



CONSULTING ENGINEERS
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FINAL REPORT

Air Quality Analysis for Potential Industrial Sites in the Regional District of Fraser Fort George, BC

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EXECUTIVE SUMMARY

RWDI AIR Inc. was retained to perform an air quality assessment of seven potential industrial sites being considered in the Regional District of Fraser-Fort George (RDFFG): Hart North, Shelley, Airport South, Willow Cale, Stoner, Clear Lake, and Isle Pierre. The primary objective of this study was to identify which of seven potential industrial sites would be least impacted from an air quality perspective by industrial development.

The study tasks included summarizing provincial and federal regulatory requirements for new facilities; gathering and processing meteorological and air quality data; dispersion modelling of seven prospective industrial sites; and review of best management practices for the types of facilities anticipated.

Several industries, under all three industrial classifications, may require an air permit based on the British Columbia (BC) Environmental Management Act Waste Discharge Regulation. These industries include industrial parts and equipment manufacture, repair and servicing, electronic components manufacture, wood products manufacture and processing, wood pellet production, petrochemical refineries and petroleum fuel storage facilities. Industries considered under the intermediate and heavy classifications may also require environmental assessments under the BC Environmental Assessment Act (BCEAA) and the Canadian Environmental Assessment Act (CEAA). Industries that potentially trigger environmental assessments under the BCEAA include the organic and inorganic chemical industry, primary metals industry, forest products industry and the petroleum and natural gas industry. Based on the CEAA, similar industries may also require a federal environmental assessment. These industries include oil and gas projects, the forestry industry and chemical products manufacturing. An environmental assessment under CEAA is triggered if a proposed project is listed in the Inclusion List Regulations, and a federal authority has exercised a duty or action in relation to the project. For example, an environmental assessment under CEAA is necessary if Transport Canada issues a permit under the Navigable Waters Protection Act to allow a new bridge to be built across a river.

An investigation into existing sources of background air quality and meteorological data in the RDFFG was performed. It was determined that since the industrial sites of Shelley, Airport South and Willow Cale are located relatively close to the Prince George Airport, meteorological observations collected at the airport by Environment Canada are representative of these three industrial sites. Furthermore, the BC Ministry of Forests operates a meteorological station within four kilometres of the Isle Pierre industrial site and could be used for baseline data. The

remaining industrial sites of Hart North, Clear Lake and Stoner are not located close to any meteorological stations. Currently, there are no ambient air quality observations available that would be considered representative of any of the industrial sites. However, the BC Ministry of Environment has plans to locate an air quality station that will measure PM_{10} and $PM_{2.5}$ near Clear Lake. Furthermore, RWDI was retained by the RDFFG to establish an air quality monitoring station near the Hart North industrial site. Once established, the Hart North air quality station will be capable of collecting site-specific measurements of air temperature, wind speed and direction, rainfall, relative humidity, barometric pressure, PM_{10} , $PM_{2.5}$, SO_2 and H_2S .

The CALMET/CALPUFF modelling system was employed to predict the maximum ambient concentrations of one generic pollutant representing all common air contaminants (CACs) of concern from three industrial classifications: light, intermediate and heavy industrial. The mix of emission sources was developed based on the RDFFG zoning bylaw and the Prince George Area Industrial Land Profile, considering target industries identified for the area by Initiatives Prince George.

To make comparisons of the seven industrial sites, the same mix of facilities and emission sources were modelled for the three industrial classifications. Three sites are being considered for light industrial operation: Shelley, Airport South and Willow Cale. Four sites are being considered for heavy industrial operation: Hart North, Stoner, Clear Lake and Isle Pierre. Six of the seven sites (excluding Airport South) are being considered for intermediate industrial operation; however, to fully compare the air dispersion characteristics between the seven potential sites, all seven sites were modelled for the intermediate industrial classification.

The industrial sites with the lowest air quality impact on Prince George, towns and residences were identified as follows:

- **Light Industrial Classification:** The one-hour and 24-hour isopleth plots for the Shelley site appear to result in the smallest concentration contours which translates to the least impacts to surrounding towns and residences. The Airport South site is located closer to the city of Prince George and nearby residences; however, it results in smaller concentration contours than the Willow Cale site. Therefore, Willow Cale is considered the least favourable light industrial site from an air quality perspective.
- **Intermediate Industrial Classification:** The one-hour and 24-hour isopleth plots show that the Clear Lake and Stoner sites appear to result in the lowest concentration contours and that dispersion tends to occur in a direction away from the nearest residences. The

isopleths plots for these sites also show the least impact on Prince George due to their distance from the city. The third most favourable intermediate industrial site from an air quality perspective is Isle Pierre as it is also located far from residences and it resulted in a small area of high predicted concentrations.

- **Heavy Industrial Classification:** The one-hour and 24-hour isopleth plots show that the Isle Pierre site seems to have the least impact on the City of Prince George and therefore is considered the most favourable heavy industrial site from an air quality perspective. Clear Lake is the next most favourable heavy industrial site followed by Hart North as they both have smaller contours and impact the City of Prince George and other residences less than Stoner.

This study involved simplified dispersion modelling to determine general dispersion characteristics from each of the seven potential industrial sites and did not consider more complex atmospheric processes, such as deposition and chemical transformation, and physical processes such as building downwash. In addition, modelling is based on typical emissions of one generic pollutant from a hypothetical mix of industrial facilities and emission sources for each industrial classification. Furthermore, this study followed a conservative approach as modelled emission rates were based on the maximum CAC emission rate as collected from Environment Canada's National Pollutant Release Inventory or other environmental assessment studies. A refined model assessment is recommended when more definitive plans are established.

Recommendations on best management practices are provided to minimize emissions and air quality impacts from the proposed industrial sites.

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1.0 INTRODUCTION

The Regional District of Fraser-Fort George (RDFFG) requires an air quality study to investigate the suitability of seven potential industrial areas for development. The motivation behind this study is largely driven by the need for additional industrial lands located near the City of Prince George and to aid developers of these lands by preparing in advance some of the necessary elements for an environmental assessment. RWDI AIR Inc. (RWDI) was retained to perform simplified dispersion modelling to investigate and compare the air quality impacts from each of the seven potential industrial sites. The primary objectives of the study are to identify the lowest impact areas for industrial development from an air quality perspective and to provide best management practices.

The scope of the study includes the collection and analysis of meteorological and air quality measurements as well as dispersion modelling at seven potential industrial sites. The data collected and model results will provide prospective industrial proponents with valuable background information that will aid in the environmental assessment of their proposed developments.

This report addresses the following five topics:

1. Research and summary of provincial and federal regulatory requirements (Section 2.0);
2. Gather and process meteorological data (Section 4.1);
3. Dispersion modelling for the seven prospective industrial sites (Section 4.2);
4. Review potential background air quality stations (Section 4.3);
5. Discussion of which of the seven potential industrial sites results in the lowest impact to the city of Prince George and surrounding residents (Section 5.0); and
6. Review of best management practices (Section 6.0).

2.0 REGULATORY REQUIREMENTS

A summary of the RDFFG zoning bylaw, permitting and other regulatory requirements that are relevant to the potential uses of the industrial sites are presented in this section.

2.1 REGIONAL DISTRICT OF FRASER-FORT GEORGE ZONING BYLAW

The RDFFG Zoning Bylaw No. 833 (RDFFG, 2009) was reviewed to determine the permitted uses of the potential industrial areas. While there are ten separate categories of industrial zones listed in the zoning bylaw, the potential industrial areas being considered will be general service/light industry (M2) or general resource/heavy industry (M3), based on discussions with the RDFFG. The permitted uses associated with these two industrial zones are listed in Table 2-1.

Table 2-1: Permitted Uses of Potential Industrial Areas

Service/Light Industry (M2)	Resource/Heavy Industry (M3)
• Farm, logging & trucking equipment repair and servicing • Industrial parts & equipment manufacture, repair and servicing • Electronic components manufacture • Card lock fuel sales • Works yard • Truck stop • Vehicle body work and mechanical repair • Storage/warehouse • Forestry complex • Single family residential	• Sawmill • Wood products manufacture and processing • Bulk fuel storage • Utility complex • Salvage/wrecking yard • Farm, logging & trucking equipment repair and servicing • Industrial parts & equipment manufacture, repair and servicing • Electronic components manufacture • Card lock fuel sales • Works yard • Truck stop • Vehicle body work and mechanical repair • Single family residential

Since there are no existing specific development proposals for the proposed industrial sites, this assessment considers a hypothetical mix of facilities for three industrial classifications (light, intermediate and heavy) based on the RDFFG Zoning Bylaw (Table 2-1) and the Prince George Area Industrial Land Profile provided by the RDFFG. Target industries for the area as recently identified by Initiatives Prince George were also considered in the development of the hypothetical facilities. The following table shows the list of hypothetical industries considered for each of the industrial site categories.

Table 2-2: Hypothetical Industries for Each Industrial Category

Industrial Category	Industry Types
Light	Semiconductor & Electronic Component Manufacturing
	Automotive Repair & Maintenance
	Warehouse/Storage
	Parking Lot
Intermediate	Industrial Machinery Manufacturing
	Ventilation, Heating and Air Conditioning Manufacturing
	Household Appliance Manufacturing
	Aerospace Products & Parts Manufacturing
	Wood Pellet Production
	Sawmill
	Veneer, Plywood & Wood Product Manufacturing
	Material Storage
	Parking Lot
Heavy	Ethylene and Polyethylene Production
	Petrochemical Refinery
	Petroleum Fuel Storage
	Pulp Mill
	Biomass Energy Production
	Aluminum Smelter
	Material Storage
	Parking Lot

2.2 PERMITTING REQUIREMENTS AND ENVIRONMENTAL ASSESSMENTS

New project developments can trigger a range of environmental regulatory requirements depending on the size of the project and potential emissions. There are two levels of government that could potentially regulate some aspect of a new industrial development:

- The Government of British Columbia through the BC Environmental Management Act [SBC 2003] Chapter 53 (BCEMA), Waste Discharge Regulation (WDR);
- The Government of British Columbia through the BC Environmental Assessment Act [SBC 2002] Chapter 43 (BCEAA); and,
- The Government of Canada through the Canadian Environmental Assessment Act, 1992, c. 37, C-15.2 (CEAA).

2.2.1 Provincial Government Requirements

Two potential acts that are relevant to permitting the industrial sites are discussed in this section: the BC Environmental Management Act and the BC Environmental Assessment Act.

2.2.1.1 *BC Environmental Management Act*

The **Environmental Management Act** and the **Waste Discharge Regulation** provide a three-tiered approach for discharges to the environment.

- Tier 1: Industries, trades, business operations or activities that fall into this tier are considered to be high risk to the environment and public health. These industries are listed in Schedule 1 of the WDR and require a waste discharge permit;
- Tier 2: Industries, trades, business operations or activities that fall into this tier are considered to be medium risk to the environment and are listed in Schedule 2 of the WDR. These dischargers should register under a code of practice or regulation if required by that code or regulation. If a code of practice or regulation has not been developed for that type of industry, a permit or approval is required.
- Tier 3: Industries, trades, business operations or activities not listed in either Schedule 1 or Schedule 2 of the WDR are considered low risk and do not require formal authorization to discharge waste. However, the discharges must not cause pollution or present a risk to public health.

The industries from Table 2-2 that may require an air permit under the Waste Discharge Regulation based on Schedules 1 and 2 are shown in Table 2-3.

Table 2-3: Industries Potentially Requiring a Permit under the WDR

Industry Type	Industrial Category	Risk Level
Electronic components manufacture	Light	High
Industrial parts & equipment manufacture, repair and servicing	Intermediate	High
Ozone depleting substances and other halocarbons management (e.g., air conditioning manufacture)	Intermediate	High
Wood pellet production	Intermediate	Medium or High
Sawmill	Intermediate	High
Veneer and plywood industry	Intermediate	High
Chemical and chemical products industry (e.g., ethylene and polyethylene production)	Heavy	High
Oil and natural gas industry (e.g., Petrochemical Refinery)	Heavy	Medium or High
Petroleum Fuel Storage	Heavy	Medium
Pulp Industry	Heavy	High
Incineration of wood residue (e.g., Biomass energy production)	Heavy	High
Aluminum industry	Heavy	High

It is recommended that facilities intending to discharge waste to the environment consult with the regional office of the BC Ministry of Environment (MOE) to confirm the authorization required. Certain activities before formal submission of the application should be completed to ensure all legal and technical requirements associated with the application process are addressed. These activities include:

- A pre-application meeting with the MOE to discuss the scope and detail of the application;
- Consultation with the public, agencies and stakeholders; and,

- A technical assessment, completed by a qualified professional, of the potential for the discharge to impact human health and the environment. A discussion with the regional office should be undertaken to determine the level of detail for the technical assessment.

After the application form is finalized, the public must be notified by posting a notice on-site, publishing a notice in a local newspaper, serving notice to the municipality and regional district. The application must also be published in the British Columbia Gazette, Part I. Any comments received from the public expressing concerns about the application must be addressed. A consultation report summarizing the comments from the public and agencies will be required for the application to be accepted.

For Tier 1 discharges, a detailed technical assessment is required. For Tier 2 discharges, where a code of practice or regulation is not in place, a technical assessment is generally not required. If a detailed technical assessment is required, it is recommended that a draft Terms of Reference be provided before initiating the assessment work. This will allow the MOE to provide guidance regarding the scope of assessment work required. The assessment should include details about the pollution prevention alternatives assessed, the source, volumes and characteristics of the waste.

Once pre-application activities have been completed, the application package (permit or approval application form, site plan, consultation report and technical assessment, if required) may be submitted to the MOE.

The codes of practice that may be applicable to the potential industries in the RDFFG include:

- Primary Wood Manufacturing Industry Code of Practice;
- Wood Residue Burner and Incinerator Regulation;
- Contaminated Sites Regulation;
- Ozone Depleting Substances and Other Halocarbons Regulation; and,
- Vehicle Dismantling and Recycling Industry Regulation.

2.2.1.2 BC Environmental Assessment Act

The Government of BC issues Environmental Assessment Certificates (EACs) under the BC Environmental Act (BCEAA). In BCEAA, a “**reviewable project**” means a project that is within a category of projects prescribed under Section 5 or that is designated by the minister under Section 6, and includes:

- (a) the facilities at the main site of the project,
- (b) any off-site facilities related to the project that the executive director or the minister may designate, and
- (c) any activities related to the project that the executive director or the minister may designate.”

A project designated as a reviewable project is one for which an EAC is required.

Section 5 of BCEAA states that it is up to the discretion of the Lieutenant Governor in Council to make regulations prescribing what constitutes a reviewable project. The Lieutenant Governor in Council may categorize projects according to size, production or storage capacity, timing, geographical location, potential for adverse effects, type of industry to which the projects are related, type of proponent or on any other basis that the Lieutenant Governor in Council considers appropriate.

Part 2 and **Part 4** of the **BC Reviewable Projects Regulation** [B.C. Reg. 370/2002] provides guidance on whether a proposed industrial project is reviewable. Several intermediate and heavy industrial industries modelled in this assessment would be considered reviewable.

Table 1 of **Part 2** lists reviewable projects from the Organic and Inorganic Chemical Industry. For the heavy industrial category, ethylene and polyethylene production may be considered to be a reviewable project under this section. For new facilities, if the production capacity is greater than 100,000 tonnes per year or if the produced materials are classified under the **Transportation of Dangerous Goods Act** and production is over 5,000 tonnes per year then the project is reviewable.

Table 2 of **Part 2** lists reviewable projects from the Primary Metals Industry. This includes primary smelting and refining of non-ferrous metals such as aluminum smelting which was one of the hypothetical industries for the heavy industrial classification. Regardless of the size of the facility, projects in the Primary Metals Industry are reviewable.

Table 4 of **Part 2** shows the reviewable projects from the Forest Products Industry. The intermediate and heavy industrial categories include facility types that require EACs. Pulp manufacturing facilities, regardless of size, including the pulp industry, newsprint industry and paperboard industry require EACs. The sawmill and planing mill products industry with a production capacity greater than 750,000 board feet per day require EACs. New facilities manufacturing plywood or both plywood and veneer with a production capacity greater than

170,000 m³ per year or facilities manufacturing veneer, but not plywood, with a capacity greater than 250,000 m³ per year require EACs.

Table 8 of **Part 4** lists petroleum and natural gas projects that are considered reviewable. These include new energy storage facilities with the capability to store an energy resource in a quantity that can yield greater than 3 petajoules (PJ) of energy by combustion. However, development or use of naturally occurring underground reservoirs for petroleum or natural gas storage is not reviewable if it is located in the Western Canadian Sedimentary Basin of northeast BC. New natural gas processing plant facilities that have a the design capacity to process natural gas at a rate of less than 5.634 million m³ per day and will result in more than 2 tonnes per day of sulphur emissions require EACs. New natural gas processing facilities that process more than 5.634 million m³ per day of natural gas will also require EACs.

Section 6 of BCEAA describes the Minister of the Environment's (the Minister) power to designate a project as reviewable. "Even though a project does not constitute a reviewable project under the regulations, the minister by order may designate the project as a reviewable project if:

- (a) the Minister is satisfied that the project may have a significant adverse environmental, economic, social, heritage or health effect, and that the designation is in the public interest, and
- (b) the Minister believes on reasonable grounds that the project is not substantially started at the time of the designation."

2.2.2 Federal Government Requirements

The **Canadian Environmental Assessment Act** (CEAA) is the legal basis for the federal environmental assessment process. The CEAA sets out the responsibilities and procedures for carrying out the environmental assessments of projects that involve federal government decision making. There are four questions that help determine whether an environmental assessment (EA) is required under the CEAA. They are outlined in the flow chart presented in Figure 2-1.

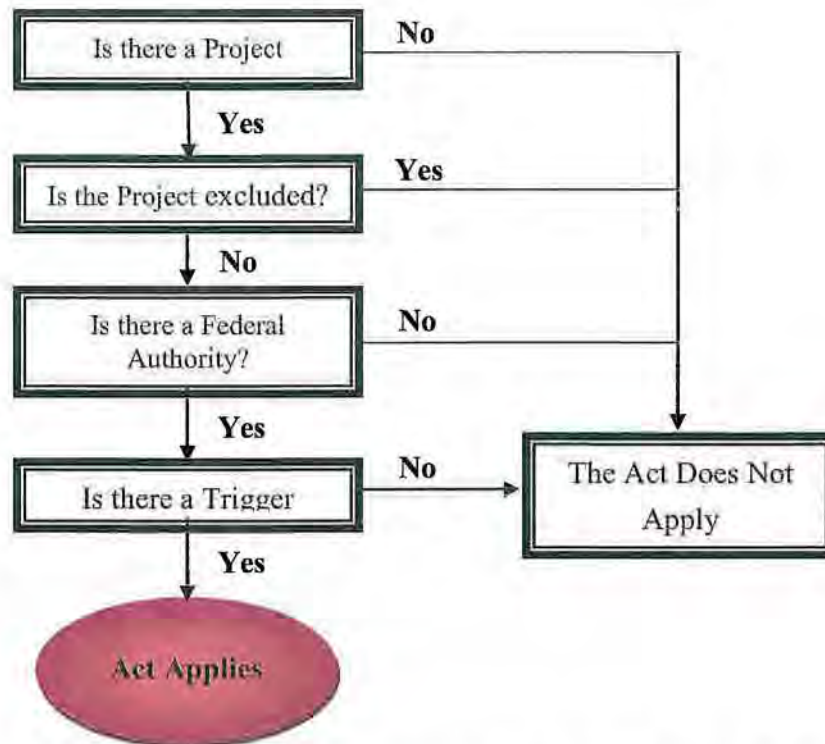


Figure 2-1: Flowchart to Determine Whether the CEAA Applies

The Act applies when all four of the criteria outlined in Figure 2-1 are met.

Criteria 1: Is There a Project?

Under CEAA subsection 2(1), a project is defined as:

- Any proposed undertaking in relation to a physical work; or
- Any proposed physical activity not relating to a physical work that is set out in the **Inclusion List Regulations**.

A “physical work” is defined as something that has been or will be constructed and has a fixed location, such as a bridge, building or pipeline. Therefore, an “undertaking in relation to physical work” includes the demolition of a bridge, the construction of a multi-lane highway or the modification and operation of a natural gas pipeline.

Proposed activity set out in the **Inclusion List Regulations** addresses the projects that have the potential for significant adverse environmental effects. Examples of activities set out in the Inclusion List Regulation that may be relevant to the proposed industrial sites are: harmful alteration, disruption or destruction of fish habitat; construction of drainage or the laying of pipes within the right-of-way of a railway line; and the remediation of contaminated land.

Criteria 2: Is The Project Excluded?

If the proposal meets the definition of a “project” under the CEAA, then the **Exclusion List Regulations** must be reviewed to determine if the project is exempt. A project is exempt from an EA if it is listed in the **Exclusion List Regulations**. Many of the exclusions are set by thresholds or conditions, such as distance to the nearest water body or size of building.

Criteria 3: Is There a Federal Authority?

Federal authorities are described as responsible authorities, expert federal authorities and the Canadian Environmental Assessment Agency. The CEAA defines “federal authority” in subsection 2(1) and refers to regulations made under the CEAA such as the **Federal Authorities Regulations** and to schedules I and II of the **Financial Administration Act**.

Examples of federal authorities are the Environment Canada, Minister of National Defence, Department of Fisheries and Oceans, Department of Natural Resources and the National Research Council of Canada.

Criteria 4: Is There a “Trigger”?

A trigger occurs when a federal authority exercises one or more of the following duties or actions in relation to a project:

- Proposes a project as its proponent;
- Grants money or other financial assistance to the proponent for the purpose of enabling a project to be carried out in whole or in part;
- Sells, leases or otherwise disposes of land or any interest in land to enable a project to be carried out in whole or in part; or,
- Exercises a regulatory function in relation to a project (such as issuing a permit or license) in accordance with a provision of a statute or regulation that is listed in the **Law List Regulations**.

For example, an EA would be triggered if Transport Canada issues a permit under section 5 of the **Navigable Waters Protection Act** to allow a new bridge to be built across a river. Another example is if Infrastructure Canada agrees to fund municipal infrastructure projects, but is not directly involved in the construction activities.

If it is determined that an environmental assessment is required under the CEAA, then the type of EA needs to be determined. There are two main types of study required by the Canadian Environmental Assessment Act (CEAA): a “screening” or a comprehensive study. A screening is defined as an environmental assessment that is conducted where a project is not described in the comprehensive study list or the exclusion list and includes consideration for community and aboriginal knowledge. Most projects are assessed relatively quickly under a screening type of environmental assessment. A screening systematically documents the anticipated environmental effects of a proposed project and determines the need to modify the project plan or recommend measures to mitigate the environmental effects. Comprehensive studies are conducted for large-scale, complex projects that are likely to have significant adverse environmental effects. Consequently, a comprehensive study is a more stringent type of environmental assessment than a screening. For example, public participation and implementation of a follow-up program are mandatory in a comprehensive study, whereas they are discretionary in a screening. Several facility types within the intermediate and heavy industrial classifications could trigger a comprehensive study based on the CEAA; others could trigger a screening assessment.

Part IV of the Schedule of the **Comprehensive Study List Regulations, P.C. 1994-1687 October 7, 1994**, entitled **Oil and Gas Projects**, indicates that the proposed construction of an oil refinery, including a heavy oil upgrader, with an input capacity of more than 10,000 m³/day (Section 13(a)) or a petroleum storage facility with a capacity of more than 500,000 m³ (Section 13(e)) requires a comprehensive study.

Part VII of the Schedule of the **Comprehensive Study List Regulations** entitled **Industrial Facilities**, states that the proposed construction of the following facilities requires a comprehensive study:

- Pulp mill or pulp and paper mill (Section 20);
- Facilities that manufacture chemical products with a production capacity of 250,000 t/a or more (Section 22(d));
- Facilities that manufacture wood products that are pressure-treated with chemical products, with a production capacity of 50,000 t/a or more (Section 22(f)); and,
- Facilities that manufacture plywood or particle board with a production capacity of 100,000 m³/a or more (Section 22(g)).

2.3 AMBIENT AIR QUALITY CRITERIA

Air quality criteria (objectives and standards) are developed by environmental and health authorities to provide guidance for environmental protection decisions. They are based on scientific studies that consider the effects of the contaminant on such receptors as humans, wildlife, vegetation, as well as aesthetic qualities such as visibility. They are used in environmental assessments to evaluate potential effects on air quality. Federal and provincial air quality objectives for common air contaminants are summarized in Table 2-4.

Particulate matter (PM) is often defined in terms of size fractions. Particles less than 40 μm in diameter typically remain suspended in the air for some time. Suspended PM less than 10 μm in diameter is termed PM_{10} and PM less than 2.5 μm in diameter is termed $\text{PM}_{2.5}$. Exposure to PM aggravates a number of respiratory illnesses and may even cause premature death in people with existing heart and lung disease. The smaller particles are generally thought to be of greater concern to human health than the larger particles.

Sulphur dioxide (SO_2) is produced primarily by the combustion of fossil fuels containing sulphur. Sulphur dioxide reacts in the atmosphere to form sulphuric acid, a major contributor to acid rain, and particulate sulphates, which can reduce visibility. Sulphur dioxide is irritating to the lungs and is frequently described as smelling of burning sulphur.

Nitrogen dioxide (NO_2) is produced when fossil fuels are burned at high temperatures. Nitrogen dioxide can also combine with other air contaminants to form fine particulates, which can reduce visibility. It can be further oxidized to form nitric acid, a component of acid rain. Nitrogen dioxide also plays a major role in the secondary formation of ozone. In humans, NO_2 acts as an irritant affecting the mucous membranes of the eyes, nose, throat, and respiratory tract. Continued exposure to NO_2 can irritate the lungs and lower resistance to respiratory infection, especially for people with pre-existing asthma and bronchitis.

In addition to these criteria air contaminants, industrial facilities may result in emissions of volatile organic compounds (VOCs). These represent a group of organic chemical compounds that under normal conditions have high enough vapour pressures to significantly vaporize and enter the atmosphere. There are currently no federal or provincial ambient air quality objectives for VOCs collectively, but individual species have been identified with various health and odour concerns.

Table 2-4: Federal and Provincial Ambient Air Quality Objectives and Standards for Common Air Contaminants

Contaminant	Averaging Period	Objectives/Standards (µg/m ³)						Canada-wide Standard
		Federal			British Columbia			
		Maximum Desirable	Maximum Acceptable	Maximum Tolerable	Level A	Level B	Level C	
PM ₁₀	24-hour	--			50			--
PM _{2.5}	24-hour	--			25 ^(a)			30 ^(b)
	Annual	--			8			--
SO ₂	1-hour	450	900	--	450	900	900-1,300	--
	24-hour	150	300	800	160	260	360	
	Annual	30	60	--	25	50	80	
NO ₂	1-hour	--	400	1000	--			--
	24-hour	--	200	300				
	Annual	60	100	--				

Notes: (a) Based on the 98th percentile value.

(b) Based on the annual 98th percentile value, averaged over three consecutive years.

3.0 STUDY AREA

An 80 km by 90 km study area was used for the air quality analysis. Encompassing the seven potential industrial sites and about 10 km on all sides of the industrial sites, this represents the area in which potential air quality effects from the industrial sites will most likely occur.

Figure 3-1 shows the topography of the study area along with the relative locations of the seven potential industrial sites, two of which are subdivided into multiple development areas. The Hart North industrial site is situated between the BC Rail line and Highway 97 approximately 30 km north-northeast of Prince George. The Shelley industrial site consists of two development areas located near the banks of the Fraser River just east of Shady Valley. Located just south of the Prince George Airport, the Airport South industrial site is the closest of the seven potential industrial sites to the City of Prince George. The Willow Cale industrial site is adjacent to the CN Railway about 10 km south-southeast of Prince George. The Stoner industrial site is situated on a bench near the town of Stoner. The Clear Lake industrial site encompasses the existing Clear Lake sawmill between Clear Lake and Nadsilich Lake. The Isle Pierre industrial site consists of three development areas situated along the Nechako River near Bednesti Lake.

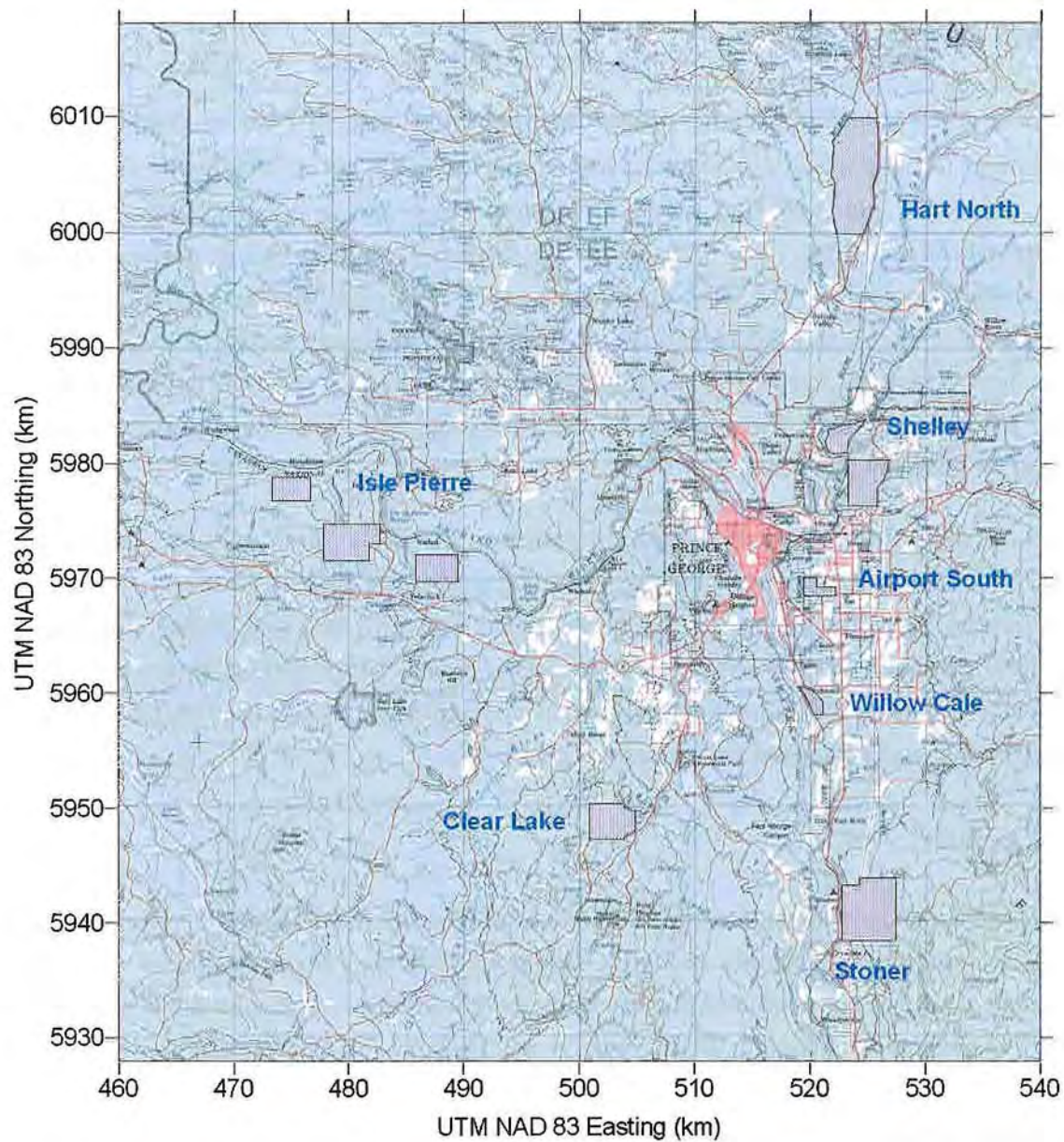


Figure 3-1: Topography of 80 km by 90 km Study Area with Locations of the Potential Industrial Sites

4.0 METHODOLOGY

The CALMET/CALPUFF modelling system was employed to predict the maximum ambient concentrations of one generic pollutant representing common air contaminants (CACs) of concern from three potential land uses: light, intermediate and heavy industrial. The CAC emissions considered in the study were particulate matter (PM₁₀ and PM_{2.5}), nitrogen dioxide (NO₂), sulphur dioxide (SO₂) and volatile organic compounds (VOCs). The CALMET meteorological model was used to develop three-dimensional hourly meteorological fields of wind and temperature for the study area. CALMET was used in conjunction with the CALPUFF air quality dispersion model to simulate the effects of time- and space-varying meteorological conditions on pollutant transport.

The University of Northern British Columbia (UNBC) has recently completed CALMET/CALPUFF dispersion modelling of the Prince George airshed for the Prince George Airshed Improvement Roundtable (PG AIR). PG AIR kindly provided the CALMET input files for use in this project. RWDI completed a third-party review of the dispersion modelling and made recommendations for improving the Prince George air quality study (RWDI 2009). These recommendations were followed in this assessment.

4.1 CALMET

The CALMET meteorological model assimilates observations from multiple meteorological stations and simulates the changes in mixing height and boundary layer mechanics that result from variable land use and terrain within the study area of interest. A general discussion of the CALMET model approach used in this air quality analysis is provided in this section.

4.1.1 Model Period

CALMET was initialized for the one-year period from January 1 to December 31, 2005. This represents the year for which a computer simulation of hourly wind patterns in the region was previously conducted for Metro Vancouver using the MM5 prognostic meteorological model. The inclusion of such prognostic meteorological model outputs in dispersion modelling increases the accuracy and currency of results.

4.1.2 Model Domain

The CALMET model domain was chosen to be an 84 km by 94 km area encompassing the 80 km by 90 km study area to allow for two kilometres of assimilated meteorology on all sides that could influence dispersion at the edge of the study area. Domain resolution was set at 500 m, giving 168 cells in the east-west direction and 188 cells in the north-south direction. In the vertical direction, 10 layers were chosen, with the top of each layer set as 20, 40, 80, 160, 300, 600, 1000, 1500, 2200 and 3000 m above ground level.

4.1.3 Surface Meteorology

The surface meteorological data compiled by UNBC, as revised in July 2009, was used as a starting point for this air quality analysis. The surface data compiled by UNBC includes six stations in the Prince George area:

- Plaza 400 surface station operated by the BC Ministry of Environment (BC MOE),
- Northwood surface station operated by BC MOE,
- Prince George Pulp surface station operated by BC MOE,
- Glenview School surface station operated by BCMOE,
- UNBC surface station operated by UNBC, and
- Prince George Airport surface station operated by Environment Canada.

To assimilate meteorological observations outside the Prince George airshed, two additional stations were included in this air quality analysis: the Bednesti surface station operated by the BC Ministry of Forests and the Tamarac surface station operated by the BC Ministry of Transportation. The relative locations of the eight surface stations are shown in Figure 4-1 as red crosses.

4.1.4 Upper Air Meteorology

The upper air meteorological file prepared by UNBC was reformatted and used as input to the CALMET model. The upper air meteorological file is based on twice-daily upper air sounding data at the Prince George Airport, with missing data filled in by interpolation of flights at the same time on adjacent days.

4.1.5 Terrain Elevation and Land Use Characterization

Terrain elevations, shown in Figure 4-1, were extracted from 1:50,000 scale Canadian Digital Elevation Data. The most prominent topographical features in the CALMET model domain are the Nechako, Chilako and Fraser River valleys. Baseline thematic mapping land use information was obtained from the Integrated Land Management Data Warehouse. Land use within the study area (see Figure 4-1) is relatively homogenous, with forested land covering the majority of the domain.

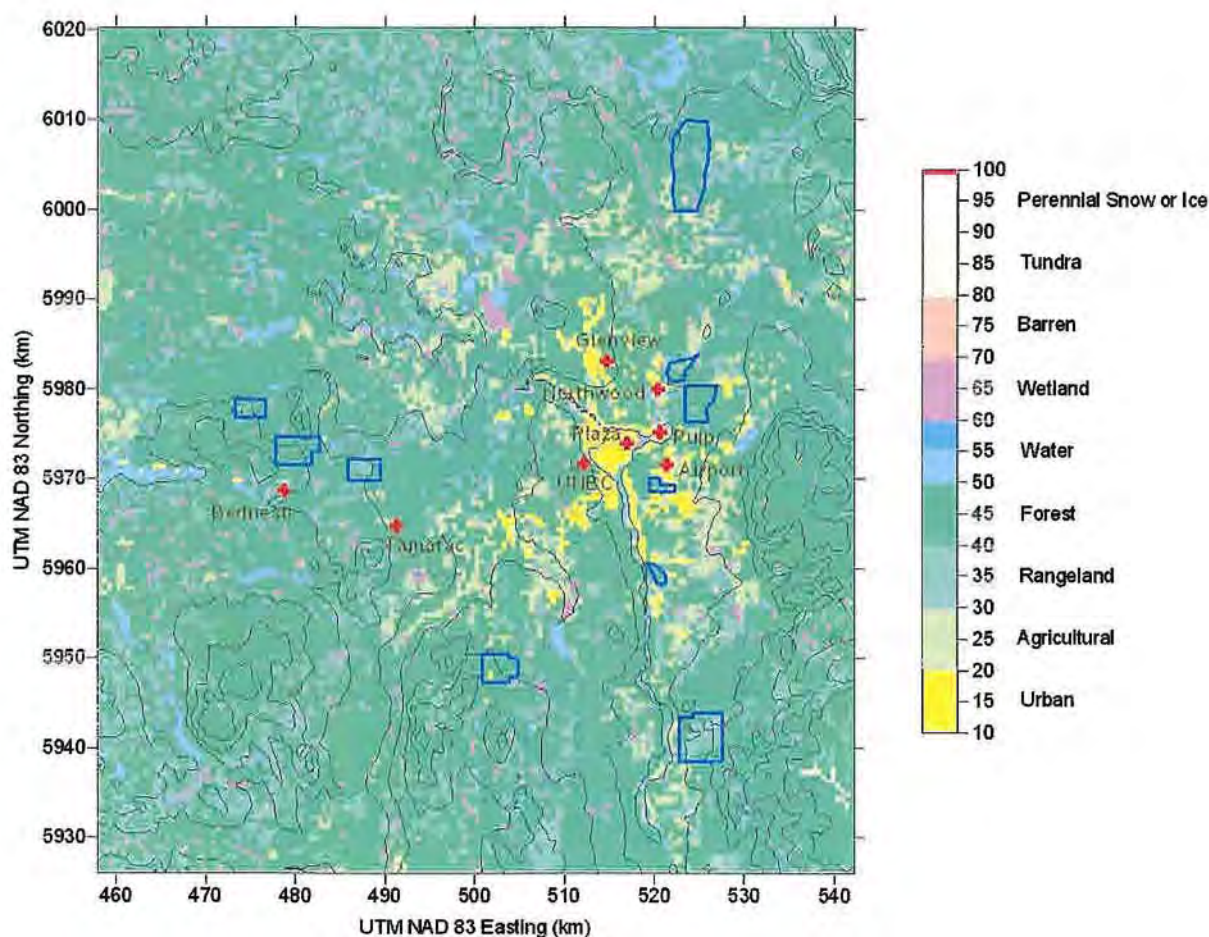


Figure 4-1: Variable Land Use and Terrain Elevations in CALMET Model Domain with Locations of Surface Stations Shown as Red Crosses

4.1.6 Geophysical Parameters

The CALMET model requires gridded geophysical parameters including surface roughness length, albedo, Bowen ratio, soil heat flux, vegetation leaf area index, and anthropogenic heat flux. To more accurately represent the seasonally dependent geophysical parameters in the CALMET model, five seasons were specified:

- Season 1: Mid-summer with lush vegetation (June to July);
- Season 2: Autumn with cropland that has not yet been harvested (August to September);
- Season 3: Winter with freezing temperatures, no snow on ground (February to March and October to November);
- Season 4: Winter with sub-freezing temperatures, snow cover on ground (December to January); and
- Season 5: Transitional spring with partially green short annuals (April to May).

All geophysical parameters were defined by land use type and seasonal category based on CALMET defaults in combination with recent studies (US EPA, 2008; Zhang et al., 2002 and 2003). A full listing of the geophysical parameters is included in Appendix A.

4.1.7 Model Options and User Switches

In general, the diagnostic model options were chosen in accordance with the *Guidelines for Air Quality Dispersion Modelling in BC* (BC MOE 2008) and other CALMET studies performed with similar meteorological data. User switch settings are included in Appendix A. Features of note include:

- The model was initialized using MM5 prognostic meteorological model output at a 36-km resolution.
- Surface observations were extrapolated upward. This was done using the option to invoke Monin-Obukhov similarity theory and is included to more accurately represent winds at lower levels in areas of complex terrain.

4.1.8 Results

The CALMET model simulation was assessed by reviewing various model outputs and, where possible, comparing to observations. These outputs include surface wind roses for various locations, CALMET-derived stabilities and mixing heights, and domain wind-vector plots under various stability and flow regimes.

Wind patterns vary between the seven potential industrial sites, as shown by the frequency distributions in Figure 4-2. The distributions are shown in a “wind rose” format, which is essentially a bar chart in a polar format. The direction of the bar indicates the direction from which the wind is blowing, the colour indicates the wind speed class and the length of the bar indicates the frequency of occurrence. At the Hart North industrial site, winds are predicted by CALMET to be predominantly along the east-west axis. At the Shelley and Airport South industrial sites, winds are most frequently from the south-southwest, following the alignment of the Fraser River valley. Winds are also affected by the orientation of the Fraser River valley at the Willow Cale and Stoner industrial sites, where winds are most frequently predicted from the south-southeast. At the Clear Lake and Isle Pierre industrial sites, winds are predicted by CALMET to be more variable, mostly blowing from the south-southeast to west.

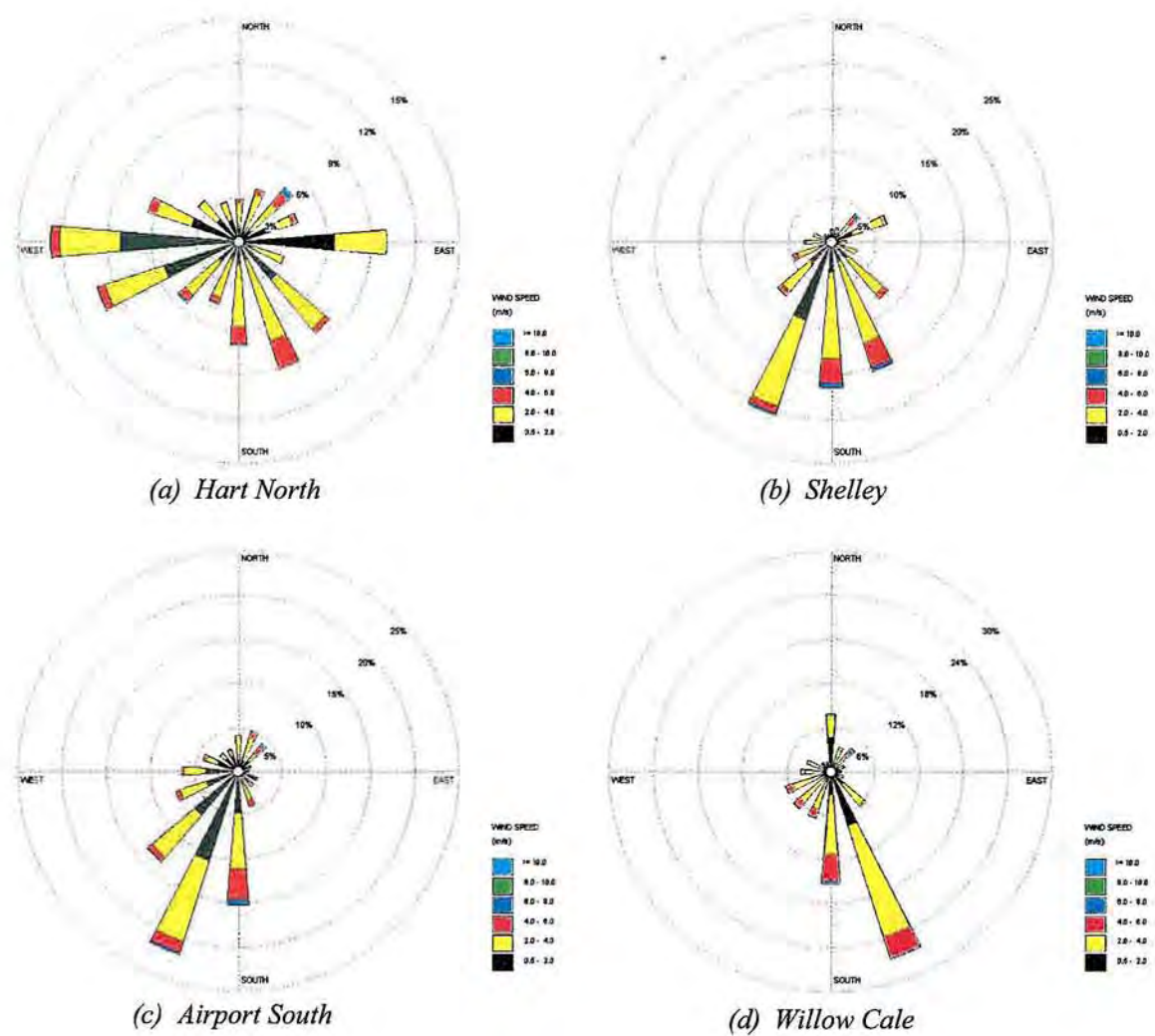


Figure 4-2: Wind Roses at the Potential Industrial Sites Based on CALMET Output

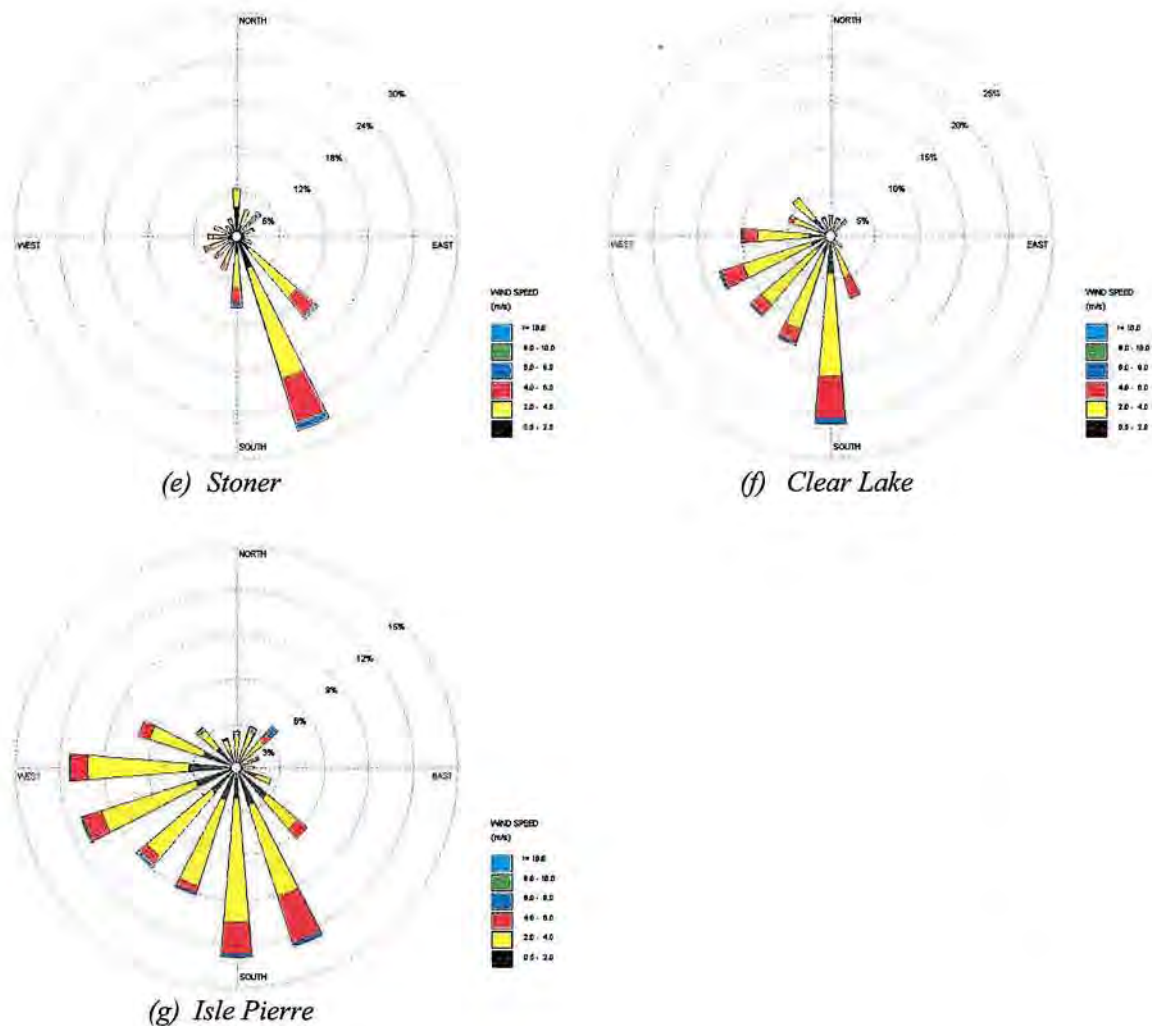


Figure 4-2: Wind Roses at the Potential Industrial Sites Based on CALMET Output (cont.)

The Pascal Gifford (PG) stability class scheme represents six levels of turbulence that can occur in the atmosphere. PG classes A, B and C are referred to as “unstable” and represent day-time periods when atmospheric turbulence is enhanced due to solar heating. PG classes E and F are referred to as “stable” and represent night-time periods when turbulence is suppressed due to surface cooling. PG class D (referred to as neutral) represents day- or night-time periods that are either overcast or characterized by high wind speed, mechanically dominated conditions. Table 4-1 shows the PG stability class frequency distributions predicted by CALMET at the potential industrial sites. PG classes D and F are the most frequently expected.

**Table 4-1: PG Stability Class Frequency Distribution at the Potential Industrial Sites
Based on CALMET Output**

Industrial Site	A	B	C	D	E	F
Hart North	0.2%	10.9%	17.9%	33.8%	10.3%	26.9%
Shelley	0.4%	10.5%	16.3%	37.9%	11.9%	23.0%
Airport South	0.5%	10.5%	18.1%	34.7%	7.8%	28.4%
Willow Cale	0.3%	9.4%	15.6%	39.3%	12.5%	22.8%
Stoner	0.4%	8.5%	15.7%	42.9%	11.4%	21.2%
Clear Lake	0.5%	9.4%	14.6%	44.4%	13.2%	18.0%
Isle Pierre	0.3%	10.0%	15.8%	39.3%	13.1%	21.5%

CALMET-derived wind vectors follow the expected terrain flows under various stability and flow regimes. Winds in the CALMET model domain, as illustrated by red arrows in Figure 4-3, tend to flow up-slope during unstable daytime conditions. Conversely, winds tend to flow down slope during stable night-time conditions. Under neutral conditions, the characteristic high winds create a more uniform field with less noticeable terrain effects.

The wind flow regimes shown in Figure 4-3 are presented to demonstrate that the CALMET model results appear to be reasonable and to illustrate wind regimes during typical unstable, neutral and stable stability conditions. These figures represent a snapshot in time and do not represent annual average conditions.

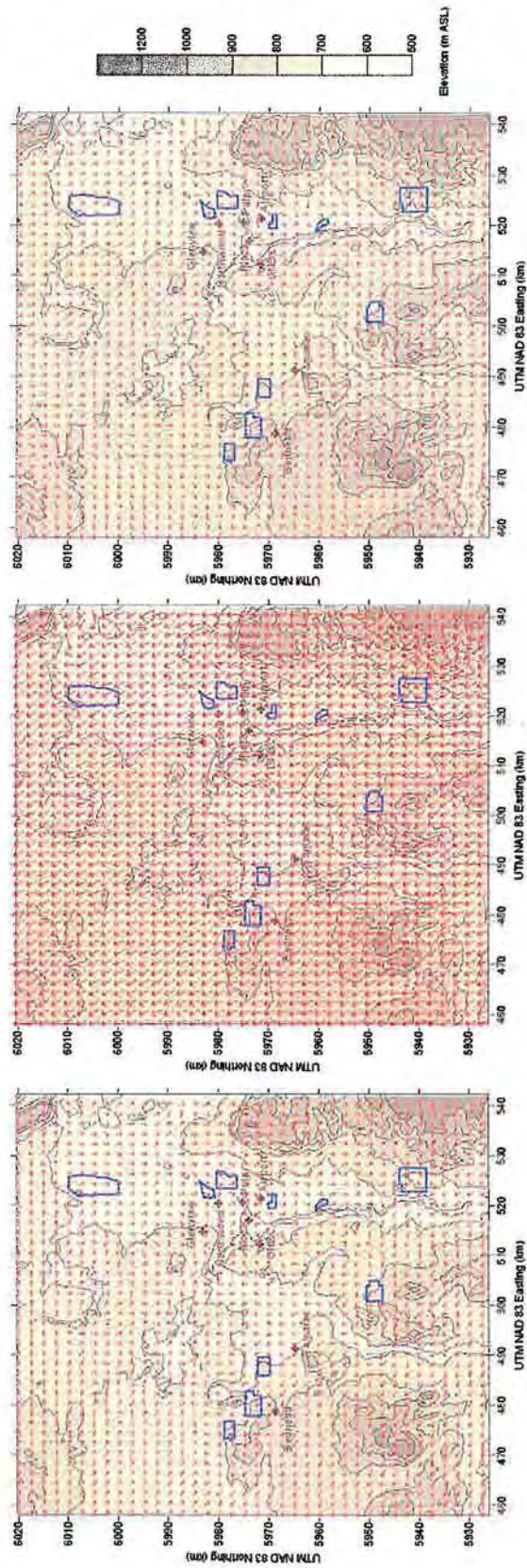


Figure 4-3: CALMET Surface Vector Wind Fields during Typical Unstable, Neutral and Stable Conditions

4.2 CALPUFF

The CALPUFF dispersion model was used with the three-dimensional meteorological fields output by CALMET to predict the maximum expected concentrations due to CAC emissions from the seven industrial sites. Since the seven industrial sites will range in size and operations, three industrial classifications were considered: light, intermediate and heavy. For the purpose of comparing the various industrial sites within each classification, the same mix of industrial source emissions was considered for each site.

The following ranges of industrial classifications are being proposed for the seven potential industrial sites, as indicated by RDFFG:

- Hart North: Intermediate to Heavy;
- Shelley: Light to Intermediate;
- Airport South: Light;
- Willow Cale: Light to Intermediate;
- Stoner: Intermediate to Heavy;
- Clear Lake: Intermediate to Heavy; and,
- Isle Pierre: Intermediate to Heavy.

Each industrial site was modelled according to these industrial classification(s). For instance, Hart North was modelled for the intermediate and heavy industrial classifications, but not the light industrial classification. The only exception is Airport South which was modelled for the intermediate industrial classification as well as the light industrial classification for which it is being proposed. Modelling all seven sites with the intermediate classification allows a direct comparison of the dispersion characteristics of all sites.

4.2.1 Model Domain

The CALPUFF model domain was defined as 80 km by 90 km shown in Figure 3-1. This area is contained within the CALMET model domain boundaries and represents the area in which potential air quality effects from the seven industrial sites are likely to occur. The coordinates of the domain vertices are given in Table 4-2.

Table 4-2: Coordinates of CALPUFF Model Domain (All Coordinates are for NAD 83 Grid Zone 10)

Domain Vertex	UTM Easting (km)	UTM Northing (km)
Southwest	460.0	5928.0
Northwest	460.0	6018.0
Southeast	540.0	5928.0
Northeast	540.0	6018.0

4.2.2 Receptor Locations

A Cartesian grid of discrete receptors contained within the CALPUFF model boundaries was applied with the following receptor spacing:

- 500-m spacing for a 14 by 14 km area encompassing the City of Prince George; and
- 1-km spacing for the remainder of the 80 by 90 km study area.

A fine receptor grid (500-m) spacing was applied to the City of Prince George since the main concern of this study is the potential of air emissions from the industrial sites to impact air quality in Prince George and surrounding residences. To avoid erroneous results, receptors generated from the Cartesian grid described above located within the assumed facility layout in which the hypothetical mix of industrial source emissions is located (see Section 4.2.5), were removed from the dispersion model assessment. This resulted in the removal of one receptor located within the Stoner industrial site for the intermediate and heavy industrial classifications. Receptor locations are shown in Figure 4-4 for the light industrial classification. Terrain elevations for the receptors were extracted from 1:50,000 scale Canadian Digital Elevation Data, also used in the CALMET modelling.

4.2.3 Pollutants Modelled

A generic pollutant was modelled. Its emission rate was set equal to the highest CAC (PM₁₀, PM_{2.5}, NO_x, SO₂ or VOCs) emission rate from each emission source considered in the assessment. Further details regarding this approach are provided in Section 4.2.5.

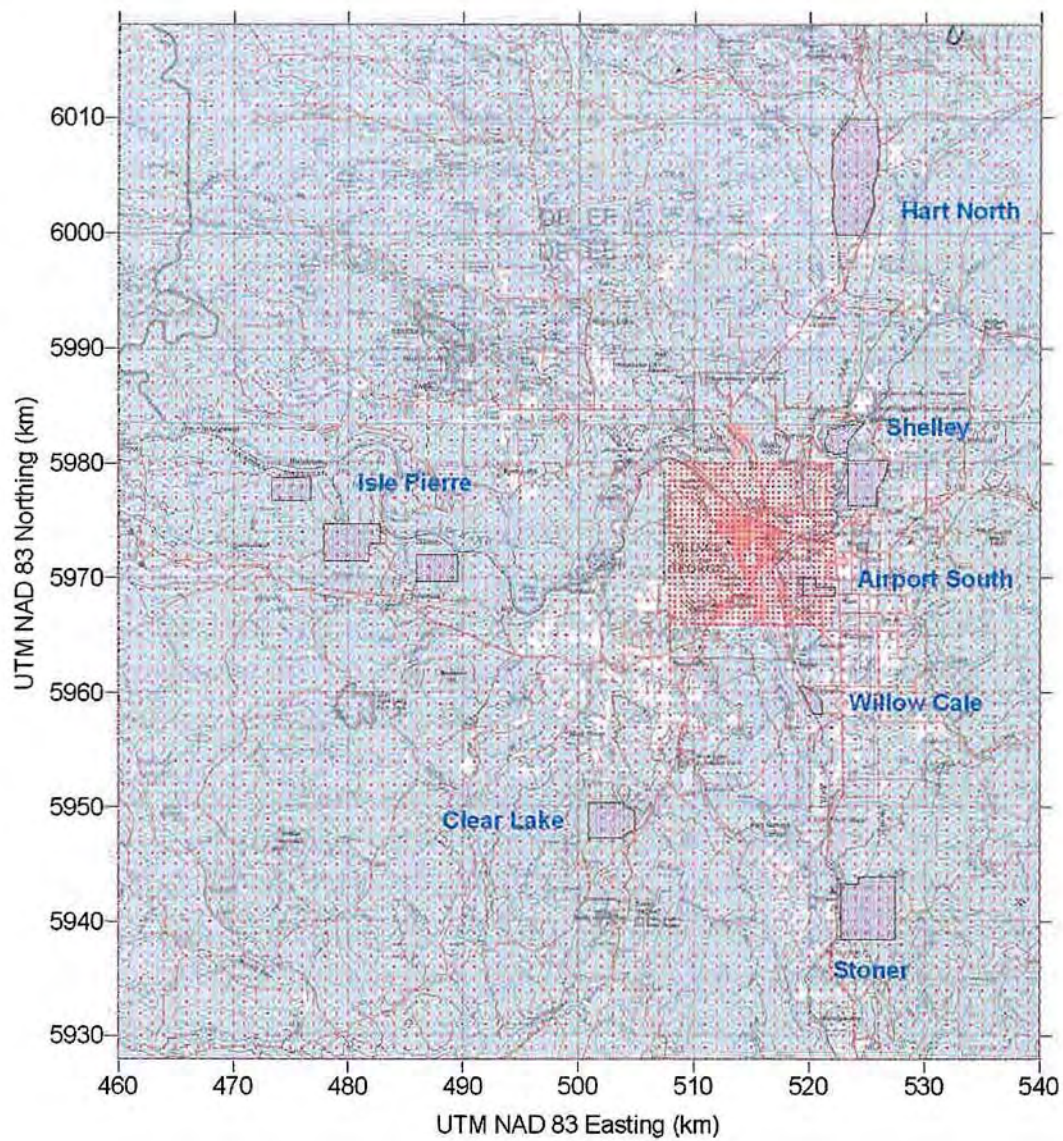


Figure 4-4: Location of Receptors Used for Dispersion Modelling

4.2.4 Technical Dispersion Options

All technical options relating to the CALPUFF dispersion model were set according to the *Guidelines for Air Quality Dispersion Modelling in BC* (BC MOE 2008) or to the model defaults. These include parameters and options such as the calculation of plume dispersion coefficients, the plume path coefficients used for terrain adjustments, exponents for the wind speed profile, and wind speed categories. Building downwash effects were not included for this study. A list of the technical options is provided in Appendix B.

4.2.5 Source Characterization

Since there are no existing specific development proposals for the proposed industrial sites, this assessment considers a hypothetical mix of facilities for the three industrial classifications based on the RDFFG Zoning Bylaw (see Section 2.2) and the Prince George Area Industrial Land Profile provided by the RDFFG. Target industries for the area as recently identified by Initiatives Prince George were also considered in the development of the hypothetical facilities.

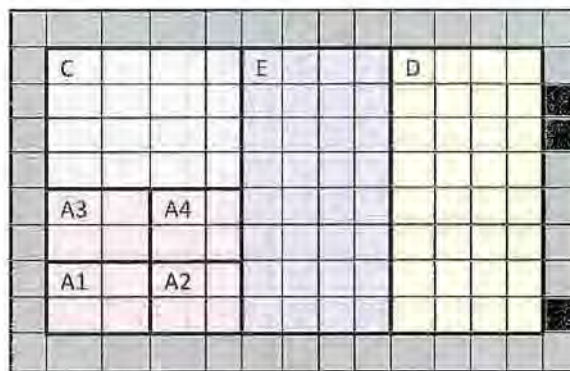
Emissions of PM₁₀, PM_{2.5}, NO_x, SO₂ and VOCs were estimated for common sources at each of the hypothetical facilities based on 2007 annual emissions of select representative facilities as reported to Environment Canada's National Pollutant Release Inventory (NPRI), or based on environmental assessment studies of representative proposed facilities. Road dust emissions generated by public, employee, service and delivery vehicles in unpaved parking lots were also considered. A generic pollutant emission rate was determined for each emission source and used in the dispersion modelling.

Table 4-3 shows an example of the average emission rates collected based on NPRI data and other environmental assessments for the light industrial category. The generic pollutant emission rate was set equal to the highest CAC emission rate for each emission source; these values are highlighted in red in the table. For example, the emission rate used for modelling parking lots in the light industrial classification is the PM₁₀ emission rate of 0.03 g/s whereas the VOC emission rate was used to model automotive repair and maintenance facility emissions. Thus, the generic pollutant assessed in the modelling represents a combination of emissions regardless of the CAC.

The same facility layout (illustrated in Figure 4-5 for the light industrial category) was assumed no matter what the shape or size of the potential site. Industrial machinery and electronics manufacturing facilities were based on a 400 m² (20 by 20 m) plot since the maximum area for such facilities is 450 m² according to the RDFFG Zoning Bylaw. Plot areas for all other

facilities were assumed based on previous project experience. For light industrial, a total plot size of 140 m by 100 m was assumed. Facility IDs A1 to D in Figure 4-5 can be cross-referenced to the sources listed in Table 4-3. The raster sizes for intermediate and heavy industrial areas are 280 m by 240 m and 750 m by 600 m, respectively. A summary of all CAC emission rates used for modelling is provided in Table 4-4.

Figure 4-5: Example Facility Raster for the Light Industrial Category



*Notes: Light industrial raster size is assumed to be 140 m by 100 m (1 cell = 10 metres)
Facility identifications A1 to D correspond to sources listed in Table 4-3.*

Material stockpiles, storage tanks and parking lots were modelled as area sources in CALPUFF. All other sources were modelled as point sources. Source parameters were determined based on stack information reported to NPRI, or based on previous experience with similar facilities.

Table 4-3: Selection of CAC Emission Rates for Light Industrial Dispersion Modelling

Facility ID	Facility Type	Source	Pollutant Emission Rate (g/s)				
			PM ₁₀	PM _{2.5}	NO _x	SO ₂	VOC
A1	Electronics Manufacturing	Solvent exhaust	0.00	0.00	0.00	0.00	0.3
A2	Electronics Manufacturing	Solvent exhaust	0.00	0.00	0.00	0.00	0.3
A3	Electronics Manufacturing	Solvent exhaust	0.00	0.00	0.00	0.00	0.3
A4	Electronics Manufacturing	Solvent exhaust	0.00	0.00	0.00	0.00	0.3
C	Automotive Repair & Maintenance	Solvent exhaust	0.1	0.08	0.00	0.00	7.0
D	Warehouse/Storage	Building exhaust	0.2	0.07	0.00	0.00	0.00
		Outside stockpile	0.8	0.1	-	-	-
E	Parking Lot	Road dust	0.03	0.003	-	-	-

Note: CAC emissions highlighted in red were used for dispersion modelling for the light industrial category.

Table 4-4: Summary of CAC Emission Rates for Dispersion Modeling

Facility Type	Number of Facilities	Source	Source Type	Modelled Emission Rate (g/s)	CAC With Highest Emission Rate
<i>Light Industrial</i>					
Semiconductor & Electronic Component Manufacturing ^(a)	4	Solvent exhaust	Point	0.3	VOCs
Automotive Repair & Maintenance	1	Solvent exhaust	Point	7.0	VOCs
Warehouse/Storage	1	General building ventilation	Point	0.2	PM ₁₀
		Stockpile	Area	0.8	PM ₁₀
Parking Lot	1	Road dust	Area	0.03	PM ₁₀
<i>Intermediate Industrial</i>					
Industrial Machinery Manufacturing ^(b)	4	General building ventilation	Point	0.4	VOCs
Ventilation, Heating and Air Conditioning Manufacturing	2	General building ventilation	Point	0.6	VOCs
Household Appliance Manufacturing	1	General building ventilation	Point	0.1	NO _x
Aerospace Products & Parts Manufacturing	1	General building ventilation	Point	0.5	VOCs
Wood Pellet Production	1	Dryer	Point	0.4	PM ₁₀
Sawmill	1	Heater/Boiler	Point	12.0	VOCs
Veneer, Plywood & Wood Product Manufacturing	1	Press/Dryer	Point	1.5	VOCs
Material Storage	1	Stockpile	Area	0.8	PM ₁₀
Parking Lot	1	Road dust	Area	0.07	PM ₁₀

Table 4-4: Summary of CAC Emission Rates for Dispersion Modelling, cont.

Facility Type	Number of Facilities	Source	Source Type	Modelled Emission Rate (g/s)	CAC With Highest Emission Rate
<i>Heavy Industrial</i>					
Ethylene and Polyethylene Production	1	Furnace	Point	13.0	NO _x
		Flare	Point	13.0	NO _x
Petrochemical Refinery	1	Process heaters	Point	6.0	NO _x and SO ₂
		Cooling tower	Point	0.4	PM ₁₀
		Flare	Point	6.0	NO _x and SO ₂
Petroleum Fuel Storage	1	Storage tanks	Area	2.5	VOCs
Pulp Mill	1	Power boiler	Point	9.0	NO _x
		Recovery boiler	Point	9.0	NO _x
		Lime kiln	Point	2.0	NO _x
		Smelt tank	Point	4.0	VOCs
Biomass Energy Production	1	Boiler	Point	45.0	NO _x
Aluminum Smelter	1	Calciner/Roaster	Point	1200.0	SO ₂
Material Storage	2	Stockpile	Area	0.8	PM ₁₀
Parking Lot	3	Road dust	Area	0.1 to 0.2	PM ₁₀

Notes: (a) May be representative of facilities such as those used for the production of solar photovoltaic cells, wind turbine electrical components, etc.

(b) May be representative of facilities such as those used for the production of solar thermal systems, wind turbine structural components, etc.

4.3 BACKGROUND AIR QUALITY

An investigation into existing measurements of air quality and meteorology in the RDFFG was performed and several sources were identified as potentially representative of the industrial sites. Table 4-5 lists the names of meteorological or air quality stations that could be used for baseline data for each proposed industrial site.

Table 4-5: Meteorological or Air Quality Stations Relevant to the Proposed Industrial Sites

Site No	Industrial Site	Parameter measured			
		Meteorology	PM ₁₀ and PM _{2.5}	SO ₂	H ₂ S
1	Hart North		-	-	-
2	Shelley #2	EC: PG Airport	-	-	-
3	PG Airport South	EC: PG Airport	-	-	-
4	Willow Cale Road	EC: PG Airport	-	-	-
5	Isle Pierre	MOF: Bednesti	-	-	-
6	Clear Lake	-	MOE: Baldy Hughes	-	-
7	Stoner	-	-	-	-

Note: Environment Canada is abbreviated as EC, Ministry of Environment is abbreviated as MOE and Ministry of Forests is abbreviated as MOF.

There are no air quality or meteorology stations near the proposed Hart North industrial site. Therefore, since this site is of high importance to the RDFFG, the RDFFG has retained RWDI to establish an air quality station at this site. Once established, the air quality station will be capable of collecting site-specific measurements of air temperature, wind speed and direction, rainfall, relative humidity, barometric pressure, PM₁₀, PM_{2.5}, SO₂ and H₂S. It is proposed that one year of measurements be collected at this site.

Shelley, Airport South and Willow Cale industrial sites are all relatively close to the Prince George Airport. The meteorological station at the airport operated by Environment Canada (EC) is well suited to represent these three industrial sites. Therefore, further observation of meteorology is not needed. However, it will be necessary to monitor PM₁₀ and PM_{2.5} if background measurements are desired. It is proposed that one station located near the airport

could be representative of all three sites. It is thought that measurements of SO₂ and H₂S are not needed at this station since it is unlikely that light or intermediate industrial sites will have high emissions of these pollutants.

The BC Ministry of Forests (MOF) operates a meteorological station within four kilometres of the Isle Pierre industrial site. Observations taken at the BC MOF site would be representative of Isle Pierre and further observation of meteorology is not needed. However, it will be necessary to monitor PM₁₀, PM_{2.5}, SO₂ and H₂S if background air quality measurements are desired.

The BC Ministry of Environment (MOE) plans to locate an air quality station that will measure PM₁₀ and PM_{2.5} near Clear Lake. These measurements are expected to be representative of baseline air quality for the Clear Lake industrial site. The BC MOE has commented that it would be favourable to install a meteorological station near the air quality station. Ideally, passive SO₂ and H₂S measurement should be installed at this site as well.

There are no air quality stations near the Stoner industrial site. Therefore, if site-specific information is desired at this location then an air quality station will need to be established in this area. The air quality station should measure meteorology, PM₁₀, PM_{2.5}, SO₂ and H₂S.

After further discussions with the BC MOE, it was determined that the two RWDI operated air quality stations in the Regional District would not be representative of any of the proposed industrial sites. It was thought by the BC MOE that the station located at Giscome owned by Graymont is too far from the Hart North site and therefore would not be a representative site. Furthermore, the Pinnacle Pellet air quality station located near Cinema is too far south of the Stoner industrial site to be a good background station for Stoner.

4.4 MODEL OUTPUT INTERPRETATION

Maximum concentrations of the generic pollutant modelled in CALPUFF were predicted for each model run at each receptor. These maximum concentrations refer to a mix of the CACs considered and therefore cannot directly be compared to ambient air quality objectives. Furthermore, model results are based on the expected emissions from a hypothetical mix of industrial facilities and emission sources within each industrial classification that may not be representative of actual facilities that may be proposed for the industrial sites. As discussed in Section 2.0, specific modelling may be required by the BC MOE to obtain environmental approvals for industrial proposals depending upon their size and level of emissions.

Since a generic pollutant was modelled in CALPUFF, it was not possible to consider deposition and/or chemical transformation effects. These processes will play different roles in affecting the predicted ambient concentrations, depending on the pollutant. Particulates, particularly those of the larger size fractions, tend to re-deposit on the ground within several hundred metres of their release. NO_x emissions from facility exhaust stacks are comprised of nitric oxide (NO) and NO_2 . The primary emission is in the form of NO with reactions in the stack and atmosphere resulting in the conversion of NO to NO_2 . The final ambient concentrations of NO_2 , on which ambient air quality objectives are based, depend on the background NO_x and ozone levels in the area. Furthermore, SO_2 and NO_x species undergo chemical transformations in the atmosphere to form secondary particulates. The simplified CALPUFF dispersion modelling performed for this assessment does not consider these various processes and only considers the dispersion of the emitted species in the atmosphere.

5.0 RESULTS

Maximum concentrations of the generic pollutant were predicted for the light, intermediate and heavy industrial classifications. Plots showing pollutant concentration contours (isopleths) were produced for one-hour and 24-hour average results as these are the most common averaging periods for ambient air quality objectives. Note that each site was only modelled for the industrial classifications for which they are proposed, with the exception of Airport South which was modelled for the intermediate industrial classification as well as the light industrial classification (see Section 4.2).

5.1 LIGHT INDUSTRIAL

The results of dispersion modelling of the generic pollutant emissions for the three potential sites representing the light industrial classification (Shelley, Airport South and Willow Cale) are presented in the form of isopleth maps showing contours of constant concentration.

Figure 5-1 shows the maximum predicted one-hour average results for the light industrial sites. The isopleths predicted for the Shelley and Airport South industrial sites cover smaller areas than the isopleths predicted for Willow Cale. Furthermore, the predicted area of impact for Willow Cale encompasses the community of Buckhorn.

Figure 5-2 shows the maximum predicted 24-hour average results for the light industrial sites. As with the one-hour plots, the largest concentration contours are predicted for the Willow Cale site. Shelley and Airport South have similar sizes of contour plots.

Differences in the spatial distribution of predicted impacts between the three industrial sites are most likely due to differences in terrain in the vicinity of the sites. The Willow Cale industrial site is located in a narrow valley and therefore plumes from this site are likely to impact elevated terrain on either side of the valley. The Shelley and Airport South industrial sites, on the other hand, are located on a plateau on the east side of the valley. Therefore plumes from these sites are likely to impact elevated terrain on the east, and flow over the valley on the west.

The potential light industrial site with the least impact on the city of Prince George, surrounding towns and residences overall is Shelley. Shelley appears to result in the smallest concentration contours based on the one-hour and 24-hour modelling results, is located the furthest from Prince George, and situated in an area in which there are few residences in its immediate vicinity.

Although Airport South also has small contours compared to Willow Cale, it is located closer to the city of Prince George and surrounding residences; therefore, Airport South is the second most favourable light industrial site from an air quality perspective.

Willow Cale impacts fewer residents than Airport South; however, it has the largest concentration contours. Therefore, it is the least favourable light industrial site from an air quality perspective.

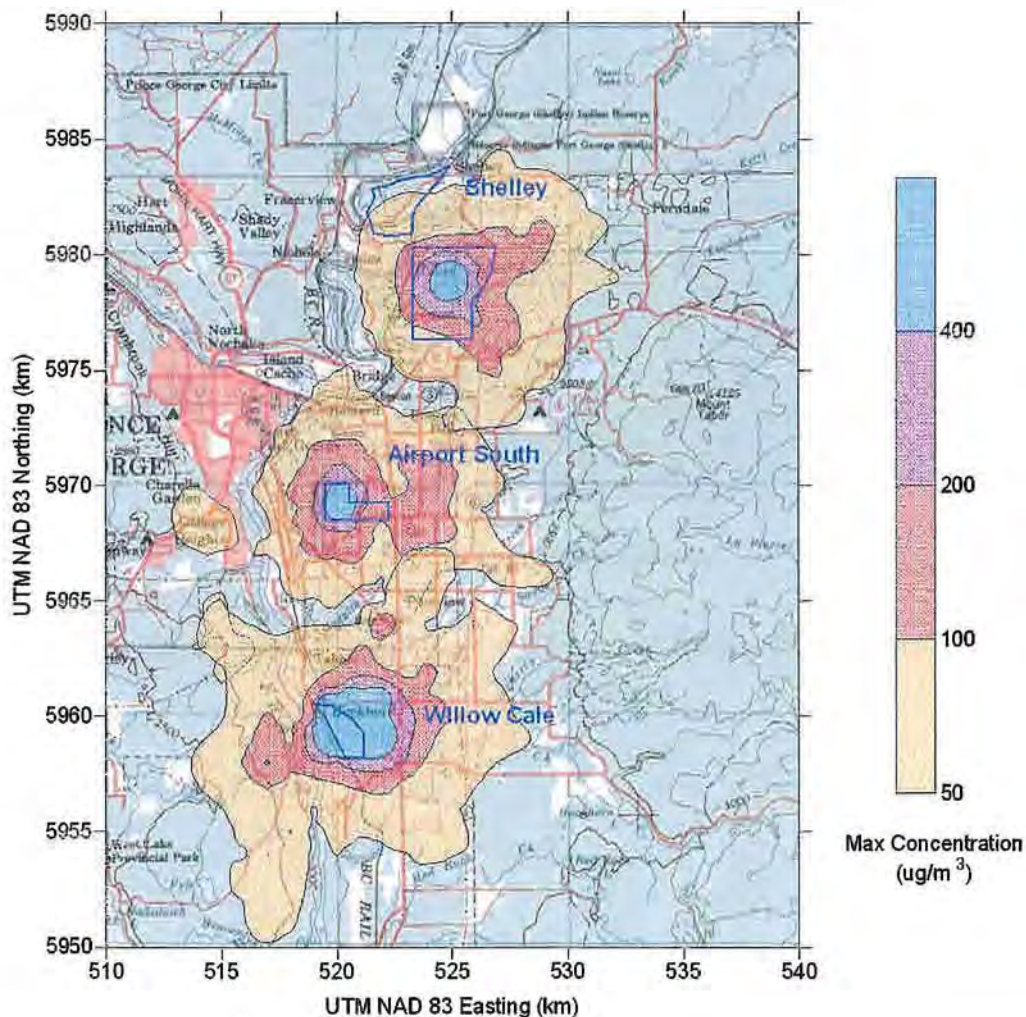


Figure 5-1: Maximum Predicted One-hour Generic Pollutant Concentrations for Potential Light Industrial Sites

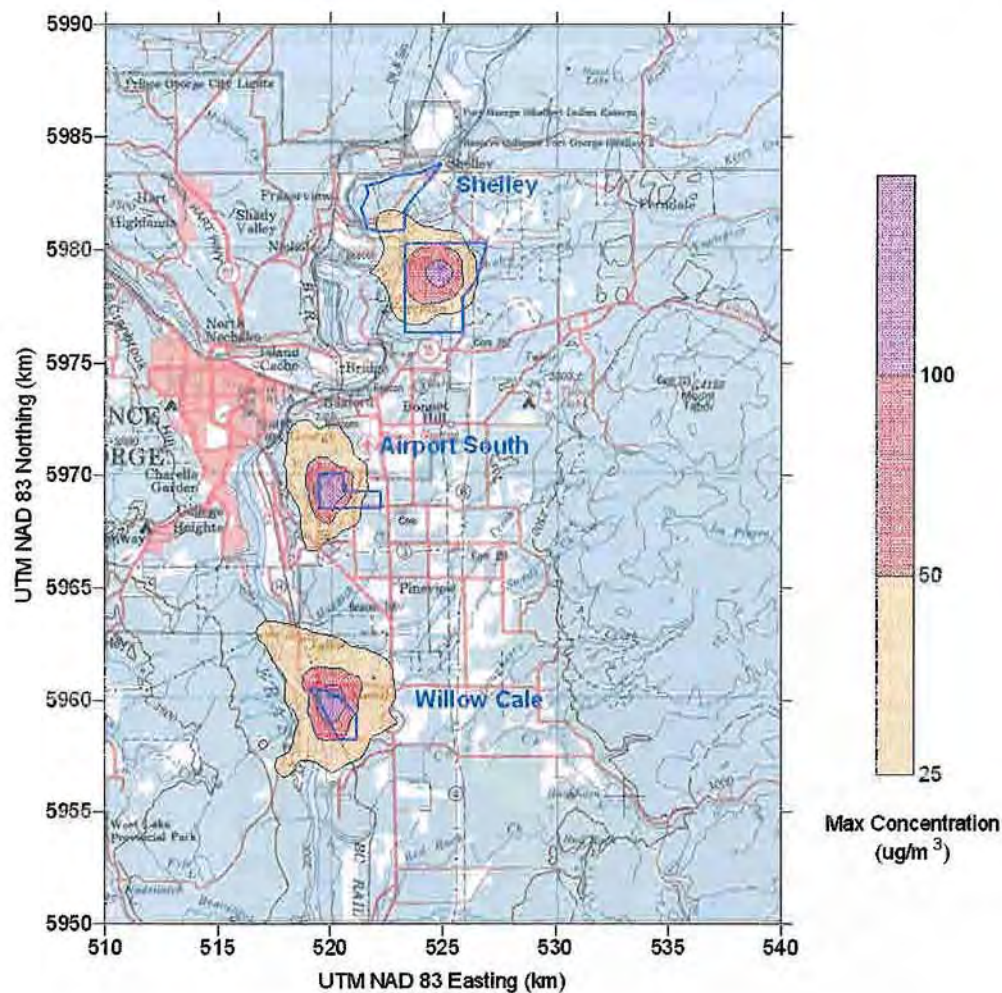


Figure 5-2: Maximum Predicted 24-hour Generic Pollutant Concentrations for Potential Light Industrial Sites

5.2 INTERMEDIATE INDUSTRIAL

The results of dispersion modelling for all seven potential sites representing the intermediate industrial classification are presented in the form of isopleth maps showing contours of constant concentration.

Compared to the isopleths maps for the light industrial classification (Figure 5-1 and Figure 5-2), the isopleths maps for the intermediate industrial classification illustrated in Figure 5-3 and Figure 5-4 appear to show smaller concentration contours at Shelley, Airport South and Willow Cale. As shown in Table 4-4, the intermediate industrial classification is associated with more industrial facilities and higher CAC emission rates. However, facilities in the intermediate industrial classification tend to be larger and have higher stack heights designed to disperse the exhaust gas. As a result, the predicted air quality impacts for the intermediate industrial classification may be less than those for the light industrial classification despite the greater emissions.

Figure 5-3 shows the maximum predicted one-hour average results for the intermediate industrial sites. Isle Pierre seems to have the smallest concentration contours compared to the isopleths for the other six industrial sites. Isle Pierre has a small $200 \mu\text{g}/\text{m}^3$ concentration contour and an even smaller $400 \mu\text{g}/\text{m}^3$ concentration contour. The concentration contours for the Stoner and Clear Lake sites are similar in size and both do not have a $400 \mu\text{g}/\text{m}^3$ concentration contour. Hart North has one of the larger $400 \mu\text{g}/\text{m}^3$ concentration contours. Airport South seems to have similar sized $400 \mu\text{g}/\text{m}^3$ concentration contour as Hart North and is located closer to the city of Prince George and nearby residences. Willow Cale has larger concentration contours than Shelley and there is an extra $100 \mu\text{g}/\text{m}^3$ concentration contour that is separated to the southwest of the industrial site.

Figure 5-4 shows the maximum predicted 24-hour average results for the proposed intermediate industrial sites. The $25 \mu\text{g}/\text{m}^3$ isopleths for Airport South, Shelley and Willow Cale are similar in size and smaller compared to the other four isopleths but they have higher predicted concentrations than Clear Lake and Stoner, which do not have a $100 \mu\text{g}/\text{m}^3$ isopleth. As with the one-hour plot, Willow Cale has an additional $25 \mu\text{g}/\text{m}^3$ concentration contour that is separated to the southwest of the industrial site. Isle Pierre has smaller $25 \mu\text{g}/\text{m}^3$ concentration contours than Clear Lake and Stoner; however Isle Pierre has a small $100 \mu\text{g}/\text{m}^3$ concentration contour which Clear Lake and Stoner do not have. Hart North also has a $100 \mu\text{g}/\text{m}^3$ concentration contour, which is bigger than that of Isle Pierre.

The spatial distributions of predicted impacts reflect the terrain and meteorological conditions in the respective area. Plumes are likely to impinge on surrounding elevated terrain; accordingly the spatial distributions shown in Figure 5-3 and Figure 5-4 show the greatest impacts toward the direction of elevated terrain in the vicinity of each industrial site. The presence and size of the highest concentration contours in the immediate vicinity of the modelled emission sources reflect the wind speeds expected at each location. For instance, the Hart North and Airport South industrial sites, with the largest $400 \mu\text{g}/\text{m}^3$ contour in Figure 5-3, are expected to see low wind speeds less than 2 m/s over 40% of the time. Conversely, the Stoner and Clear Lake industrial sites, both of which do not have a $400 \mu\text{g}/\text{m}^3$ contour in Figure 5-3, are expected to see low wind speeds less than 2 m/s only about 20% of the time. The average hourly wind speed at Hart North and Airport South are about 2.1 m/s, which is lower than the average hourly wind speed of 2.8 m/s at Stoner and Clear Lake.

The predicted impacts for Shelley, Willow Cale and Airport South may encompass several residences located in the immediate vicinity of the proposed industrial areas. Isle Pierre, Clear Lake, Hart North and Stoner appear to have the least impact on Prince George, surrounding towns and residences due to the small predicted footprint of impact, the tendency for dispersion to occur in a direction away from the nearest residences, and their relative distance from Prince George. Clear Lake and Stoner have the lowest predicted concentrations of all seven sites. Therefore Clear Lake and Stoner are considered the most favourable intermediate industrial areas from an air quality perspective. Isle Pierre is the next industrial site that results in less impact to residences as it is situated further away from the majority of residences and the area of highest predicted concentrations (greater than $400 \mu\text{g}/\text{m}^3$) is small. A greater area is impacted by emissions at Hart North; however, it is located further away from the City of Prince George and surrounding residences than Shelley, Airport South and Willow Cale and therefore is considered the fourth most favourable site. Of the remaining three sites, Shelley seems to have the smallest contours and is therefore ranked fifth. The areas of highest predicted concentrations are smaller for Willow Cale than for Airport South but Willow Cale is located closer to residences. It is therefore difficult to say which of Airport South and Willow Cale is the least favourable from an air quality perspective.

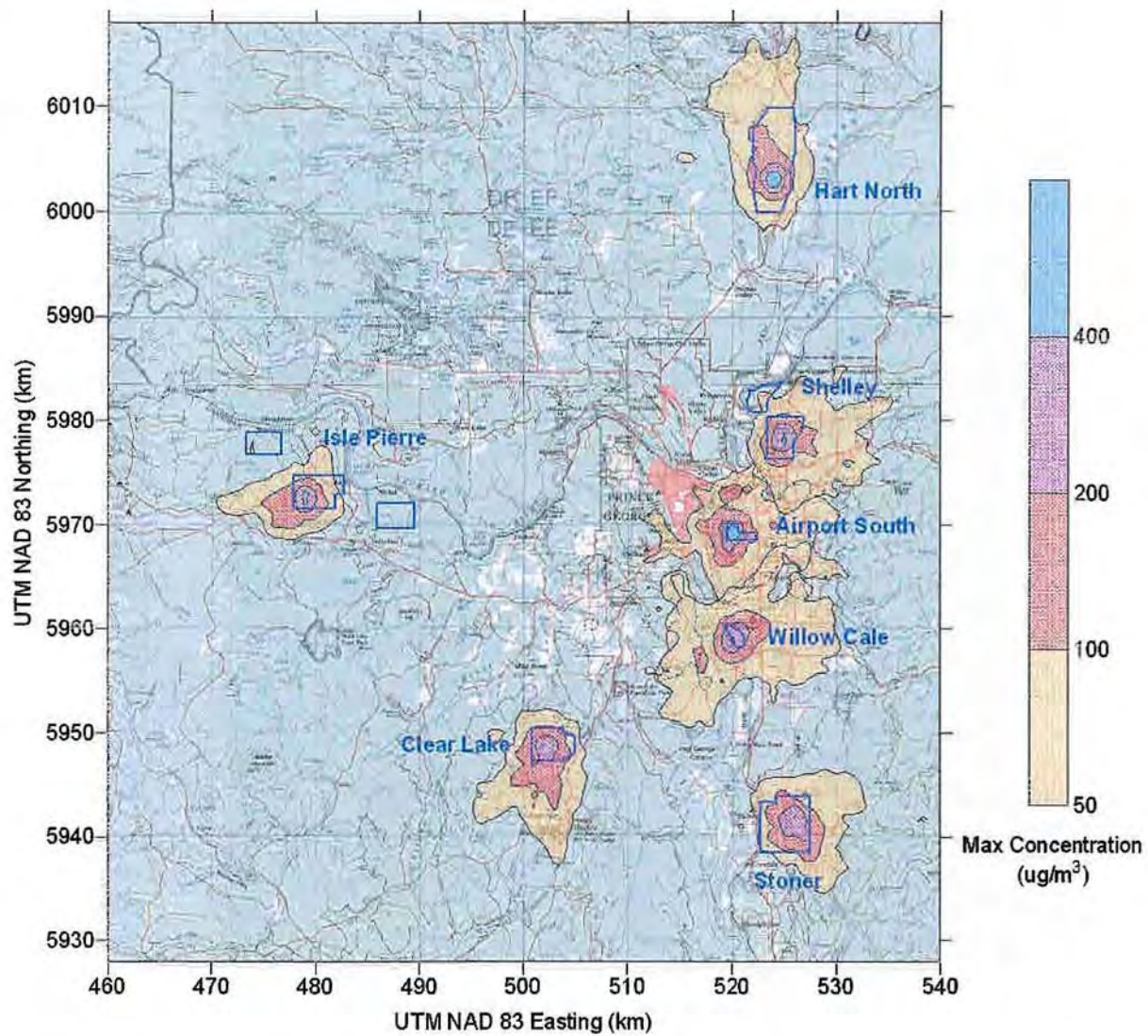


Figure 5-3: Maximum Predicted One-hour Generic Pollutant Concentrations for Potential Intermediate Industrial Sites

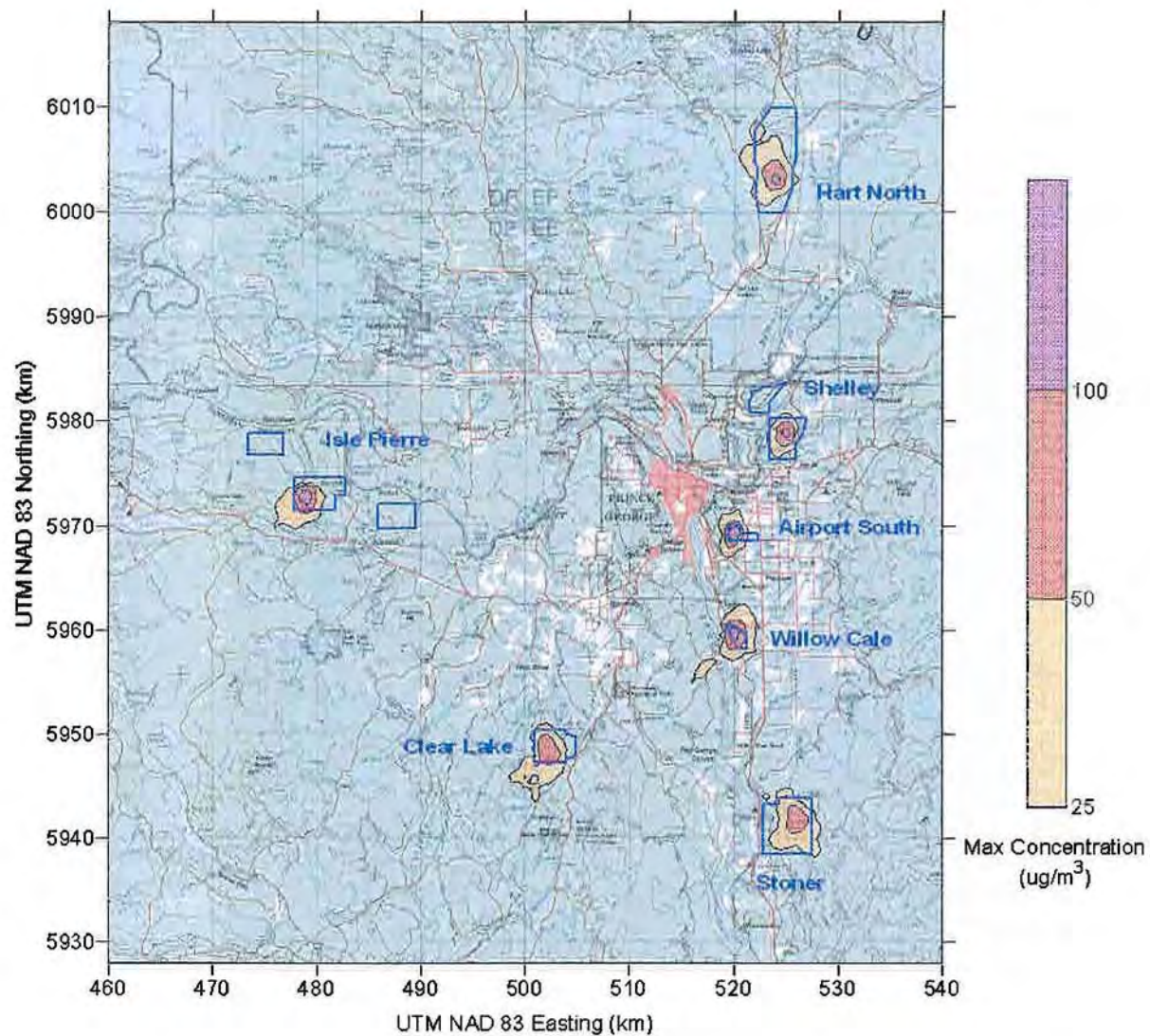


Figure 5-4: Maximum Predicted 24-hour Generic Pollutant Concentrations for Potential Intermediate Industrial Sites

5.3 HEAVY INDUSTRIAL

The results of dispersion modelling for the four potential sites representing the heavy industrial classification (Clear Lake, Hart North, Isle Pierre and Stoner) are presented in the form of isopleth maps showing contours of constant concentration.

Compared to the isopleths maps for the intermediate industrial classification (Figure 5-3 and Figure 5-4), the isopleths maps for the heavy industrial classification illustrated in Figure 5-5 and Figure 5-6 show higher concentrations at all sites. The dispersion patterns, however, are similar. For example, the largest one-hour impacts from the Hart North site are predicted towards the north for both industrial classifications (compare Figure 5-3 and Figure 5-5). The main difference between the intermediate and heavy industrial classifications is the much to greater magnitude of emissions from heavy industrial sources. For example, the emission rate used for the aluminum smelter in the heavy industrial case is two orders of magnitude greater than the emission rate of any source in the intermediate industrial case.

Figure 5-5 shows the maximum predicted one-hour average results for the heavy industrial sites. For the Hart North and Clear Lake sites, one-hour average concentrations between 200 to 400 $\mu\text{g}/\text{m}^3$ are predicted at Prince George and nearby communities. For the Isle Pierre site, one-hour average concentrations predicted at Prince George are less than 200 $\mu\text{g}/\text{m}^3$. Residences to the east and south of the city appear not to be impacted by the modelling results from Isle Pierre. Isle Pierre also seems to have the smallest high concentration contours ($> 900 \mu\text{g}/\text{m}^3$). The Stoner site has a slightly smaller 100 $\mu\text{g}/\text{m}^3$ concentration contour compared to Clear Lake; however, Stoner has larger high concentration contours (400 and 900 $\mu\text{g}/\text{m}^3$) that overlap the City of Prince George. Also, a small contour area of 900 $\mu\text{g}/\text{m}^3$ can be seen close to the city due to emissions from Stoner. The 200 $\mu\text{g}/\text{m}^3$ and $> 900 \mu\text{g}/\text{m}^3$ isopleths for Hart North encompass the largest areas of all four sites.

Figure 5-6 shows the maximum predicted 24-hour average results for heavy industrial sites. High concentrations predicted for Isle Pierre cover the smallest area of all four sites and appear to impact the City of Prince George the least. Stoner appears to have the greatest potential to impact air quality in the City of Prince George. The potential impact of Hart North and Clear Lake on the City appear to be similar but predicted isopleths associated with Hart North cover a much greater area than those associated with Clear Lake.

The spatial distributions and spatial extents of predicted impacts at each industrial site are related to both the terrain in the vicinity of the site as well as meteorological conditions expected at those locations as described in Section 5.2.

It is important to note that the main contribution to the high concentration contours illustrated in Figure 5-5 and Figure 5-6 for the heavy industrial classification is the high SO₂ emission rate from the aluminum smelter. The SO₂ emission rate from the hypothetical aluminum smelter is assumed to be 1,200 g/s based on average NPRI-reported emissions from other aluminum smelters in Canada. This represents a worst-case scenario, with SO₂ emissions over 100 times the total typical emissions from a petrochemical refinery or pulp mill. Since this is a hypothetical example, the result of interest is the difference in spatial distribution of predicted concentrations not the absolute values of the concentration contours in Figure 5-5 and Figure 5-6. Nonetheless, these results do suggest that considerable mitigation of emissions might be required prior to an aluminum smelter being permitted in the Prince George airshed.

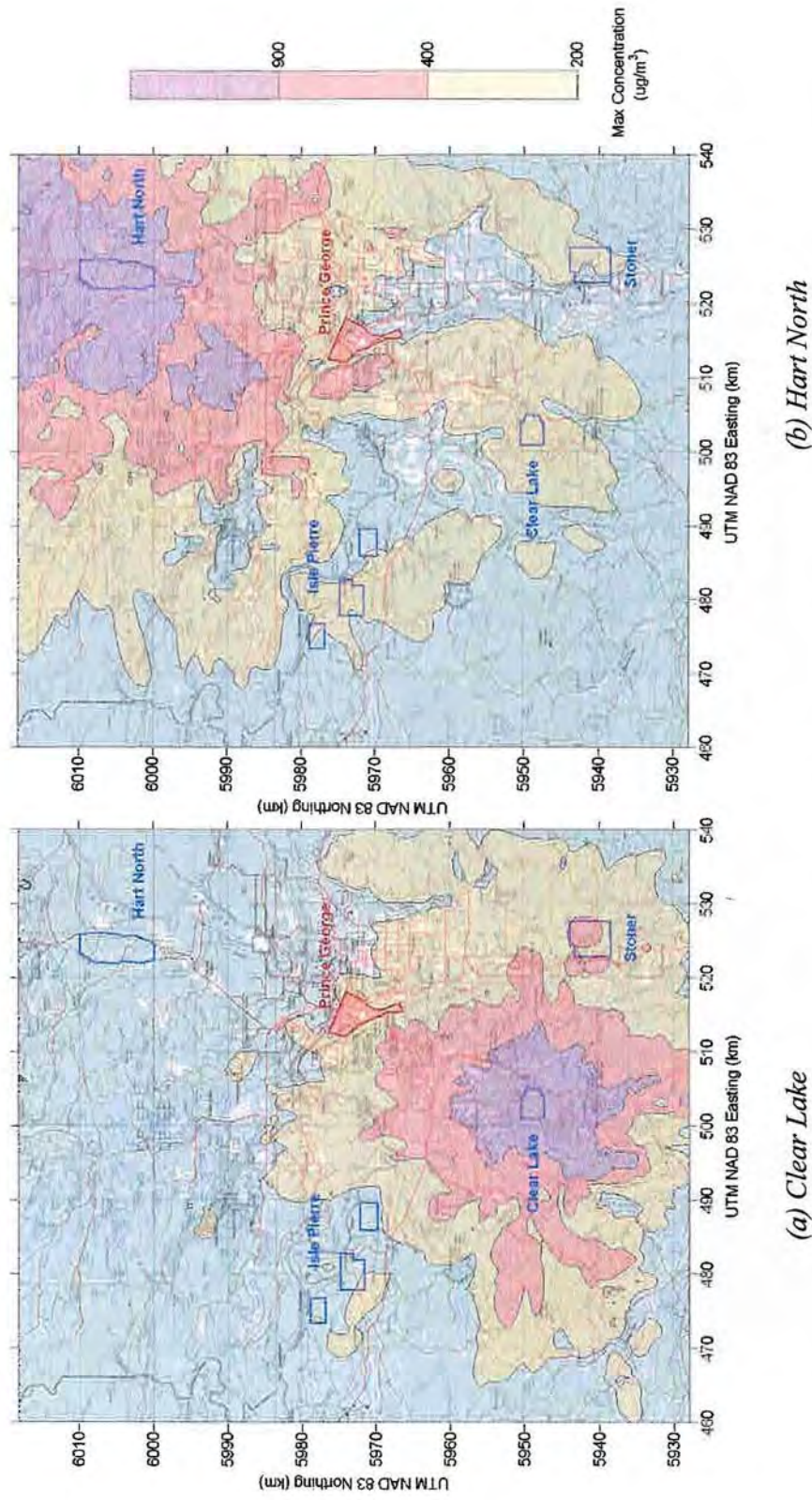


Figure 5-5: Maximum Predicted One-hour Generic Pollutant Concentrations for Potential Heavy Industrial Sites

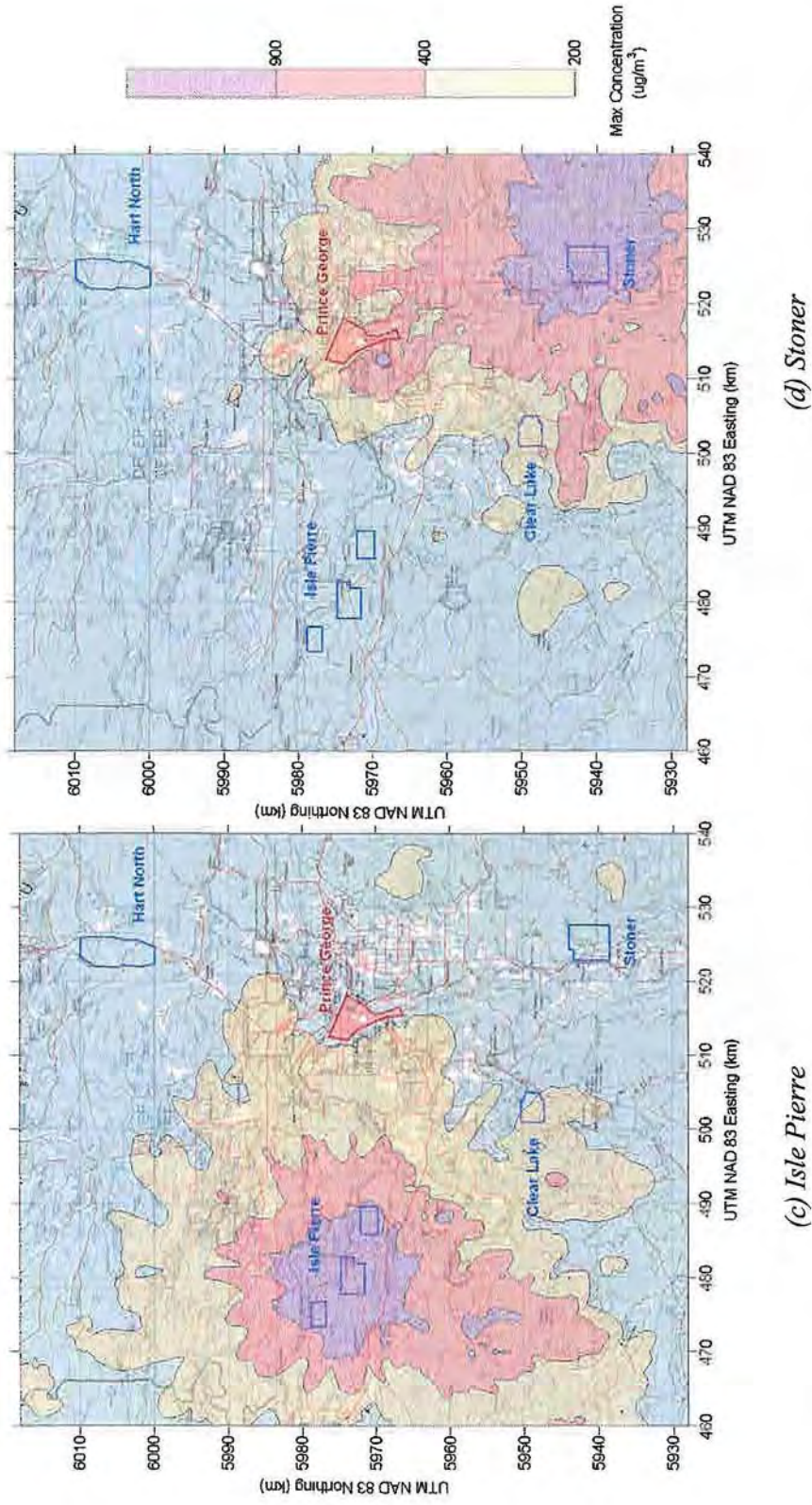


Figure 5-5: Maximum Predicted One-hour Generic Pollutant Concentrations for Potential Heavy Industrial Sites (cont.)

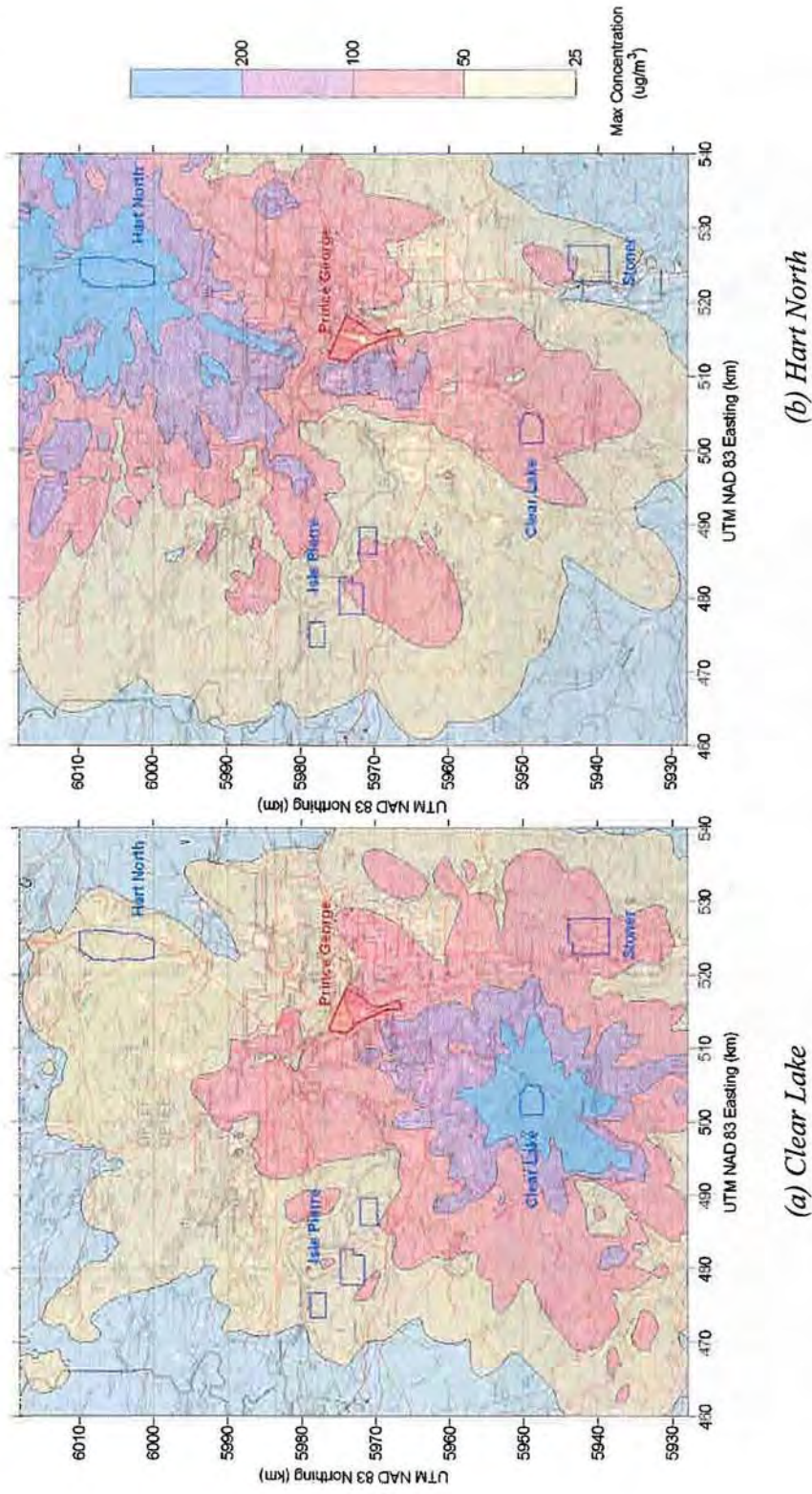


Figure 5-6: Maximum Predicted 24-hour Generic Pollutant Concentrations for Potential Heavy Industrial Sites

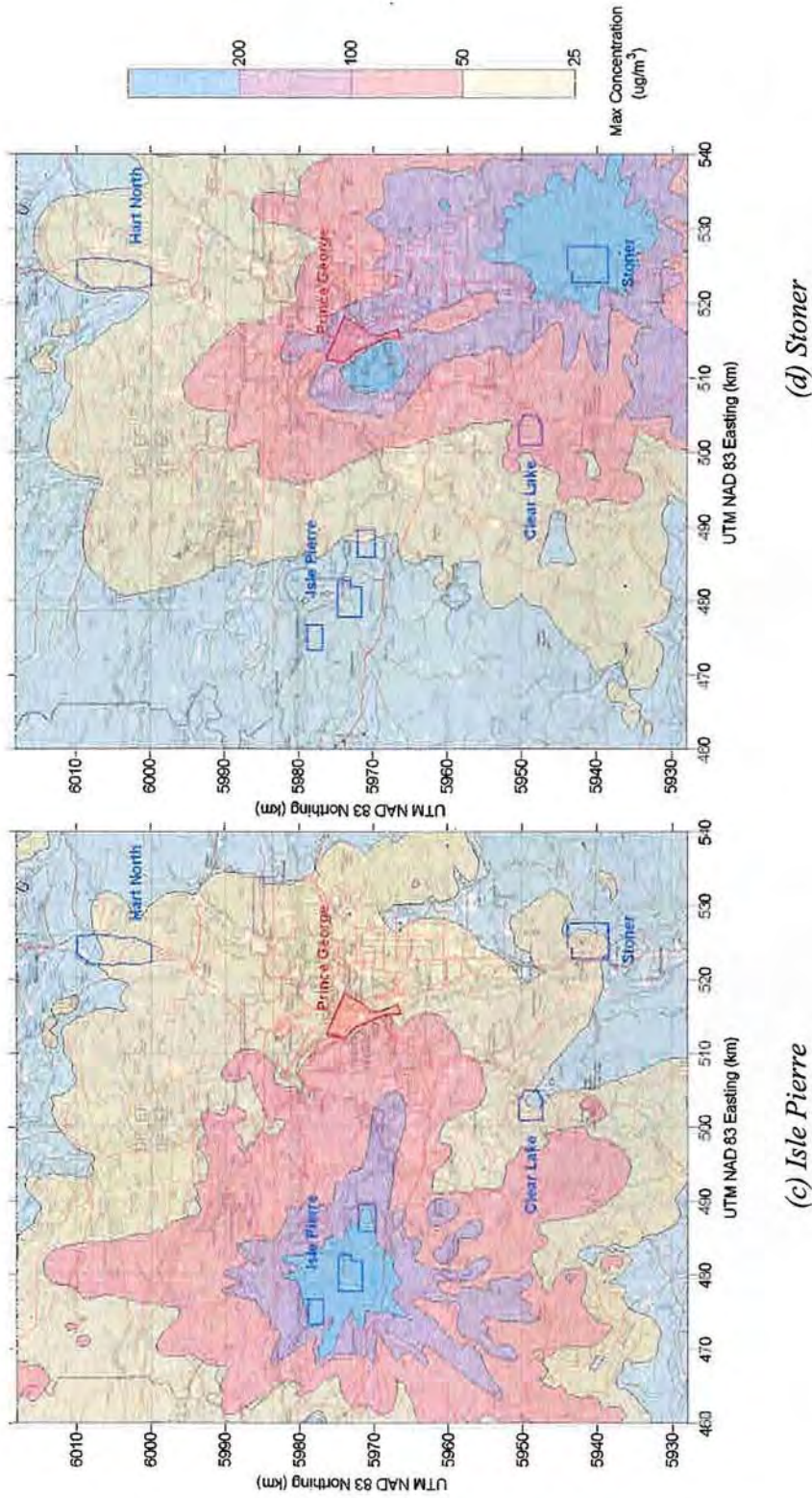


Figure 5-6: Maximum Predicted 24-hour Generic Pollutant Concentrations for Potential Heavy Industrial Sites (cont.)

Overall, the potential industrial site with the least predicted impact on the city of Prince George, surrounding towns and residences is Isle Pierre. Isle Pierre has smaller concentration contours compared to the three other sites based on the one-hour and 24-hour modelling results, it is located furthest from Prince George, and has the least number of residences located in the surrounding area. Clear Lake is the next site that results in the least impact to Prince George and nearby communities. Compared to Hart North and Stoner, it has smaller high concentration contours and is also located further from the majority of residences. There are fairly large high concentration contours predicted at the Hart North site; however, compared to Stoner, it impacts residences and the city of Prince George less. From an air quality perspective, the least favourable heavy industrial site is Stoner.

6.0 BEST MANAGEMENT PRACTICES

Based on Table 4-4, the contaminants with the highest emission rates considered for this study are SO₂, VOCs and NO_x. The largest sources of SO₂ are the aluminium smelter and the petrochemical refinery. The sawmill heater/boiler, veneer press/dryer, petroleum storage tanks and pulp mill smelt tank are the largest sources of VOCs. The largest sources of NO_x are the pulp mill boilers, the ethylene and polyethylene furnace and flare, and the refinery process heaters and flare.

The heavy industrial classification model results presented in this report show large extents of impact throughout the study area. These model results are primarily due to the high SO₂ emission rates expected for aluminum smelters. Mitigation technologies at this type of facility should be considered if it were to be included in the industrial plans. Post-combustion flue gas desulphurization options include wet scrubber with limestone, dual alkali or a freshwater-lime sorbent slurry; spray drying with a calcium hydroxide slurry; and duct injection with a dry sorbent. Without the incorporation of such mitigation technologies, it would be difficult to meet ambient air quality objectives and obtain required environmental certificates and permits to operate.

Wherever possible, roads and parking lots should be paved and dust emissions on these surfaces should be managed. Factors affecting paved road dust emissions include the road surface silt loading, mean vehicle weight, and traffic volumes. The use of tracked vehicles and heavy trucks should be restricted to prevent damage to road surface and base. Best management practices to minimize road dust emissions include covering loads in trucks with heavy tarpaulins to prevent spillage of material and removing any material that has deposited on the travel lanes via vacuum sweeping or water flushing. Application of coarser winter traction material as opposed to finer sands that would contribute to heavier silt loadings would also reduce dust emissions. Excess salt and sand applied to the roads during winter should be removed at the end of the season. Minimizing activities during PM episodes is another mitigation strategy.

If it is not possible to pave roads or parking lots, dust emissions from these surfaces should be managed by keeping the areal coverage of unpaved roads to a minimum. Unpaved industrial roads should also be kept as short as possible. If vehicles are required to travel on an unpaved road, such as a laneway, the neighbourhood should be designed such that the vehicles have easy access to paved arterial roads. For example, if vehicles are required to exit a property via an unpaved laneway they should have easy access to an arterial road (i.e., a property with high

vehicle traffic should not be located at the end of a dead-end lane, instead it should be located next to an arterial road so that the distance travelled on the unpaved road is minimized). Furthermore, controls can be put in place to either limit the amount of traffic on unpaved roads or lower the speed limit, which will minimize PM emissions. Other improvement methods include covering the unpaved road surface with another material of lower silt content. For example, a dirt road can be covered with gravel or slag; however, maintenance will be required to keep the road completely covered. Chemical dust suppressants may also be applied. The application rate will depend on the type of chemical dust suppressant that is selected. Water absorbing suppressants (e.g., magnesium chloride, calcium chloride or sodium chloride), organic petroleum products and lignin derivatives generally require one to two treatments per season.

Wind-blown dust emissions from stockpiles should be minimized by reducing exposure of the stockpiles to wind. Where possible, open piles should be replaced with enclosures such as open-ended buildings, three-sided bunkers or even storage silos equipped with PM emission control technology such as fabric filters. Porous wind fences or screens can be installed upwind of open piles. Tarpaulins, plastic or other material can be used as a temporary covering for open stockpiles during high wind events. Stockpile activities such as loading and contouring should be confined to the downwind side of the pile.

The rate at which VOCs are emitted depends on combustion efficiency of the boiler or heater. The presence of VOCs in exhaust gas are mainly due to incomplete combustion. VOCs are discharged into the atmosphere when some of the fuel remains unburned or is only partially burned during the combustion process. Smaller boilers tend to emit more VOCs than larger boilers due to lower combustion efficiency. For the automotive sector, low-VOC solvent based products can be used or reducing the amount of solvent use will lower VOC emissions. Leak detection and repair should be completed for storage tanks, compressors, pumps and high pressure equipment. Venting from storage tanks should be avoided and ideally the tanks should have floating roofs to minimize fugitive emissions. Frequent inspections or leak detection is recommended as well as promptness of repairs. Non-leaking replacement equipment can be selected. Product capture and recovery can be implemented for process vents, stacks and confined building ventilation exhaust vents. This requires process modifications, carbon adsorption or absorption. Splash or top-loading of fuel into storage tanks causes increased agitation and causes more VOC vapours to be vented. If practicable, bottom loading should be considered for loading storage tanks.

Mitigation measures to minimize NO_x emissions include: using well-maintained equipment, reduce unnecessary idling of project equipment and position necessary emission sources (e.g.,

portable diesel generators, compressors) as far as is practical from sensitive receptors (e.g., schools, hospitals). NO_x control techniques for boilers and heaters include implementing combustion modifications such as low excess air, staged combustion, flue gas recirculation and low NO_x burners with overfire air. These control methods can reduce NO_x emissions by 5 to 50%. Emissions from flares can be reduced by minimizing flaring.

7.0 CONCLUSIONS AND RECOMMENDATIONS

Dispersion modelling was used to predict the relative effects on air quality of CAC emissions from a hypothetical mix of sources at seven potential industrial sites using standard protocols and modelling guidelines. The primary objectives of the study were to identify the lowest impact areas for industrial development from an air quality perspective and to provide best management practices.

Based on the CALPUFF modelling results, the following proposed industrial sites have the least potential to impact the air quality of the city of Prince George and its surrounding communities:

- **Light Industrial Classification:** The one-hour and 24-hour isopleth plots showed that the Shelley site appears to result in the smallest concentration contours. In conjunction with its location in an area with few residences in the immediate vicinity, this translates to the least impacts to surrounding towns and residences. The second most favourable industrial site is Airport South as it has smaller contours than Willow Cale, despite the fact that it is located closer to the city of Prince George and surrounding residences. Willow Cale had the largest concentration contours and is the least favourable industrial site from an air quality perspective.
- **Intermediate Industrial Classification:** The one-hour and 24-hour isopleth plots show that the Clear Lake and Stoner sites appear to result in the lowest concentration contours and that dispersion tends to occur in a direction away from the nearest residences. The isopleth plots for these sites also show the least impact on Prince George due to their distance from the city. The third most favourable intermediate industrial site from an air quality perspective is Isle Pierre as it is also located far from residences and it resulted in a small area of high predicted concentrations.
- **Heavy Industrial Classification:** The one-hour and 24-hour isopleth plots show that the Isle Pierre site seems to have the least impact on the City of Prince George and therefore is considered the most favourable heavy industrial site from an air quality perspective. Clear Lake is the next most favourable heavy industrial site followed by Hart North as they both have smaller contours and impact the City of Prince George and other residences less than Stoner.

This study involved simplified dispersion modelling of one generic pollutant representing a number of CACs and considered only the general dispersion of the pollutant in the atmosphere

without taking into account any deposition and/or chemical transformation processes. Furthermore, this study was based on a hypothetical mix of industrial facilities within the light, intermediate and heavy industrial classifications, based on typical emissions expected for such facilities. For these reasons, refined modelling assessments are recommended, and would likely be required for a number of the facility types, for specific proposed developments.

8.0 REFERENCES

Air & Waste Management Association. 2000. *Air Pollution Engineering Manual*, Second Edition.

BC Ministry of Environment. 2008. *Guidelines for Air Quality Dispersion Modelling in British Columbia*.

BC Ministry of Environment. 2009. *Waste Discharge Authorizations*. Available at: http://www.env.gov.bc.ca/epd/waste_discharge_auth/intro.htm. Accessed: November, 2009.

BC Ministry of Environment. 2008. *Waste Discharge Regulation*. Available at: <http://www.env.gov.bc.ca/epd/main/ema.htm#2>. Accessed: November, 2009.

BC Ministry of the Environment. 2004. *Environmental Management Act*. Available at: <http://www.env.gov.bc.ca/epd/main/ema.htm>. Accessed: November, 2009.

BC Ministry of the Environment. 2002. *Environmental Assessment Act. Reviewable Projects Regulation*. Available at: http://www.bclaws.ca/Recon/document/freeside/--%20E%20--/Environmental%20Assessment%20Act%20%20SBC%202002%20%20c.%2043/05_Regulation/s/13_370_2002.xml. Accessed: November, 2009.

BC Ministry of the Environment. 2002. *Environmental Assessment Act*. Available at: http://www.bclaws.ca/Recon/document/freeside/--%20E%20--/Environmental%20Assessment%20Act%20%20SBC%202002%20%20c.%2043/00_02043_01.xml. Accessed: November, 2009.

Canadian Environmental Assessment Agency. 2009. *Basics of Environmental Assessment*. Available at: <http://www.ceaa-acee.gc.ca/default.asp?lang=En&n=B053F859-1>. Accessed: November, 2009.

Canadian Environmental Assessment Agency. 2003. *Canadian Environmental Assessment Act: How to Determine if the Act Applies*. Available at: <http://www.ceaa-acee.gc.ca/default.asp?lang=En&n=B58A1210-1&offset=2&toc=show>. Accessed: November, 2009.

Department of Justice of Canada. 1992. *Canadian Environmental Assessment Act*. Available at: <http://laws.justice.gc.ca/en/c-15.2/text.html>. Accessed: November, 2009.

Department of Justice Canada. 1994. *Inclusion List Regulations*. Available at: <http://laws.justice.gc.ca/en/c-15.2/sor-94-637/index.html>. Accessed: November, 2009.

Earth Tech Inc. 2000. *A User's Guide for the CALMET Meteorological Model (Version 5)*.

Environment Canada. 2007. *National Pollutant Release Inventory – 2007 Dataset*.

Hansen, Kurt. 2009. *Industrial Air Pollution Control Technology Review VOCs, NO_x & SO₂*. Prepared for the Canadian Prairie & Northern Section (CPANS). Calgary luncheon. May 13, 2009.

Mackenzie Green Energy Centre. 2007. *Mackenzie Green Energy Centre Application for Environmental Assessment Certificate*.

RDDFG. 2009. *Schedule 'A' to Regional District of Fraser-Fort George Zoning Bylaw No. 833 – Zoning Regulations*.

RWDI AIR Inc. 2009. *Third Party Review of the Prince George Air Quality Research Modelling Study*. Submitted to the Research Working Group of the Prince George Air Improvement Roundtable.

RWDI AIR Inc. 2008. *Air Quality Analysis for the Industrial Land Use Plan – Prince George Airport West*. Submitted to L & M Engineering Limited.

RWDI AIR Inc. 2009. *Westcoast Fort Nelson North Processing Facility Air Quality Environmental Assessment*. Submitted to TERA Environmental Consultants.

US Environmental Protection Agency. 2008. *AERSURFACE User's Guide*. EPA Report No. 454/B-08-001.

Zhang et. al. 2002. *Modelling gaseous dry deposition in AURAMS: a unified regional air-quality modelling system*. Atmospheric Environment 36: pp. 537-360.