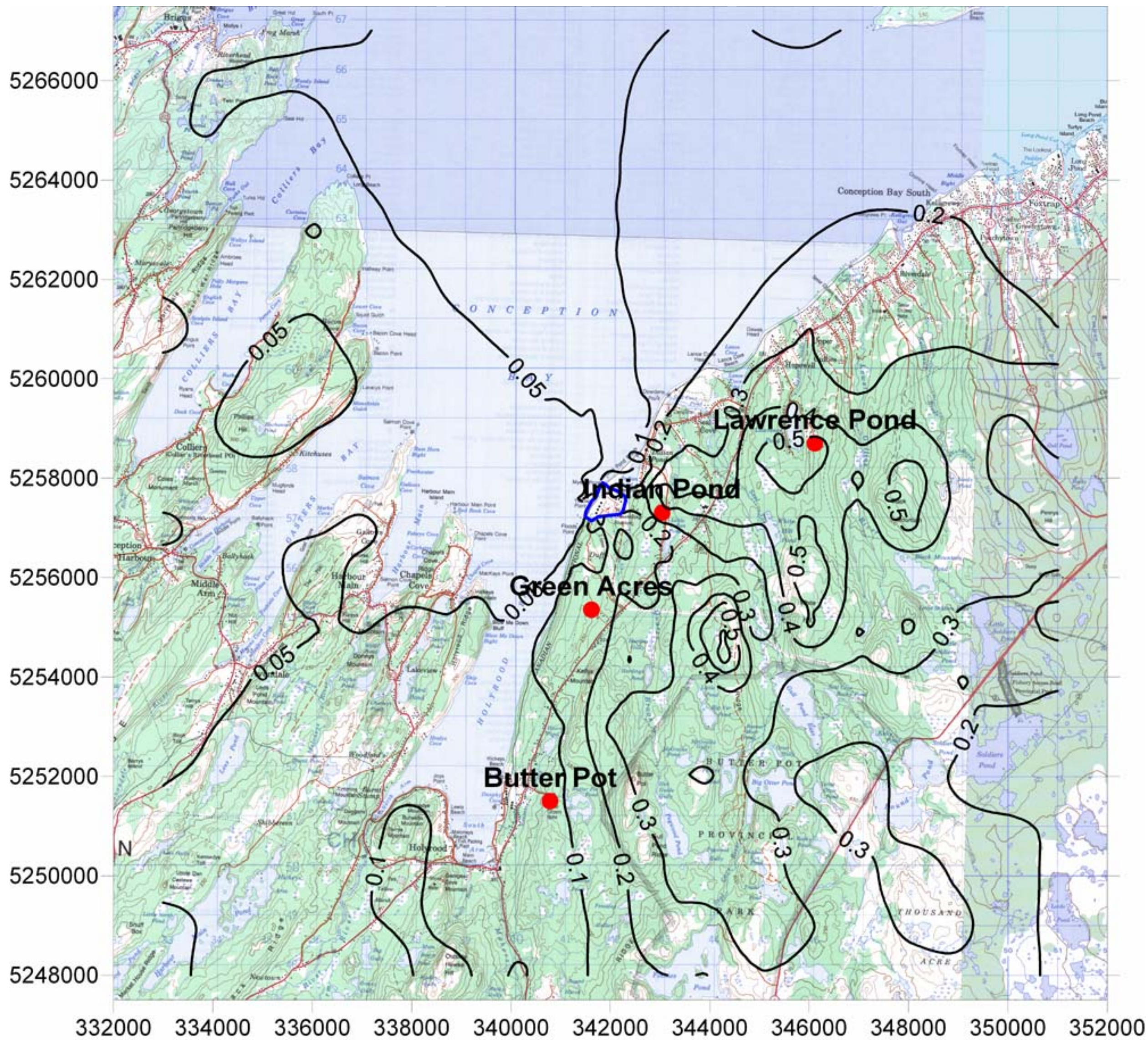
Note: Annual Ambient Air Quality Standard for SO_2 = 60 µg/m^3

FIGURE D.10
MAXIMUM PREDICTED ANNUAL NO_2 CONCENTRATION (µg/m^3)



Note: Annual Ambient Air Quality Standard for NO_2 = 100 µg/m^3

FIGURE D.11
MAXIMUM PREDICTED ANNUAL TSP CONCENTRATION (µg/m³)



Note: Annual Ambient Air Quality Standard for TSP= 60 µg/m³

APPENDIX E

TOP 50 PREDICTED HOURLY CONCENTRATIONS

TABLE E.1
TOP 50 PREDICTED HOURLY SO_2 CONCENTRATIONS (µg/m^3)

Rank	Year	Month	Day	Hour	Conc	X(km)	Y(km)	Wind Speed (m/s)	Wind Dir (°)	Mix Ht (m)	Stability Class	Temp (K)
1	4	11	6	10	3419.4	342.5	5257.2	11.0	212.2	2328.6	4	281.3
2	4	11	6	10	3302.1	342.6	5257.2	11.0	212.2	2328.6	4	281.3
3	4	11	6	10	3302.1	342.6	5257.2	11.0	212.2	2328.6	4	281.3
4	4	11	6	10	3104.6	342.3	5257.3	11.0	212.2	2328.6	4	281.3
5	4	11	6	11	2950.2	342.5	5257.4	11.3	213.4	2521.3	4	281.5
6	4	11	6	10	2949.6	342.7	5257.1	11.0	212.2	2328.6	4	281.3
7	4	11	6	10	2926.5	342.8	5257.1	11.0	212.2	2328.6	4	281.3
8	4	11	6	11	2903.9	342.4	5257.4	11.3	213.4	2521.3	4	281.5
9	4	11	6	11	2903.9	342.4	5257.4	11.3	213.4	2521.3	4	281.5
10	4	11	6	11	2840.2	342.6	5257.4	11.3	213.4	2521.3	4	281.5
11	4	11	6	11	2840.2	342.6	5257.4	11.3	213.4	2521.3	4	281.5
12	4	11	6	10	2780.6	342.4	5257.3	11.0	212.2	2328.6	4	281.3
13	4	11	6	10	2664.5	342.7	5257.2	11.0	212.2	2328.6	4	281.3
14	4	11	6	11	2555.7	342.7	5257.4	11.3	213.4	2521.3	4	281.5
15	4	11	6	10	2549.5	342.4	5257.2	11.0	212.2	2328.6	4	281.3
16	4	11	6	10	2549.5	342.4	5257.2	11.0	212.2	2328.6	4	281.3
17	4	11	6	11	2543.9	342.3	5257.4	11.3	213.4	2521.3	4	281.5
18	4	11	6	10	2448.4	342.6	5257.1	11.0	212.2	2328.6	4	281.3
19	4	11	6	11	2441.3	342.8	5257.3	11.3	213.4	2521.3	4	281.5
20	4	11	6	10	2424.4	343.0	5257.0	11.0	212.2	2328.6	4	281.3
21	4	11	6	11	2387.9	342.7	5257.3	11.3	213.4	2521.3	4	281.5
22	4	9	8	20	2370.8	343.0	5257.8	4.2	246.5	594.2	5	289.5
23	4	11	6	11	2257.2	342.8	5257.4	11.3	213.4	2521.3	4	281.5
24	4	11	6	11	2257.2	342.8	5257.4	11.3	213.4	2521.3	4	281.5
25	4	11	6	10	2238.1	342.2	5257.3	11.0	212.2	2328.6	4	281.3
26	4	11	6	11	2194.9	343.0	5257.3	11.3	213.4	2521.3	4	281.5
27	4	11	6	11	2135.7	342.6	5257.3	11.3	213.4	2521.3	4	281.5
28	4	11	6	10	2055.6	342.8	5257.0	11.0	212.2	2328.6	4	281.3
29	4	11	6	10	2055.6	342.8	5257.0	11.0	212.2	2328.6	4	281.3
30	4	11	6	10	2040.1	342.5	5257.3	11.0	212.2	2328.6	4	281.3
31	4	11	6	10	1974.4	342.8	5257.2	11.0	212.2	2328.6	4	281.3
32	4	11	6	10	1974.4	342.8	5257.2	11.0	212.2	2328.6	4	281.3
33	4	9	8	19	1895.1	343.2	5257.8	4.6	247.2	721.1	5	290.3
34	4	11	6	10	1830.9	343.2	5257.0	11.0	212.2	2328.6	4	281.3
35	4	11	6	11	1815.1	342.2	5257.4	11.3	213.4	2521.3	4	281.5
36	4	11	6	11	1815.1	342.2	5257.4	11.3	213.4	2521.3	4	281.5
37	4	11	6	11	1760.1	343.0	5257.4	11.3	213.4	2521.3	4	281.5
38	4	11	6	9	1688.7	342.5	5257.1	10.7	210.8	2235.7	4	281.1
39	4	9	7	21	1667.2	343.0	5258.6	3.3	242.6	377.1	6	287.5
40	4	9	8	19	1662.8	342.8	5257.7	4.6	247.2	721.1	5	290.3
41	4	11	6	11	1593.7	343.2	5257.2	11.3	213.4	2521.3	4	281.5
42	4	9	8	19	1592.2	342.7	5257.7	4.6	247.2	721.1	5	290.3
43	4	11	6	10	1584.5	343.4	5256.8	11.0	212.2	2328.6	4	281.3
44	4	11	6	11	1576.5	343.0	5257.2	11.3	213.4	2521.3	4	281.5
45	4	11	6	9	1562.7	342.3	5257.2	10.7	210.8	2235.7	4	281.1
46	4	11	6	10	1552.6	342.1	5257.4	11.0	212.2	2328.6	4	281.3
47	4	9	8	20	1551.4	343.6	5258.0	4.2	246.5	594.2	5	289.5
48	4	9	7	21	1540.1	342.8	5258.4	3.3	242.6	377.1	6	287.5
49	4	9	7	21	1540.1	342.8	5258.4	3.3	242.6	377.1	6	287.5
50	4	11	6	9	1521.2	342.6	5257.0	10.7	210.8	2235.7	4	281.1

Note: Meteorological conditions were extracted from grid point closest to plant site

TABLE E.2
TOP 50 PREDICTED HOURLY NO_x CONCENTRATIONS (µg/m³)

Rank	Year	Month	Day	Hour	Conc	X(km)	Y(km)	Wind Speed (m/s)	Wind Dir (°)	Mix Ht (m)	Stability Class	Temp (K)
1	4	11	6	10	440.2	342.5	5257.2	11.0	212.2	2328.6	4	281.3
2	4	11	6	10	425.2	342.6	5257.2	11.0	212.2	2328.6	4	281.3
3	4	11	6	10	425.2	342.6	5257.2	11.0	212.2	2328.6	4	281.3
4	4	9	8	20	421.7	343.0	5257.8	4.2	246.5	594.2	5	289.5
5	4	11	6	10	399.6	342.3	5257.3	11.0	212.2	2328.6	4	281.3
6	4	11	6	10	380.1	342.7	5257.1	11.0	212.2	2328.6	4	281.3
7	4	11	6	11	379.7	342.5	5257.4	11.3	213.4	2521.3	4	281.5
8	4	11	6	10	377.4	342.8	5257.1	11.0	212.2	2328.6	4	281.3
9	4	11	6	11	373.8	342.4	5257.4	11.3	213.4	2521.3	4	281.5
10	4	11	6	11	373.8	342.4	5257.4	11.3	213.4	2521.3	4	281.5
11	4	11	6	11	365.6	342.6	5257.4	11.3	213.4	2521.3	4	281.5
12	4	11	6	11	365.6	342.6	5257.4	11.3	213.4	2521.3	4	281.5
13	4	11	6	10	357.9	342.4	5257.3	11.0	212.2	2328.6	4	281.3
14	4	11	6	10	343.2	342.7	5257.2	11.0	212.2	2328.6	4	281.3
15	4	9	8	19	337.1	343.2	5257.8	4.6	247.2	721.1	5	290.3
16	4	11	6	11	329.0	342.7	5257.4	11.3	213.4	2521.3	4	281.5
17	4	11	6	10	328.2	342.4	5257.2	11.0	212.2	2328.6	4	281.3
18	4	11	6	10	328.2	342.4	5257.2	11.0	212.2	2328.6	4	281.3
19	4	11	6	11	327.4	342.3	5257.4	11.3	213.4	2521.3	4	281.5
20	4	11	6	10	315.4	342.6	5257.1	11.0	212.2	2328.6	4	281.3
21	4	11	6	11	314.4	342.8	5257.3	11.3	213.4	2521.3	4	281.5
22	4	11	6	10	314.0	343.0	5257.0	11.0	212.2	2328.6	4	281.3
23	4	11	6	11	307.4	342.7	5257.3	11.3	213.4	2521.3	4	281.5
24	4	9	7	21	296.7	343.0	5258.6	3.3	242.6	377.1	6	287.5
25	4	9	8	19	295.7	342.8	5257.7	4.6	247.2	721.1	5	290.3
26	4	11	6	11	290.6	342.8	5257.4	11.3	213.4	2521.3	4	281.5
27	4	11	6	11	290.6	342.8	5257.4	11.3	213.4	2521.3	4	281.5
28	4	11	6	10	288.1	342.2	5257.3	11.0	212.2	2328.6	4	281.3
29	4	9	8	19	283.2	342.7	5257.7	4.6	247.2	721.1	5	290.3
30	4	11	6	11	283.1	343.0	5257.3	11.3	213.4	2521.3	4	281.5
31	4	9	8	20	275.9	343.6	5258.0	4.2	246.5	594.2	5	289.5
32	4	11	6	11	274.9	342.6	5257.3	11.3	213.4	2521.3	4	281.5
33	4	9	7	21	274.1	342.8	5258.4	3.3	242.6	377.1	6	287.5
34	4	9	7	21	274.1	342.8	5258.4	3.3	242.6	377.1	6	287.5
35	4	9	8	21	269.9	342.8	5257.8	3.9	250.4	504.5	5	289.2
36	4	9	8	21	269.9	342.8	5257.8	3.9	250.4	504.5	5	289.2
37	4	9	7	18	265.7	342.2	5257.8	3.7	243.3	498.1	4	288.6
38	4	9	7	18	265.7	342.2	5257.8	3.7	243.3	498.1	4	288.6
39	4	11	6	10	265.3	342.8	5257.0	11.0	212.2	2328.6	4	281.3
40	4	11	6	10	265.3	342.8	5257.0	11.0	212.2	2328.6	4	281.3
41	4	9	8	20	263.4	346.1	5258.7	4.2	246.5	594.2	5	289.5
42	4	11	6	10	262.7	342.5	5257.3	11.0	212.2	2328.6	4	281.3
43	4	9	8	19	258.5	342.4	5257.6	4.6	247.2	721.1	5	290.3
44	4	9	8	19	258.5	342.4	5257.6	4.6	247.2	721.1	5	290.3
45	4	11	6	10	254.5	342.8	5257.2	11.0	212.2	2328.6	4	281.3
46	4	11	6	10	254.5	342.8	5257.2	11.0	212.2	2328.6	4	281.3
47	4	9	7	21	254.1	342.7	5258.3	3.3	242.6	377.1	6	287.5
48	4	9	7	19	252.5	343.0	5258.8	3.5	243.7	417.1	5	288.3
49	4	9	8	20	245.8	342.3	5257.6	4.2	246.5	594.2	5	289.5
50	4	9	7	19	241.1	342.8	5258.6	3.5	243.7	417.1	5	288.3

Note: Meteorological conditions were extracted from grid point closest to plant site

TABLE E.3
TOP 50 PREDICTED HOURLY TSP CONCENTRATIONS (µg/m^3)

Rank	Year	Month	Day	Hour	Conc	X(km)	Y(km)	Wind Speed (m/s)	Wind Dir (°)	Mix Ht (m)	Stability Class	Temp (K)
1	4	9	8	20	233.2	343.0	5257.8	4.2	246.5	594.2	5	289.5
2	4	9	8	19	186.5	343.2	5257.8	4.6	247.2	721.1	5	290.3
3	4	9	7	21	164.1	343.0	5258.6	3.3	242.6	377.1	6	287.5
4	4	9	8	19	163.5	342.8	5257.7	4.6	247.2	721.1	5	290.3
5	4	9	8	19	156.5	342.7	5257.7	4.6	247.2	721.1	5	290.3
6	4	9	8	20	152.8	343.6	5258.0	4.2	246.5	594.2	5	289.5
7	4	9	7	21	151.5	342.8	5258.4	3.3	242.6	377.1	6	287.5
8	4	9	7	21	151.5	342.8	5258.4	3.3	242.6	377.1	6	287.5
9	4	9	8	21	149.2	342.8	5257.8	3.9	250.4	504.5	5	289.2
10	4	9	8	21	149.2	342.8	5257.8	3.9	250.4	504.5	5	289.2
11	4	11	6	10	149.0	342.5	5257.2	11.0	212.2	2328.6	4	281.3
12	4	9	8	20	147.0	346.1	5258.7	4.2	246.5	594.2	5	289.5
13	4	9	7	18	146.8	342.2	5257.8	3.7	243.3	498.1	4	288.6
14	4	9	7	18	146.8	342.2	5257.8	3.7	243.3	498.1	4	288.6
15	4	11	6	10	144.1	342.6	5257.2	11.0	212.2	2328.6	4	281.3
16	4	11	6	10	144.1	342.6	5257.2	11.0	212.2	2328.6	4	281.3
17	4	9	8	19	142.8	342.4	5257.6	4.6	247.2	721.1	5	290.3
18	4	9	8	19	142.8	342.4	5257.6	4.6	247.2	721.1	5	290.3
19	4	9	7	21	140.4	342.7	5258.3	3.3	242.6	377.1	6	287.5
20	4	9	7	19	139.7	343.0	5258.8	3.5	243.7	417.1	5	288.3
21	4	9	8	20	135.8	342.3	5257.6	4.2	246.5	594.2	5	289.5
22	4	11	6	10	135.1	342.3	5257.3	11.0	212.2	2328.6	4	281.3
23	4	9	7	19	133.3	342.8	5258.6	3.5	243.7	417.1	5	288.3
24	4	9	8	19	133.1	343.8	5258.0	4.6	247.2	721.1	5	290.3
25	4	9	8	21	132.6	343.4	5258.0	3.9	250.4	504.5	5	289.2
26	4	9	8	20	131.0	344.8	5258.4	4.2	246.5	594.2	5	289.5
27	4	11	6	10	129.1	342.7	5257.1	11.0	212.2	2328.6	4	281.3
28	4	9	7	20	129.1	342.7	5258.4	3.2	244.3	351.8	6	288.1
29	4	9	7	21	128.9	343.2	5258.8	3.3	242.6	377.1	6	287.5
30	4	11	6	10	128.5	342.8	5257.1	11.0	212.2	2328.6	4	281.3
31	4	11	6	11	128.5	342.5	5257.4	11.3	213.4	2521.3	4	281.5
32	4	11	6	11	126.4	342.4	5257.4	11.3	213.4	2521.3	4	281.5
33	4	11	6	11	126.4	342.4	5257.4	11.3	213.4	2521.3	4	281.5
34	4	9	8	20	126.4	342.6	5257.7	4.2	246.5	594.2	5	289.5
35	4	9	7	18	125.3	342.3	5257.9	3.7	243.3	498.1	4	288.6
36	4	11	6	11	123.8	342.6	5257.4	11.3	213.4	2521.3	4	281.5
37	4	11	6	11	123.8	342.6	5257.4	11.3	213.4	2521.3	4	281.5
38	4	9	7	18	122.3	342.6	5258.2	3.7	243.3	498.1	4	288.6
39	4	9	7	18	122.3	342.6	5258.2	3.7	243.3	498.1	4	288.6
40	4	9	7	21	122.0	342.1	5257.7	3.3	242.6	377.1	6	287.5
41	4	11	6	10	121.0	342.4	5257.3	11.0	212.2	2328.6	4	281.3
42	4	9	7	16	116.7	342.8	5258.0	4.3	244.0	926.9	3	289.2
43	4	9	7	16	116.7	342.8	5258.0	4.3	244.0	926.9	3	289.2
44	4	11	6	10	116.5	342.7	5257.2	11.0	212.2	2328.6	4	281.3
45	4	9	7	18	115.8	342.8	5258.3	3.7	243.3	498.1	4	288.6
46	4	9	7	20	111.8	342.6	5258.3	3.2	244.3	351.8	6	288.1
47	4	9	7	19	111.7	342.3	5258.0	3.5	243.7	417.1	5	288.3
48	4	11	6	11	111.5	342.7	5257.4	11.3	213.4	2521.3	4	281.5
49	4	11	6	10	111.0	342.4	5257.2	11.0	212.2	2328.6	4	281.3
50	4	11	6	10	111.0	342.4	5257.2	11.0	212.2	2328.6	4	281.3

Note: Meteorological conditions were extracted from grid point closest to plant site

TABLE E.4
TOP 50 PREDICTED HOURLY CO CONCENTRATIONS (µg/m^3)

Rank	Year	Month	Day	Hour	Conc	X(km)	Y(km)	Wind Speed (m/s)	Wind Dir (°)	Mix Ht (m)	Stability Class	Temp (K)
1	4	9	8	20	362.8	343.0	5257.8	4.2	246.5	594.2	5	289.5
2	4	9	8	19	290.0	343.2	5257.8	4.6	247.2	721.1	5	290.3
3	4	9	7	21	255.1	343.0	5258.6	3.3	242.6	377.1	6	287.5
4	4	9	8	19	254.5	342.8	5257.7	4.6	247.2	721.1	5	290.3
5	4	9	8	19	243.7	342.7	5257.7	4.6	247.2	721.1	5	290.3
6	4	9	8	20	237.4	343.6	5258.0	4.2	246.5	594.2	5	289.5
7	4	9	7	21	235.7	342.8	5258.4	3.3	242.6	377.1	6	287.5
8	4	9	7	21	235.7	342.8	5258.4	3.3	242.6	377.1	6	287.5
9	4	9	8	21	232.2	342.8	5257.8	3.9	250.4	504.5	5	289.2
10	4	9	8	21	232.2	342.8	5257.8	3.9	250.4	504.5	5	289.2
11	4	9	7	18	228.7	342.2	5257.8	3.7	243.3	498.1	4	288.6
12	4	9	7	18	228.7	342.2	5257.8	3.7	243.3	498.1	4	288.6
13	4	9	8	20	226.6	346.1	5258.7	4.2	246.5	594.2	5	289.5
14	4	9	8	19	222.5	342.4	5257.6	4.6	247.2	721.1	5	290.3
15	4	9	8	19	222.5	342.4	5257.6	4.6	247.2	721.1	5	290.3
16	4	9	7	21	218.5	342.7	5258.3	3.3	242.6	377.1	6	287.5
17	4	9	7	19	217.1	343.0	5258.8	3.5	243.7	417.1	5	288.3
18	4	9	8	20	211.5	342.3	5257.6	4.2	246.5	594.2	5	289.5
19	4	9	7	19	207.3	342.8	5258.6	3.5	243.7	417.1	5	288.3
20	4	9	8	19	206.6	343.8	5258.0	4.6	247.2	721.1	5	290.3
21	4	9	8	21	206.0	343.4	5258.0	3.9	250.4	504.5	5	289.2
22	4	9	8	20	202.9	344.8	5258.4	4.2	246.5	594.2	5	289.5
23	4	9	7	20	200.8	342.7	5258.4	3.2	244.3	351.8	6	288.1
24	4	9	7	21	200.3	343.2	5258.8	3.3	242.6	377.1	6	287.5
25	4	9	8	20	196.8	342.6	5257.7	4.2	246.5	594.2	5	289.5
26	4	9	7	18	195.2	342.3	5257.9	3.7	243.3	498.1	4	288.6
27	4	9	7	18	190.5	342.6	5258.2	3.7	243.3	498.1	4	288.6
28	4	9	7	18	190.5	342.6	5258.2	3.7	243.3	498.1	4	288.6
29	4	9	7	21	190.0	342.1	5257.7	3.3	242.6	377.1	6	287.5
30	4	9	7	16	181.4	342.8	5258.0	4.3	244.0	926.9	3	289.2
31	4	9	7	16	181.4	342.8	5258.0	4.3	244.0	926.9	3	289.2
32	4	9	7	18	180.1	342.8	5258.3	3.7	243.3	498.1	4	288.6
33	4	9	7	20	174.0	342.6	5258.3	3.2	244.3	351.8	6	288.1
34	4	9	7	19	173.9	342.3	5258.0	3.5	243.7	417.1	5	288.3
35	4	9	7	18	172.6	342.4	5258.0	3.7	243.3	498.1	4	288.6
36	4	9	7	18	172.6	342.4	5258.0	3.7	243.3	498.1	4	288.6
37	4	9	7	15	171.8	342.8	5257.9	4.6	243.7	929.6	3	289.5
38	4	9	7	15	170.1	343.0	5258.0	4.6	243.7	929.6	3	289.5
39	4	9	7	12	168.5	342.8	5257.6	4.6	234.1	917.8	3	288.6
40	4	9	7	12	168.5	342.8	5257.6	4.6	234.1	917.8	3	288.6
41	4	9	7	21	165.9	343.4	5259.0	3.3	242.6	377.1	6	287.5
42	4	9	7	17	163.7	342.8	5258.2	4.0	244.3	910.8	4	288.9
43	4	9	7	17	163.7	342.8	5258.2	4.0	244.3	910.8	4	288.9
44	4	9	7	16	161.9	342.6	5257.9	4.3	244.0	926.9	3	289.2
45	4	9	7	15	161.6	343.2	5258.0	4.6	243.7	929.6	3	289.5
46	4	9	7	15	159.4	342.7	5257.8	4.6	243.7	929.6	3	289.5
47	4	9	7	16	158.2	342.5	5257.9	4.3	244.0	926.9	3	289.2
48	4	9	7	18	156.7	342.5	5258.1	3.7	243.3	498.1	4	288.6
49	4	9	7	20	156.5	343.2	5259.0	3.2	244.3	351.8	6	288.1
50	4	9	7	19	156.0	342.2	5257.9	3.5	243.7	417.1	5	288.3

Note: Meteorological conditions were extracted from grid point closest to plant site

APPENDIX F

CALMET/CALPUFF MODELLING FILES