W B E A

Wood Buffalo Environmental Association
Technical Reports

Southern Air Monitoring Plan (FINAL)

Southern Operators Sub-Group (AATC)

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Executive Summary

Resource extraction projects are continually being planned, approved and developed in the Wood Buffalo Environmental Association (WBEA) airshed. The northern region of the airshed has been and continues to be developed with mineable projects and recently with thermal recovery processes. The air and forest health monitoring programs administered through the WBEA have been designed and implemented to monitor for possible environmental effects as a result of these developments.

Monitoring programs in the southern area were designed based on specific industry applications. With planned development of resource extraction in the southern region expected to increase, this report proposes a regional Southern Air Monitoring Plan focused on the following eight objectives:

1. To provide air quality data in support of exposure assessments on environment and human health.
2. Address gaps in air quality and deposition monitoring in the WBEA Airshed's southern region.
3. Determine air quality relative to ambient air quality objectives, guidelines, standards or criteria.
4. Support the monitoring and reporting requirements associated with air quality or deposition management frameworks and EPEA regulatory approvals.
5. Characterize background and transboundary air quality in the region.
6. Detect poor air quality events so the public can be notified.
7. Provide chemical profiles for source apportionment.
8. Determine long-term trends.

The proposed concepts and monitoring objectives of the Southern Air Monitoring Plan will be developed and implemented over three phases. Phase 1 is to establish fixed monitoring stations in the communities of Conklin and Janvier and meteorological towers at all facilities, consolidate existing air monitoring activities in the region into the Southern Air Monitoring Plan and establish a background air monitoring station. The Phase 2 of the plan will focus on establishing either a fixed or portable monitoring station requirements based on a facility's production thresholds. Passive or new technology monitoring program will also be implemented in support of the acid deposition and particulate and ozone management frameworks. After three years of data collection, Phase 3 will be to conduct a dispersion modelling study of emissions from the facilities in the region for cumulative effects, ambient air quality and meteorological data analysis for identification of monitoring gaps, elimination of redundancies and opportunities for efficiencies.

Acknowledgements

A task group from the WBEA Ambient Air Technical Committee met regularly to review and plan the proposed monitoring plan for the southern region of the airshed. The authors would like to acknowledge the efforts of the task group. The following individuals were members of this task group:

Nicole Wallace, ConocoPhillips Canada – First Chairperson of the Task Group
Erin Davies, StatOil Canada Ltd. – Second Chairperson of the Task Group
Ann Simpson, Syncrude Canada – Chairperson, WBEA AATC
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Contents

Introduction

In 1993, the Government of Alberta developed a regional approach to air quality monitoring under the Clean Air Strategic Alliance (CASA). The WBEA was the second airshed to be created under CASA. In 1996 CASA formally endorsed the WBEA monitoring program, and the following year, WBEA assumed responsibility for ownership and operation of a regionally consolidated air quality monitoring network in the Regional Municipality of Wood Buffalo (RMWB) region.

WBEA operates the largest airshed, in the largest municipality in the country. From north central Alberta to the borders of Saskatchewan and the Northwest Territories, the RMWB covers 68,454 square kilometres, making it one of the largest municipalities in North America.

WBEA is a not-for-profit, multi-stakeholder monitoring association made up of 38 member organizations, including representatives from three levels of government, First Nations and Métis communities, environmental non-government organizations and industry. This dynamic collaboration of communities, environmental groups, industry, government and Aboriginal stakeholders is one of WBEA's greatest strengths.

WBEA's consensus-based approach to governance and decision making brings together a group of people with the purpose of addressing interests or concerns underlying each party's position on an issue. The focus is on finding solutions to the problems faced by each party so that every participant can agree to a final set of recommendations.

At WBEA, consensus is reached when each stakeholder can live with the outcome. Stakeholders may not achieve all their goals, but the optimal solution is in everyone's best interests. The resulting recommendations are likely to be more innovative and longer-lasting than those reached through traditional negotiation processes. WBEA's consensus approach creates a respectful and mindful forum for discussions and decisions related to important environmental monitoring issues.

WBEA's vision is to operate a state of the art monitoring system that meets the needs of residents and stakeholders in the Wood Buffalo Region. WBEA's mission is to monitor air quality and air quality related environmental indicators/impacts, and to generate accurate and transparent information that enables users to make informed decisions.

Continuous ambient air quality and meteorological data are collected through a program overseen by WBEA's Ambient Air Technical Committee (AATC), and implemented by a staff of 12 air quality specialists/technicians. By the beginning of 2015, WBEA will be operating 18 continuous monitoring stations, each measuring from 3 to 10 air quality parameters. The continuously measured parameters include CH_4, CO, H_2S, NMHC, NH_3, NO, NO_2, NO_X, O_3, $PM_{2.5}$, SO_2, THC and TRS. All sites also measure temperature, wind speed and wind direction. Selected sites measure relative humidity, barometric pressure, global radiation, precipitation, dew point, surface wetness and vertical temperature gradient.

WBEA's Forest Health Monitoring Program is coordinated through the Terrestrial Effects Monitoring (TEEM) committee. This program integrates soil, vegetation, air quality and deposition monitoring at locations selected for their sensitivity and/or exposure to anthropogenic air emissions. The Forest Health Monitoring Program has used passive monitoring samplers since 1998, beginning with the deployment of NO_2, SO_2, and O_3 passives samplers, and expanding the number of sites and the recent addition of NH_3, and HNO_3/NHO_2.

Figure 1 shows the current location of the WBEA Air and Forest Health Monitoring Programs.

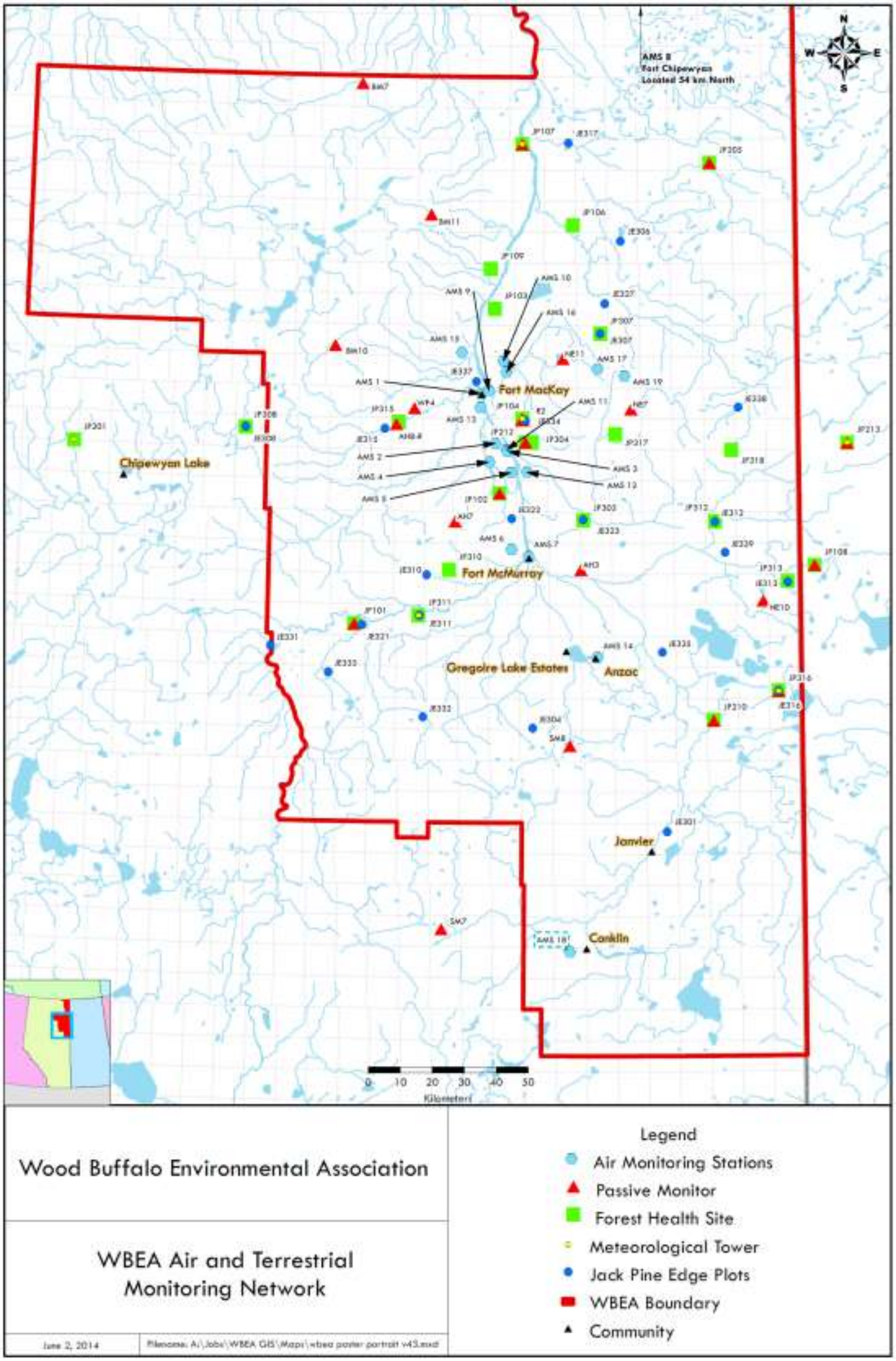

Figure 1. WBEA Air and Forest Health Monitoring Network

Scope of this report

The current WBEA Air and Forest Health Monitoring programs began in the mid-1990s in response to regulatory requirements associated with an industry approval public hearing and associated project approval conditions. While the genesis of the program occurred during a process specific to an industry application, the Air and Forest Health programs at WBEA has evolved into multi-stakeholder initiatives that were largely driven by local community concerns regarding the effect of air emissions on health and the environment.

To date the focus of these programs have been in the resource extraction areas in the northern region of the airshed.

Comparatively, resource extraction developments in the southern region of the airshed, the area between Fort McMurray and Lac La Biche, are currently on a smaller scale than the mining projects of the north. Monitoring activities in the southern region were designed based on specific industry applications. With the planned development of resource extraction in the southern region expected to increase over the next several decades, the intent of this report is to propose an air monitoring plan for the region to provide an understanding of the environmental effects and facility operation compliance with respect to Alberta Ambient Air Quality Objectives (AAAQOs) and Canada Ambient Air Quality Standards (CAAQS).

Ambient Monitoring Plan Development Approach

An approach to developing the ambient air monitoring plan for the region considered the monitoring objectives and local geographical features such as terrain, meteorology, site characteristics, emission sources and supporting infrastructure, such as power and road access.

In preparation of the potential ambient air and forest health monitoring plan for the southern region, input from local stakeholders were requested. The current WBEA and industry monitoring activities and WBEA ambient air monitoring network reviews were considered and program design from other jurisdictions were also studied.

In developing the air monitoring plan for the southern region, the following documents were referenced and cited:

- ***The Alberta Air Monitoring Directive (AMD)***. The current AMD is undergoing a review and updating process. A new section of the AMD effective February 2014, the Ambient Air Monitoring Program Planning chapter sets an outline for gathering information to design the ambient air monitoring program and establishes a set of consistent requirements for the documentation of ambient air monitoring programs through the development, submission and review of an ambient air monitoring plan.

- ***The Alberta Ambient Air Quality Objectives (AAAQO).*** These objectives are intended to provide protection of the environment and human health to an extent technically and economically feasible, as well as socially and politically acceptable. The objectives are used to report on the state of Alberta's atmospheric environment; to inform Albertans on air quality through an air quality index; to establish approval conditions for regulated industrial facilities; to evaluate proposals for constructing facilities; to guide special ambient air quality surveys and to assess compliance near major industrial air emission sources.
- ***2009 Ambient Air Monitoring Strategy for Alberta.*** This report recommends an updated Ambient Air Monitoring Strategic Plan for Alberta. This report outlines the plans for ongoing management of the province's ambient air quality and is a foundation for the Cumulative Environmental Management work in Alberta. The Plan incorporates elements from the current system and proposes new elements that will lead to a more comprehensive and responsive system.
- ***Management Frameworks.*** There are two management frameworks that are applicable to the monitoring plan design. These are the Acid Deposition and the Particulate and Ozone Management Frameworks. These management frameworks provide a system or an approach to achieve specific outcomes or goals. The goals of these frameworks are to protect the environment, optimize economic performance and efficiency and seek continuous improvement.
- ***Lower Athabasca Area Regional Plan (LARP).*** This plan identifies and sets resource and environmental management outcomes for air, land, water and biodiversity and provides guidance on future resource decisions while considering social and economic impacts.
- ***Using Ambient Air Quality Objectives in Industrial Dispersion Modelling and Individual Industrial Site Monitoring.*** Alberta has a number of components that work together to maintain acceptable air quality. This Guideline outlines the process for the implementation of a new or revised AAAQO, interpreting and acting on modelled concentrations in relation to AAAQOs, setting additional individual industrial site monitoring and specifying a procedure for calculating ambient concentrations over different averaging times. It notes that the AAAQOs are in many cases not entirely protective of human health and the environment and therefore efforts should be made to improve air quality in order to stay well below AAAQOs.
- ***Regulatory Approvals to facility operators issued under Environmental Protection and Enhancement Act.*** Key features of the Regulatory Approvals that guide the management of industrial emissions to the atmosphere are :

    - industrial facilities must be designed and operated to prevent pollution;

    - each industrial source must use technology that allows for a high level of control of emissions as outlined in an applicable source emission standards document or approval;

    - residual emissions must be dispersed through a stack designed to keep ambient concentrations below ambient air quality objectives;

- cumulative impacts from multiple sources must be assessed and remain below the assimilative capacity of the airshed as defined by ambient air quality objectives;

- industrial operators are generally responsible for monitoring source emissions and the resulting ambient concentrations around their facilities as specified in their approvals, to demonstrate compliance with emission limits and ambient air quality objectives, and

- industrial operators must report, or cause to be reported in cooperation with others as part of an air quality monitoring zone, the monitoring results to the regulatory agency.

Ambient Air Quality or related Deposition Issues in the Area

The number of projects and developments in the southern region are expected to increase significantly over the next several decades. As new projects are constructed and commissioned, air and forest health monitoring programs are expected to record any effects resulting from these developments. Monitoring activities would also need to be coordinated to ensure measurements are made at prominent sites such as communities or sensitive receptor locations. Monitoring needs to be conducted to assess compliance and evaluate facility performance with respect to AAAQOs and CAAQS.

Ambient air quality measurements can provide an indication of air quality impacts associated with existing emission sources and a baseline for comparing air quality changes associated with future developments. The ability to assess the air quality impacts associated with emission sources depends of the location of ambient air monitoring sites and what they are monitoring and the methods used to measure air quality parameters. The current air monitoring activities in the southern region are carried out in an ad hoc basis and have limitations in terms of assessing the impact of emissions on air quality from either a local i.e. near source, or regional i.e. southern region perspective.

Responsible Authorities for the Monitoring Plan

In 1996 CASA formally endorsed the WBEA monitoring program, and the following year, WBEA assumed responsibility for ownership and operation of a regionally consolidated air quality monitoring network in the Wood Buffalo region.

While the genesis of the current monitoring program occurred during a process specific to an industry application, the air and forest health programs at WBEA evolved as a multi-stakeholder initiative and were largely driven by local community concerns regarding the effect of air emissions on health and the environment. In a similar way, the development of this air monitoring plan for the southern region is a starting point. The future design and implementation of the monitoring plan will likely evolve as a result of the input from local communities, facility operators and government.

Monitoring Plan Objectives

The purpose of the southern regional air monitoring plan is focused on the following objectives:

1. To provide air quality data in support of exposure assessments on environment and human health.
2. Address gaps in air quality and deposition monitoring in the WBEA Airshed's southern region.
3. Determine air quality relative to ambient air quality objectives, guidelines, standards or criteria.
4. Support the monitoring and reporting requirements associated with air quality or deposition management frameworks and EPEA regulatory approvals.
5. Characterize background and transboundary air quality in the region.
6. Detect poor air quality events so the public can be notified.
7. Provide chemical profiles for source apportionment.
8. Determine long-term trends.

Geography of the Area

The southern region of the WBEA Airshed is defined as the area south of Fort McMurray and north of Lac La Biche. The area is approximately 16,000 square kilometers with the highest terrain elevation being 740 meters above sea level (masl). The lowest terrain elevation in the area is 245 masl.

The area is located in the Boreal Forest Natural Region of Alberta and is vegetated by deciduous, mixed wood and coniferous forest. The area contains portions of both the Central and the Lower Boreal Highland Natural subregions (MEG Surmont EIA Application, 2012).

The area topography is characterized by undulating to hummocky uplands with extensive wetlands and numerous lakes. The Stony Mountains located along the northwestern portion of the Christina River watershed represent the largest hill complex in the region. Elevations range from 740 masl in the upper plateaus of the region to about 245 masl at the confluence of the Christina and Clearwater Rivers. Land use consists mainly of forestry, oil and gas, recreation and subsistence (Natural Regions Committee 2006). Prominent linear features include Secondary Highway 881 and the Canadian National Railway (CN), both of which traverse north to south through the area (MEG Surmont EIA Application, 2012). Figure 2 shows the terrain of the area.

There are two dominant communities in the region with scattered primary dwellings and seasonal cabins. The population of Conklin in 2012 was 318 according to a municipal census conducted by the RMWB. The population of Janvier, also known as Janvier South or Chard was 171 in 2012 according to a municipal census conducted by the RMWB.

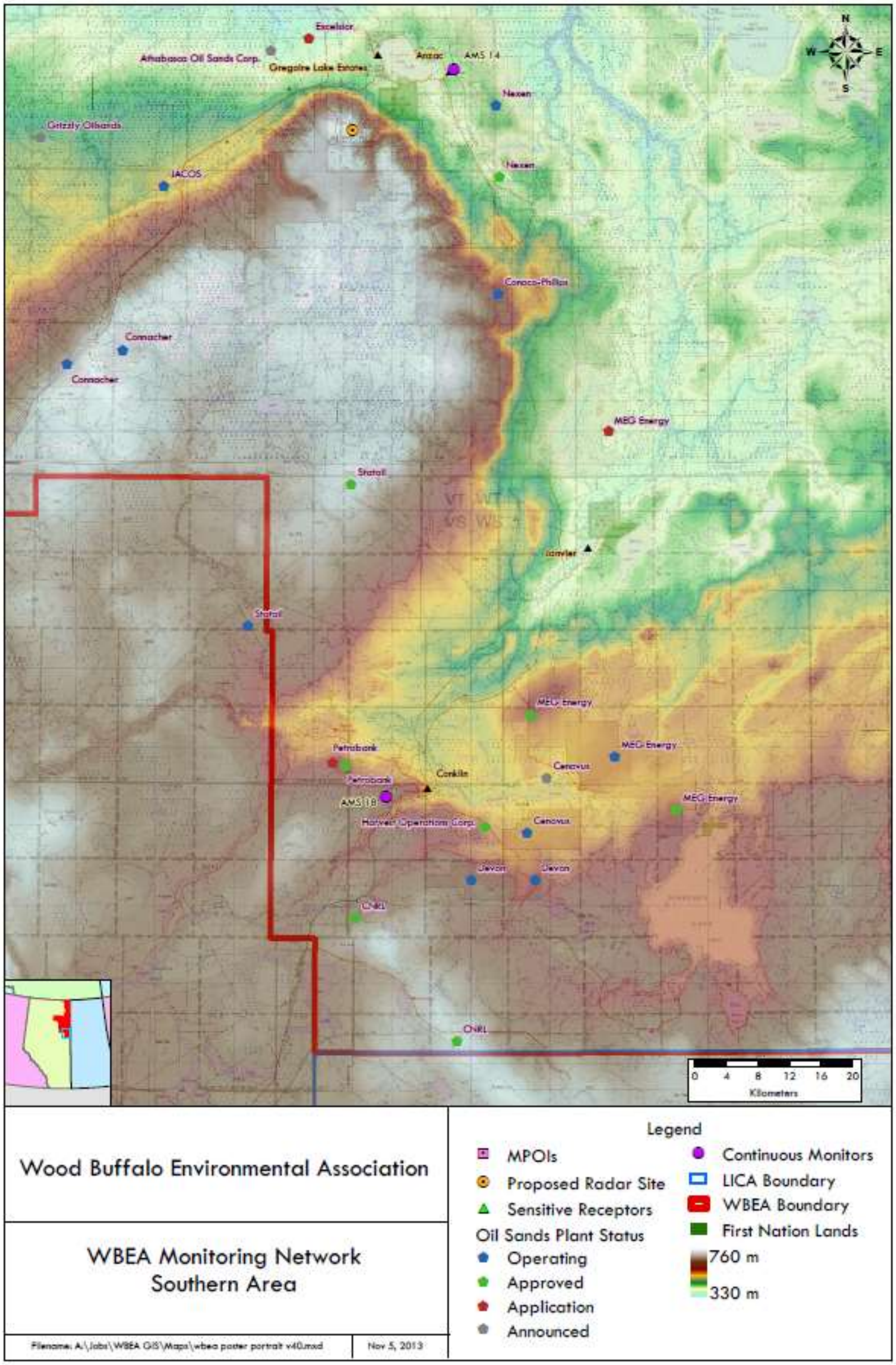

Figure 2. Terrain in Southern Region of the WBEA Airshed

Proposed Monitoring Locations

The Southern Air Monitoring Plan will be developed and implemented over three phases:

Phase 1:

1. Establish fixed ambient air monitoring stations in the communities of Conklin and Janvier.

   Rationale: These stations will be designed to primarily collect air quality data that represents the communities in the region. Data collected at these stations will address monitoring objectives:
   - To provide air quality data in support of exposure assessments on environment and human health.
   - Detect poor air quality events so the public can be notified.
   - Determine long-term trends.
   - Address gaps in air quality and deposition monitoring in the WBEA Airshed's southern region.
   - Determine air quality relative to ambient air quality objectives, guidelines, standards or criteria,
   - Provide chemical profiles for source apportionment.

2. Establish a network of permanent meteorological towers, one at each SAGD facility near its central processing facility at the approximate point of maximum predicted ground-level concentration.

   Rationale: Network of meteorological towers will address the following monitoring objectives:
   - To provide air quality data in support of exposure assessments on environment and human health.
   - Address gaps in air quality and deposition monitoring in the WBEA Airshed's southern region.
   - Determine long-term trends.

   Meteorological conditions and topography can have effect on air quality downwind of a major emission sources. In an effort to manage monitoring at all facilities and to take advantage of opportunities for continuous improvement, it is proposed for facilities that don't have a fixed continuous monitoring station and require less than 12 months of monitoring, that a meteorological tower will provide data in support of air quality exposure assessments. The on-site meteorological data can be used in future air quality dispersion modelling assessments.

3. Consolidate existing air monitoring activities in the region into the Southern Air Monitoring Plan and transfer monitoring responsibility to WBEA.

Rationale: Consolidating the EPEA approval-based monitoring activities within WBEA will address the following monitoring objectives:

- To provide air quality data in support of exposure assessments on environment and human health.
- Address gaps in air quality and deposition monitoring in the WBEA Airshed's southern region.
- Determine long-term trends.

The ability to assess the air quality impacts associated with emission sources depends on the location of ambient air monitoring sites, parameters measured and methods used to measure these parameters. Incorporation of the current EPEA approval-based monitoring activities in the Southern Air Monitoring Plan will provide the following benefits:

- Data will be managed through WBEA and the CASA Data Warehouse and will be readily available to public.
- A single service provider will enhance consistency in monitoring methods and data quality objectives to provide comparability between data sets.
- A central data and information management system.

4. Establish a fixed background station in the region for baseline data for the determination of trends and understanding of transboundary flow into and out of the airshed.

Rationale The WBEA Network Assessment report and subsequent Particulate Matter Monitoring workshop identified a need for baseline data for the determination of trends and background data for understanding transports into the airshed. A monitoring location near the southern border of the airshed operating, in parallel with the Fort Chipewyan Station, which is near the northern border of the airshed, would provide air quality data for this dual purpose. The monitoring objectives addressed by a background / transboundary are:

- Address gaps in air quality and deposition monitoring in the WBEA Airshed's southern region.
- Characterize background and transboundary air quality in the region.
- Determine long-term trends.

Phase 2:

5. Identify SAGD projects with production capacity greater than 100,000 bpd and establish one new or incorporate existing continuous monitoring station located near its central processing facility at the approximate point of maximum predicted ground-level concentration.

   Rationale: Facility specific monitoring and its integration in a regional monitoring plan will address the monitoring objective:

   - Determine air quality relative to ambient air quality objectives, guidelines, standards or criteria.

   Facilities with regulatory approvals to operate in Alberta are required to control their emissions so that levels of air pollution downwind of their industry are below the AAAQOs and other reporting obligations.

   A review of environmental impact assessments and approval applications indicates a current practice of developing facilities in multiple phases over an extended period of time. Whenever a facility has reached an actual production capacity greater than 100,000 bpd from combined development, it is deemed the industrial processes are complex and combined emissions from all sources have the potential to impact air quality. In an effort to rationalize instalment of a fixed monitoring station for each phase of development and eliminate redundancies, it recommended that a fixed monitoring station only be deployed when a facility reaches this production threshold.

6. For SAGD Projects with production levels below 100,000 bpd, establish a rotational ambient monitoring schedule to monitor ambient air for cumulative effects and compliance with AAQOs and CAAQS.

   Rationale: Facility specific monitoring and its integration in a regional monitoring plan will address the monitoring objective:

   - Determine air quality relative to ambient air quality objectives, guidelines, standards or criteria.

   For facilities that have less of a footprint on the environment and smaller emissions, efforts must be made to rationalize monitoring at individual facilities to an approach that coordinates compliance monitoring within a regional monitoring plan. Siting of stations would be based on the need for information on cumulative effects rather than establishing site-specific monitoring. This monitoring activity in conjunction with the establishment of meteorological monitoring at all facilities will provide data for the wind flows in the region and cumulative effects of air pollution on environment and human health.

7. Establish a passive monitoring network or new technology methods in the southern region to meet with AESRD's Industrial Air Quality Management System.

Rationale: Establishment of a passive or new technology method stations that will monitor for parameters to determine potential impacts of air pollution on land, water and vegetation. The monitoring objectives addressed are to:

- Provide air quality data in support of exposure assessments on environment and human health.
- Determine air quality relative to ambient air quality objectives, guidelines, standards or criteria.
- Support the monitoring and reporting requirements associated with air quality or deposition management frameworks and EPEA regulatory approvals.
- Address gaps in air quality and deposition monitoring in the WBEA Airshed's southern region.
- Characterize background and transboundary air quality in the region.
- Determine long-term trends.

A comprehensive ecosystem monitoring network is necessary to understand the cumulative effects of air pollutants on environmental receptors. Data gathered by this activity would be used to create a monthly and annual spatial map of air pollutant levels for the WBEA Airshed. The data could also be used to detect long-term trends in air quality.

Phase 3:

8. Conduct a dispersion modelling study of emissions from the facilities in the WBEA region for cumulative effects; perform ambient air quality and meteorological data analysis for identification of monitoring gaps, elimination of redundancies and opportunities for efficiencies.

Rationale: The monitoring network will be reviewed and modified based on updated scientific assessments and evaluation of the appropriate monitoring network density to meet the stated objectives.

<u>Upon acceptance of the concepts and objectives presented in this monitoring plan, a list of monitoring locations, map and schedule for portable monitoring will be forwarded to all stakeholders.</u>

Meteorological and Climate in the Area

Meteorology determines the transport and dispersion of industrial emissions, and hence plays a significant role in determining air quality downwind of emission sources.

The climate of a region is defined as the average meteorological conditions, including wind, temperature and precipitation, measured over a period of many years. Northeastern Alberta is generally described as having a cool, continental climate.

Maps by Alberta Agriculture and Rural Development of mean wind speed and prevailing wind direction based on 1971 to 2000 data per season are presented in Figure 3. The wind flows in the region vary with seasons, with winds from the north and flowing towards east during the winter season (December to February). In spring (March to May), the wind flow patterns are from the southwest and east converging west of Fort McMurray to a north easterly flow. During the summer months (June to August), the winds are predominantly from the west. The fall season (September to November) has a high variability of wind flow patterns. The winds are from the west, with influences from northern and eastern winds. These meteorological conditions were observed at different heights and may not be representative of micro-climate conditions experienced near the emission sources or nearby communities.

The data from three Environment Canada stations for the period 1971 to 2000 are also presented as windroses (Figure 4). These stations are Fort Chipewyan (north), Fort McMurray (central) and Cold Lake (south). Similar wind patterns are observed at all three of these stations. There is a general east-west wind pattern at all stations; however, winds from the east-northeast are predominant at Fort Chipewyan, while east-southeasterly winds are predominant at Fort McMurray.

As stated earlier, local topography and micro-climate conditions experienced near the emission sources or nearby communities affect the plume dispersion and air flow in a local area. On-site meteorological tower at the facilities will enable users to better understand air flow near emission sources.

Wind data from the WBEA Anzac air monitoring station, the closest station to the southern region, is presented in Figure 5. Winds at the Anzac station measured at 20 meters above ground level were predominantly from the northwest and southeast quadrants and calm conditions occur 19% of the time.

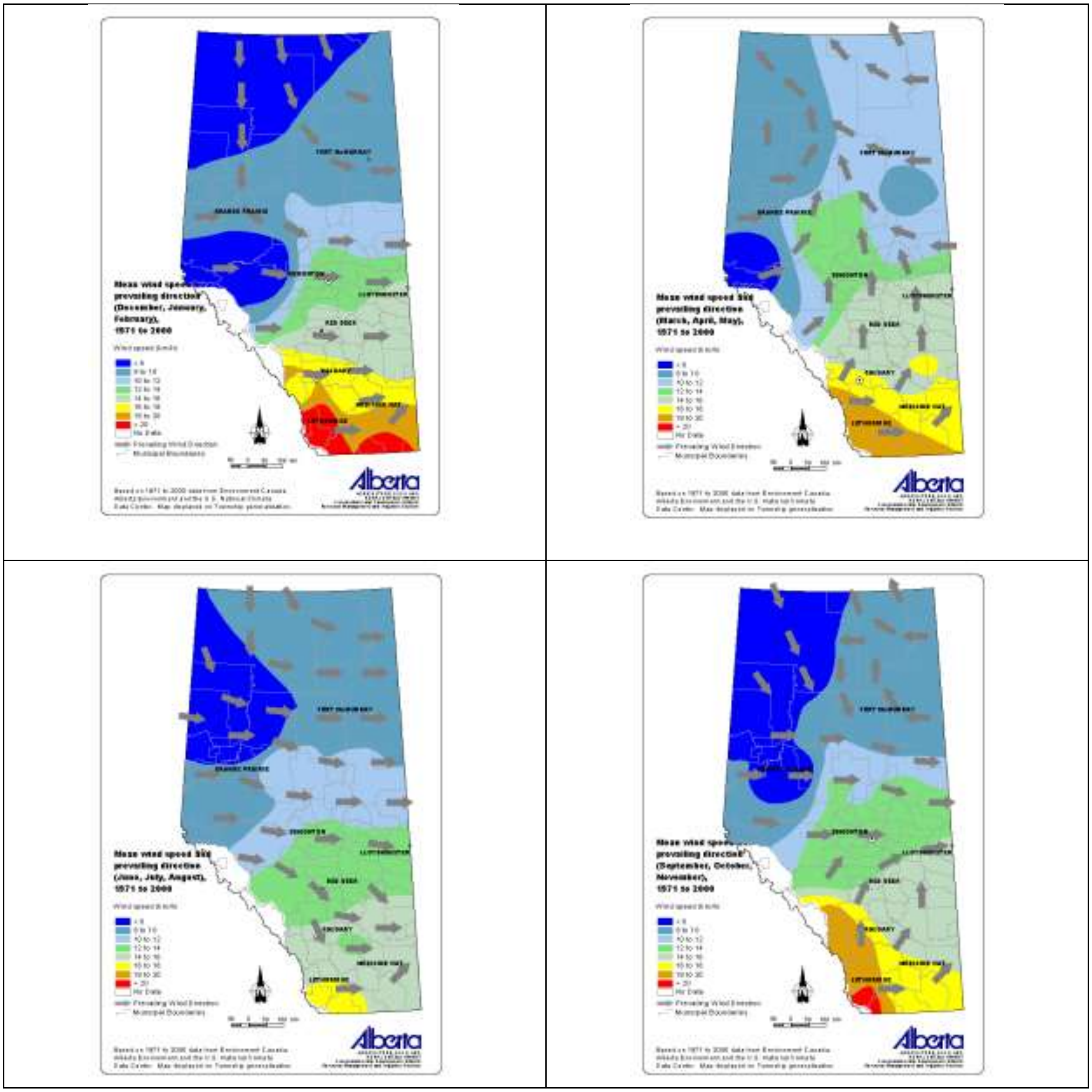

Figure 3. Wind flows per season in the region.

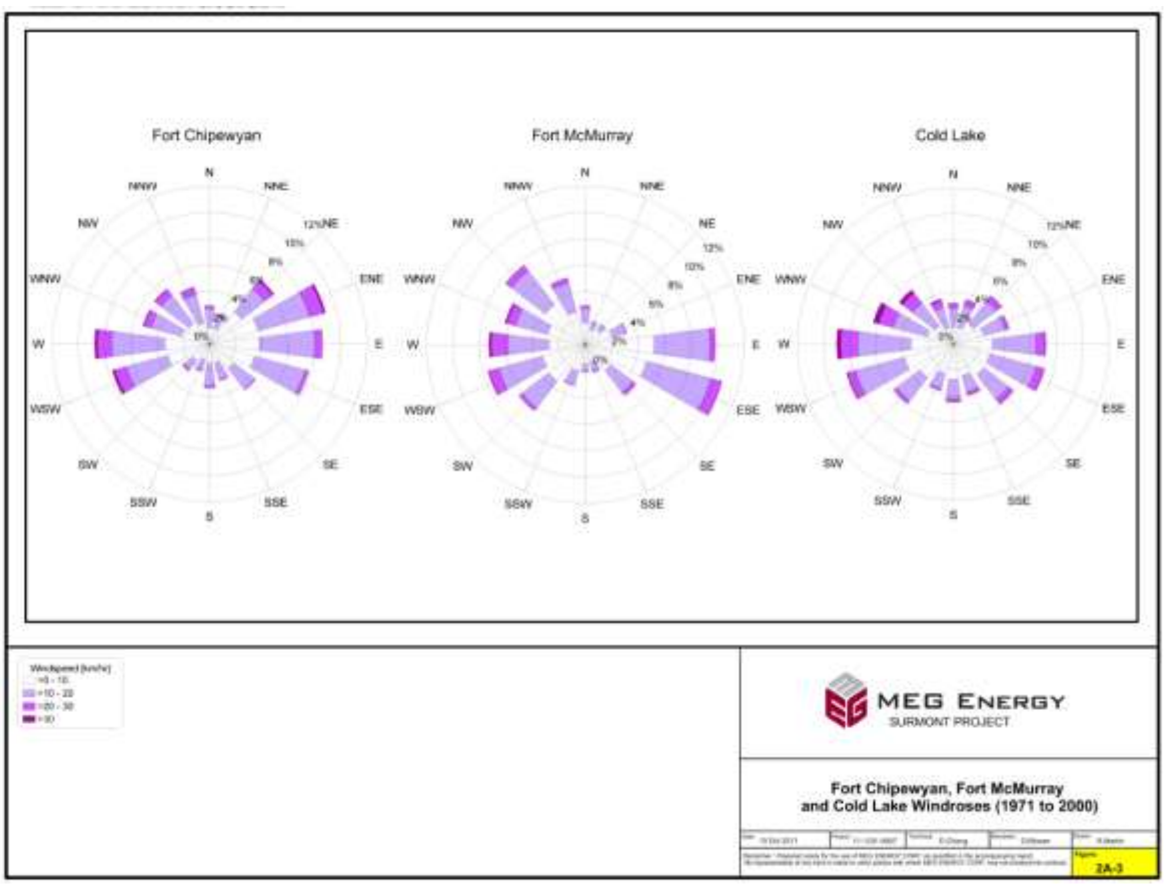

Figure 4. Regional Airport Windroses.

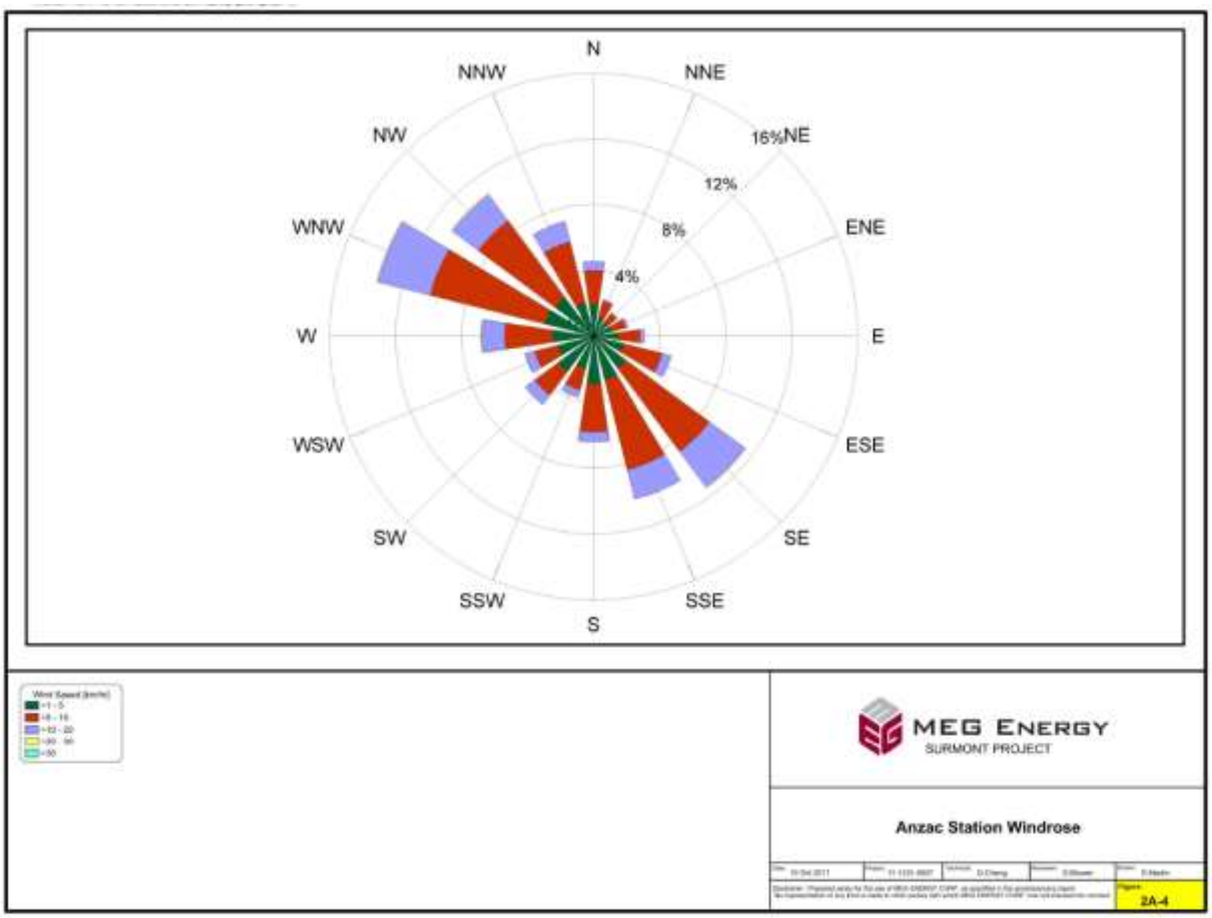

Figure 5. Anzac Air Monitoring Station Windrose.

Table 1 summarizes the historical monthly and annual mean air temperatures at the three airport locations. Annual average ambient temperatures are equal to 0.3, 0.9 and 1.6 °C at the Fort Chipewyan, Fort McMurray, and Cold Lake Airports, respectively.

Table 1. Regional Airport Mean Monthly Temperature

Month	Mean Monthly Temperature (°C) Fort Chipewyan Airport	Fort McMurray Airport	Cold Lake Airport
January	-19.5	-17.2	-17
February	-15	-12.9	-12.7
March	-7.8	-8.2	-6.2
April	2.5	3.3	3.5
May	9.6	8.5	10.4
June	14.2	14.8	14.7
July	16.7	17.2	17.2
August	15	14.5	15.8
September	9.3	9.3	10.2
October	2.9	1.7	4.1
November	-8.3	-8.3	-6.3
December	-16.5	-11.9	-14.1
Source: National Climate Data and Information Archive			
http://climate.weather.gc.ca/climateData/			

Parameters to be monitored

Monitoring stations in the communities and near facilities should measure parameters that are required to meet the corresponding monitoring objectives.

Table 2 presents the proposed parameters for the monitoring stations.

Table 2. Proposed Parameters and Measurement Methodology

		Station	Conklin	Janvier	Facilities > 100,000 bpd	Facilities < 100,000 bpd	All Facilities	Southern Boundary	All Facilities	Measurement Technology	Operation Range	Lower Detectable Limit	Precision
		Purpose	Community	Community	Compliance	Compliance	Meteorological	Background	Ecosystem				(which ever is greater)
Method	Parameter	Parameter Description	Fixed	Fixed	Fixed	Portable	Fixed	Fixed	Fixed				
Continuous	SO2	Sulfur Dioxide	X	X	X	X		X		Pulsed fluorescence	0 - 1000 ppb	<0.5 ppb	1 % or 1 ppb
	H2S	Hydrogen Sulfide			X	X				Pulsed fluorescence	0 - 100 ppb	1.0 ppb	1 % or 1 ppb
	TRS	Total Reduced Sulfur	X	X				X		Pulsed fluorescence	0 - 100 ppb	1.0 ppb	1 % or 1 ppb
	O3	Ozone	X	X				X		UV Photometric	0 - 500 ppb	0.5 ppb	1 ppb
	NO2	Nitrogen Dioxide	X	X	X	X		X		Chemiluminescence	0 - 1000 ppb	<0.5 ppb	1 % or 1 ppb
	NO	Nitrogen Oxide	X	X	X	X		X		Chemiluminescence	0 - 1000 ppb	<0.5 ppb	1 % or 1 ppb
	NOX	Oxides of Nitrogen	X	X	X	X		X		Chemiluminescence	0 - 1000 ppb	<0.5 ppb	1 % or 1 ppb
	PM2.5	Particulate Matter 2.5µm	X	X				X		Photometry / beta attenuation	0 - 1000 ug/m3	0.5 ug/m3	2 ug/m3
	THC	Total hydrocarbon	X	X				X		Gas chromatography	0 - 50 ppm	0.05 ppm	2 % or 50 ppb
	NMHC	Non-methane Hydrocarbon	X	X				X		Gas chromatography	0 - 50 ppm	0.05 ppm	2 % or 50 ppb
	CH4	Methane	X	X				X		Gas chromatography	0 - 50 ppm	0.05 ppm	2 % or 50 ppb
Meteorology	TEMP	Temperature	X	X	X	X	X	X		Sensor	-80 - +60 °C	0.2	0.2°C
	WS	Wind Speed	X	X	X	X	X	X		Sensor - Three-cup anemometer	0 - 60 m/s	0.1 m/s	1% or 0.07 m/s
	WD	Wind Direction	X	X	X	X	X	X		Sensor - Vane	0 - 360°	<0.1°	3°
	RH	Relative Humidity	X	X	X	X	X	X		Sensor	0 - 100 %		1% RH
	GR	Global Radiation	X	X				X		Sensor	0 - 2900W/m2		9 mV/kW.M2
	PRECIP	Precipitation	X	X				X		Tipping Bucket	0 - 120 mm/hr	0.1mm/tip	1% (30 mm/hr)
Semi-Continuous	PM2.5	Particulate Matter 2.5µm (metals, ions)	X	X						Teflon Filter	Sample on NAPS dates		
	VOC	Volatile Organic Compounds	X	X						Cannister	Sample on NAPS dates		
	PAH	Polycyclic Aromatic Hydrocarbons	X	X						PUF/XAD	Sample on NAPS dates		
Passive	SO2	Sulfur Dioxide							X	Permeation/ Diffusion	Monthly Samples		
	H2S	Hydrogen Sulfide							X	Permeation/ Diffusion	Monthly Samples		
	NO2	Nitrogen Dioxide							X	Permeation/ Diffusion	Monthly Samples		
	O3	Ozone							X	Permeation/ Diffusion	Monthly Samples		

Ambient Monitoring Results

Ambient air quality measurements can provide an indication of impacts associated with existing emission sources and a baseline for comparing projected air quality changes associated with future developments. The ability to assess the air quality impacts associated with emission sources depends on the location of ambient air monitoring sites and what they are monitoring and the methods used to measure air quality parameters. The current air monitoring network in the southern region has limitations in terms of its ability to assess the impact of emissions on air quality from either a local i.e. near source, or regional i.e. southern region perspective.

This section provides a comparison of ambient air quality measurements at the Fort Chipewyan air monitoring station with the air quality surveys conducted using a portable air monitoring station in the southern region. This comparison is a snapshot of air quality in the region. Due to the limited data available, long-term data trends or impacts from emission sources cannot be inferred.

Continuous Monitoring Data

WBEA has conducted a number of ambient air monitoring studies in the region.

1. Conklin, August 31 to September 14, 2009
2. Janvier, August 12 to 27, 2009
3. ConocoPhillips Surmont, October 1, 2011 to March 31, 2012
4. Conklin, May 5 to October 10, 2012
5. Cenovus Christina Lake, October 15, 2012 to January 23, 2013
6. Statoil Leismer May 23 to August 14, 2013
7. ConocoPhillips Surmont July 3 to November 4, 2013

Table 3 presents a summary of the ambient air quality monitoring conducted by WBEA in the southern region from 2011 – 2013.

Table 3. Summary of Ambient Air Quality Measurements by WBEA (2011- 2013).

Parameter	Period	units	Statistical Value	Conklin	Conoco Phillips Surmont	Cenovus Christina Lake	Statoil Leismer	Conoco Phillips Surmont	Fort Chipewyan	Global Background	AAAQO/G
			Location	May 5 - Oct 10, 2012	Oct 2011 - Mar 2012	Oct 15 2012 - Jan 23, 2013	May 23 - Aug 31, 2013	Jul 3 - Oct 31, 2013	Jan - Dec 2013	1-hour	
Sulfur Dioxide	1-hour	ppb	Maximum	3.1	52	14	7	27	19	0.04 -0.53	172
	24-hour	ppb	Maximum	1.1	26	1.7	2	9	4		48
	Annual	ppb	Average	-	-	-	-		0.3		8
Hydrogen Sulfide	1-hour	ppb	Maximum	5.9	60	2	2	6	-	0.03 - 0.84	10
	24-hour	ppb	Maximum	0.5	9	1	1	1	-		3
Nitrogen Dioxide	1-hour	ppb	Maximum	7.7	96	21	76	38	28	0.1 - 0.5	159
	24-hour	ppb	Maximum	2.8	26	11	22	12	14		-
	Annual	ppb	Average	-	-	-	-	-	0.8		24
Ozone	1-hour	ppb	Maximum	65	-	43	-	-	65	30 - 40	82
	24-hour	ppb	Maximum	50	-	37	-	-	47		-
	Annual	ppb	Average	-	-	-	-	-	27.6		-
Fine Particulate Matter	1-hour	ug/m3	Maximum	268	-	50	-	-	133.2		80
	24-hour	ug/m3	Maximum	85	-	15	-	-	56.3		30
	Annual	ug/m3	Average	-	-	-	-	-	3.8		-
Total Hydrocarbon	1-hour	ppmc	Maximum	3.6	-	3.5	3.2	4.4	-	1.9 - 2.0	-
	24-hour	ppmc	Maximum	2.5	-	2.5	2.4	2.4	-		-
	Annual	ppmc	Average	-	-	-	-	-	-		

In 2009, WBEA conducted continuous monitoring for short periods of time in the communities of Janvier and Conklin. These measurements were taken using the WBEA mobile monitoring station. The reports titled *Ambient Air Quality Monitoring in Conklin, AB, August 31st- September 14th, 2009, Ambient Air Quality Monitoring in Janvier, AB., August 12th - 27th, 2009* and *A Summary of Ambient Air Quality at Conklin, Alberta, Monitored from May 5th to October, 10th, 2012 by the Wood Buffalo Environmental Association*, are available from the WBEA website at www.wbea.org.

Passive Monitoring Data

A series of passive monitoring stations have been established in the region, which monitor SO_2, NO_2, O_3, and H_2S. The passive samplers provide monthly average measurements. Passive SO_2, NO_2 and H_2S data from facility operators in the region and WBEA for monitoring years 2011 and 2012 are presented in Tables 4 to 9. Figure 1 shows the locations of the WBEA passive monitors.

Sulphur Dioxide (SO_2)

- There were no exceedances in the airshed of the 30-day average SO_2 Alberta Ambient Air Quality Objective (AAAQO) of 11 ppb.
- The maximum measured 30-day concentration of SO_2 at an industry site was 1.8 ppb.
- The maximum 30-day concentration at the WBEA Forest Health monitoring sites was 3.0 ppb.

Nitrogen Dioxide (NO_2)

- AESRD does not have a 30-day air quality objective for NO_2.
- There are currently no measurements of NO_2 using passive samplers at the industry sites.
- The maximum 30-day concentration at the WBEA Forest Health monitoring sites was 10.1 ppb.

Hydrogen Sulphide (H_2S)

- AESRD does not have a 30-day air quality objective for H_2S.
- The maximum measured 30-day concentration of H_2S at an industry site was 0.5 ppb.
- There are currently no measurements of H_2S using passive samplers at the WBEA Forest Health monitoring sites.

Table 4. SO_2 Passive Sample Results 2011

Monitoring Location	2011 Average Monthly Concentration (ppb)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Statoil Leismer	1.5	1.6	0.4	0.2	0.3	0.1	0.1	0.3	0.3	0.3	0.6	0.9
Nexen Long Lake	1.2	1.5	1.0	0.6	0.5	0.6	0.3	0.3	0.4	0.4	0.6	0.9
MEG Energy Christina Lake	0.6	0.5	1.0	0.4	0.1	0.1	0.6	0.2	0.4	0.2	0.2	0.5
Devon Jackfish 1	0.7	1.4	1.3	0.7	0.8	0.7	0.5	0.7	1.1	0.8	1.1	1.5
Devon Jackfish 2	-	-	-	-	0.1	0.3	0.1	0.2	0.4	0.3	0.7	0.8
Cenovus Christina Lake	0.6	0.7	0.9	0.4	0.4	0.3	0.3	0.4	0.8	0.4	0.9	1.1
Conoco Phillips Surmont	1.7	1.1	0.7	0.5	0.3	0.4	0.6	0.7	0.6	0.5	1.5	1.6
WBEA Forest Health Sites												
PL7	1.9	-	1.7	1.8	-	-	-	-	-	-	-	-
PH6	-	-	-	-	-	-	-	-	-	-	-	-
AL8	-	-	-	-	-	-	-	-	-	-	-	-
PH4	1.2	-	1.6	1.0	1.2	1.3	2.1	3.0	2.4	-	2.1	-
AH8	1.1	-	1.4	0.9	0.8	0.4	0.4	0.3	0.3	-	-	-
PH2	1.3	-	2.4	2.3	1.6	0.9	0.7	1.5	0.4	-	0.9	-
PL1	2.3	-	1.7	0.8	1.0	0.3	0.2	0.3	0.3	-	0.7	-
205'	1.7	-	0.9	0.3	-	-	0.3	0.5	0.7	-	1.1	-
210'	0.9	-	1.0	0.5	0.2	0.2	0.2	0.3	0.4	-	0.6	-
212	0.6	-	1.3	1.1	0.9	2.0	1.5	2.1	1.5	-	0.5	-
213'	0.7	-	1.1	0.7	0.0	-	-	-	-	-	-	-
PL8	-	-	-	-	0.0	0.3	0.1	0.3	0.2	-	0.4	-
AH3	1.3	-	2.3	1.8	0.4	0.2	0.3	0.3	0.3	-	0.6	-
AH7	2.5	-	2.1	1.7	-	-	1.1	1.1	-	-	0.0	-
SM7	1.2	-	-	-	0.2	0.2	0.0	0.1	0.3	-	0.3	-
WF4	0.9	-	0.9	0.5	0.9	-	1.0	1.1	-	-	0.5	-
BM7	0.6	-	-	-	0.3	0.0	0.2	0.1	0.3	-	0.4	-
NE7	1.2	-	1.5	0.8	0.5	0.5	0.9	1.5	1.3	-	1.5	-
BM10	0.9	-	-	-	0.5	0.3	0.3	0.4	0.2	-	0.8	-
BM11	2.3	-	1.3	0.5	0.5	0.2	0.4	0.2	0.3	-	0.9	-
SM8	1.3	-	-	-	0.3	0.0	0.0	0.1	0.2	-	0.5	-
NE10	0.7	-	1.1	0.6	0.1	0.0	0.2	0.2	0.3	-	0.5	-
NE11	1.0	-	-	-	-	-	0.6	0.7	1.4	-	1.2	-
R2	0.9	-	2.3	1.5	-	1.0	1.6	2.3	2.2	-	1.6	-

Table 5. SO_2 Passive Sample Results 2012

Monitoring Location	2012 Average Monthly Concentration (ppb)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Statoil Leismer	0.6	1.1	0.5	0.2	0.4	0.4	0.3	0.2	0.4	0.7	0.7	1.0
Nexen Long Lake	1.3	1.3	0.7	0.6	0.5	0.6	0.6	0.5	0.4	1.0	0.9	1.8
MEG Energy Christina Lake	0.6	0.5	0.4	0.3	0.2	0.2	0.1	0.2	0.2	0.5	0.4	0.3
Devon Jackfish 1	1.4	1.6	1.1	1.0	0.8	0.7	0.8	1.0	0.4	0.6	1.1	1.3
Devon Jackfish 2	0.9	1.0	0.9	1.1	0.8	1.0	0.9	0.8	1.5	1.5	1.4	1.2
Cenovus Christina Lake	1.4	0.9	0.8	0.5	0.3	0.3	0.3	0.3	-	0.6	0.8	1.0
Conoco Phillips Surmont	1.1	0.8	0.7	0.8	0.6	0.7	0.7	0.6	0.7	0.9	1.0	1.1
WBEA Forest Health Sites												
PL7	1.5	-	1.0	0.6	0.3	0.1	0.5	0.6	0.9	-	0.9	-
PH6	-	-	-	-	-	-	-	-	-	-	-	-
AL8	-	-	-	-	-	-	-	-	-	-	-	-
PH4	1.6	-	1.5	2.7	1.9	1.6	2.2	2.8	2.4	-	0.8	-
AH8	0.9	-	1.1	1.5	0.7	0.2	0.1	0.2	0.1	-	0.6	-
PH2	0.3	-	1.2	1.0	0.9	2.0	1.5	1.1	0.8	-	1.2	-
PL1	1.1	-	2.1	0.5	0.2	0.3	0.4	0.4	0.3	-	1.0	-
205'	1.9	-	1.0	0.5	0.3	0.2	0.4	0.4	0.8	-	0.6	-
210'	0.8	-	0.7	0.3	0.3	0.2	0.2	0.4	0.4	-	0.5	-
212	1.0	-	1.2	1.6	1.6	1.8	2.0	2.5	0.8	-	1.1	-
213'	1.5	-	0.5	0.4	0.4	0.2	0.4	0.5	0.3	-	1.0	-
PL8	0.2	-	0.3	0.2	0.0	0.0	0.1	0.2	0.4	-	0.3	-
AH3	0.7	-	0.7	0.4	0.6	0.4	0.2	0.6	0.6	-	0.8	-
AH7	1.5	-	2.4	-	-	-	-	-	0.7	-	1.2	-
SM7	0.5	-	0.5	0.3	0.0	0.0	0.0	0.1	0.2	-	0.6	-
WF4	0.9	-	1.2	1.3	1.2	1.1	1.9	1.7	0.9	-	0.7	-
BM7	0.5	-	0.5	0.7	0.3	0.0	0.0	0.3	0.3	-	0.6	-
NE7	2.8	-	0.9	0.4	0.7	0.5	0.6	1.2	0.9	-	0.9	-
BM10	1.1	-	0.6	1.0	0.4	0.4	0.2	0.3	0.5	-	0.8	-
BM11	0.8	-	0.6	1.0	0.2	0.4	0.2	0.4	0.4	-	1.3	-
SM8	0.9	-	0.7	0.4	0.2	-	0.2	0.3	0.2	-	0.9	-
NE10	0.5	-	0.5	0.2	0.2	-	0.3	0.3	0.3	-	0.8	-
NE11	1.6	-	1.3	1.1	-	0.4	1.4	0.8	1.0	-	0.4	-
R2	1.4	-	1.6	2.6	1.8	1.3	1.9	3.0	1.6	-	0.6	-
JP316	-	-	-	-	-	-	-	-	0.4	-	0.5	-

Table 6. NO_2 Passive Sample Results 2011

Monitoring Location	2011 Average Monthly Concentration (ppb)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
WBEA Forest Health Sites												
PL7	3.0	-	2.1	1.1	-	-	-	-	-	-	-	-
PH6	-	-	-	-	-	-	-	-	-	-	-	-
AL8	-	-	-	-	-	-	-	-	-	-	-	-
PH4	7.1	-	2.2	1.2	1.9	1.8	1.4	2.7	3.2	-	6.1	-
AH8	1.9	-	0.9	0.3	0.5	0.3	0.3	0.1	0.4	-		-
PH2	5.0	-	3.8	2.0	2.1	1.0	0.6	0.8	0.9	-	2.8	-
PL1	1.5	-	0.8	0.3	0.7	0.3	0.1	0.0	0.2	-	0.8	-
205'	0.5	-	0.2	0.1	-	-	0.2	0.2	0.4	-	1.0	-
210'	1.0	-	0.1	0.1	0.1	0.0	0.1	0.0	0.3	-	0.5	-
212	5.6	-	1.0	0.9	0.9	1.5	1.7	1.9	2.4	-	0.4	-
213'	0.1	-	0.5	0.2	0.1	-	-	-	-	-	-	-
PL8	-	-	-	-	0.2	0.1	0.0	0.0	0.1	-	0.2	-
AH3	2.1	-	1.4	0.6	0.4	0.2	0.2	0.4	0.4	-	1.4	-
AH7	2.8	-	1.5	1.2	-	-	0.3	0.3		-		-
SM7	0.6	-	-	-	0.2	0.1	0.1	0.2	0.4	-	0.5	-
WF4	1.6	-	0.2	0.2	0.9	-	0.2	0.2	0.6	-	0.8	-
BM7	0.0	-	-	-	0.2	0.0	0.0	0.0	0.1	-	0.1	-
NE7	0.7	-	0.2	0.3	0.3	0.3	0.4	0.8	1.0	-	1.1	-
BM10	0.4	-	-	-	0.4	0.0	0.0	0.0	0.3	-	0.5	-
BM11	0.2	-	0.0	0.0	0.2	0.2	0.0	0.0	0.2	-	0.3	-
SM8	0.6	-	-	-	0.2	0.0	0.0	0.0	0.2	-	0.4	-
NE10	0.4	-	0.3	0.4	0.2	0.0	0.1	0.0	0.2	-	0.3	-
NE11	1.9	-	-	-	-	-	0.5	0.8	1.0	-	2.2	-
R2	6.0	-	2.4	2.0	-	1.6	1.3	2.3	3.2	-	4.7	-

Table 7. NO_2 Passive Sample Results 2012

Monitoring Location	2012 Average Monthly Concentration (ppb)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
WBEA Forest Health Sites												
PL7	2.9	-	0.9	0.2	0.2	0.0	0.2	0.4	1.2	-	1.2	-
PH6	-	-	-	-	-	-	-	-	-	-	-	-
AL8	-	-	-	-	-	-	-	-	-	-	-	-
PH4	10.1	-	5.2	2.9	2.8	1.5	3.1	3.1	5.0	-	5.2	-
AH8	1.4	-	1.4	0.8	0.4	0.0	0.4	0.2	0.4	-	1.3	-
PH2	2.9	-	3.5	1.0	0.6	0.8	0.9	1.1	1.9	-	2.8	-
PL1	1.0	-	1.0	0.2	0.0	0.0	0.3	0.2	0.3	-	0.6	-
205'	1.4	-	0.2	0.0	0.2	0.0	0.1	0.2	0.3	-	0.1	-
210'	1.3	-	0.6	0.0	0.0	0.0	0.1	0.1	0.3	-	0.6	-
212	6.1	-	2.9	2.9	2.0	1.6	2.2	2.0	2.9	-	1.8	-
213'	0.8	-	0.3	0.0	0.1	0.0	0.0	0.2	0.4	-	0.0	-
PL8	0.5	-	0.3	0.0	0.0	0.0	0.0	0.0	0.2	-	0.0	-
AH3	2.2	-	1.2	0.0	0.3	0.3	0.2	0.3	0.9	-	1.1	-
AH7	2.0	-	2.0	-	-	-	-	-	1.0	-	1.8	-
SM7	0.7	-	0.0	0.0	0.0	0.0	0.2	0.3	0.4	-	0.3	-
WF4	1.3	-	0.6	0.9	0.5	0.3	0.2	0.2	0.4	-	1.3	-
BM7	0.0	-	0.0	0.0	0.2	0.0	0.0	0.0	0.0	-	0.0	-
NE7	2.9	-	0.4	0.0	0.3	0.1	0.2	0.5	0.7	-	0.7	-
BM10	0.4	-	0.2	0.1	0.2	0.0	0.1	0.1	0.0	-	0.4	-
BM11	0.2	-	0.1	0.0	0.1	0.0	0.0	0.1	0.0	-	0.1	-
SM8	0.6	-	0.0	0.0	0.0	-	0.0	0.7	0.2	-	0.4	-
NE10	0.4	-	0.0	0.0	0.0	-	0.2	0.1	0.1	-	0.0	-
NE11	2.5	-	0.6	0.4	-	0.3	0.8	1.4	1.5	-	1.3	-
R2	8.5	-	2.6	2.4	2.0	1.3	1.8	1.9	3.6	-	3.5	-
JP316	-	-	-	-	-	-	-	-	0.4	-	0.1	-

Table 8. H_2S Passive Sample Results 2011

Monitoring Location	2011 Average Monthly Concentration (ppb)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Statoil Leismer	0.2	0.2	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2
Nexen Long Lake	0.2	0.3	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.5
MEG Energy Christina Lake	0.2	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Devon Jackfish 1	0.1	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.1	0.1
Devon Jackfish 2	-	-	-	-	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Cenovus Christina Lake	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.2	0.1
Conoco Phillips Surmont	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.2

Table 9. H_2S Passive Sample Results 2012

Monitoring Location	2012 Average Monthly Concentration (ppb)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Statoil Leismer	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2
Nexen Long Lake	0.2	0.2	0.2	0.1	0.1	0.2	0.2	0.2	0.3	0.1	0.2	0.3
MEG Energy Christina Lake	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2
Devon Jackfish 1	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.2
Devon Jackfish 2	0.2	0.1	0.2	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2
Cenovus Christina Lake	0.2	-	0.4	0.1	0.1	0.1	0.2	0.1	-	0.1	0.1	0.1
Conoco Phillips Surmont	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1

Geostatistical methods were used to generate maps of SO_2 and NO_2 concentrations in the region using 2011-2012 data. An Inverse Distance Weighted (IDW) method was applied to interpolate the concentrations at the unmeasured areas. In situations when the monitoring data does not provide measurements which meet strict requirements of Kriging method, the IDW method usually provides more accurate results than other geostatistical methods.

The generated maps are continuous (provide interpolated and extrapolated concentrations at the unmeasured location), yet the spatial extent of the extrapolation is limited to what is considered to be a reasonable prediction, meaning that the level of confidence in the prediction is acceptable. The areas where the level of confidence in the predictions are low (high uncertainty) are grayed out on all prediction maps.

Two uncertainty maps (for the summer season of 2012 for both pollutants) were created using the geostatistical methods of the Empirical Bayesian Kriging (EBK). Figures 6 and 7 show the uncertainty concentration maps for the SO_2 and NO_2 passive sample results, respectively.

A copy of the complete report titled, *Report on maps of concentration of NO_2 and SO_2 for the summer and winter seasons of 2010 – 2012,* is attached as an appendix.

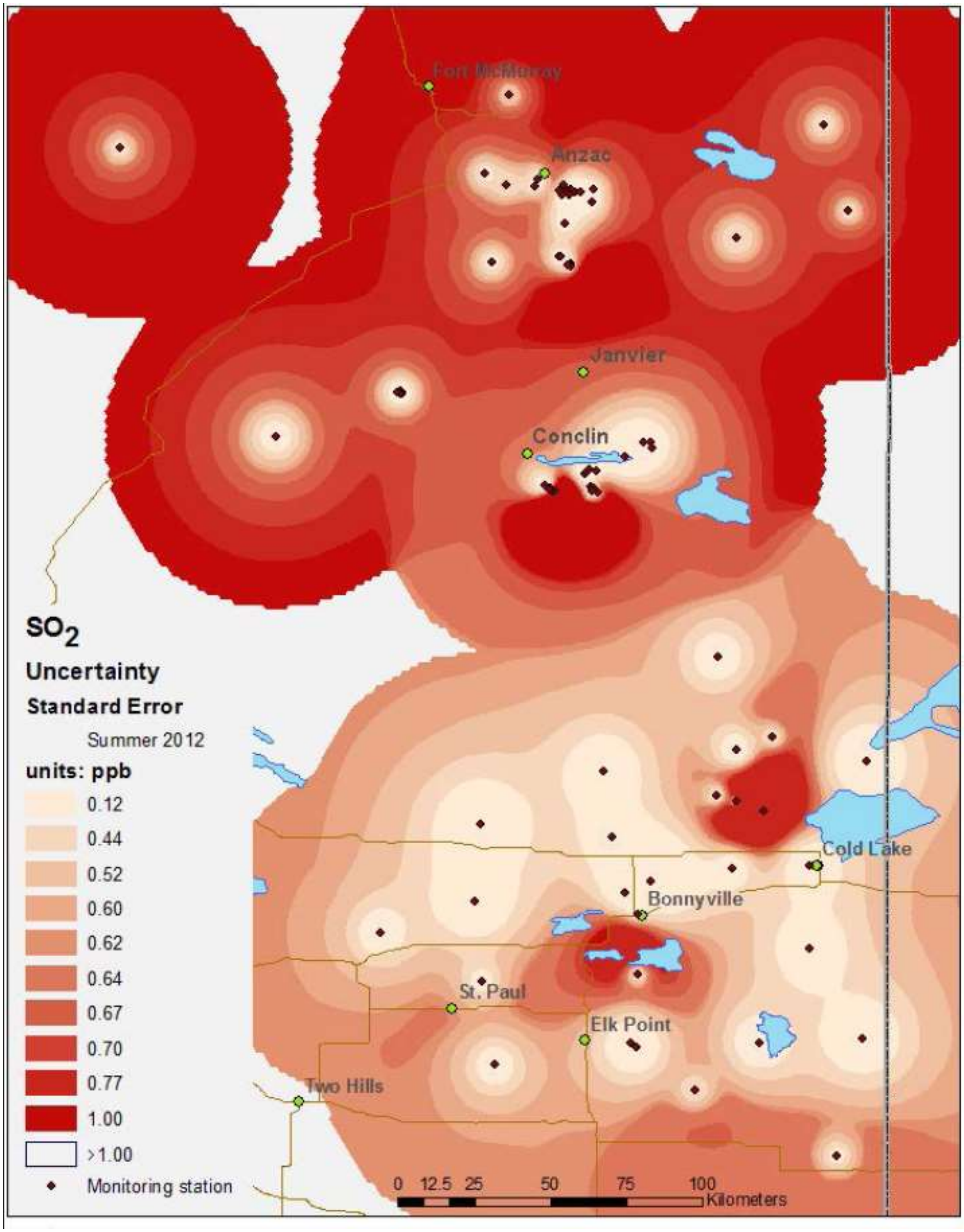

Figure 6. SO_2 Uncertainty Concentration Map - Summer 2012.

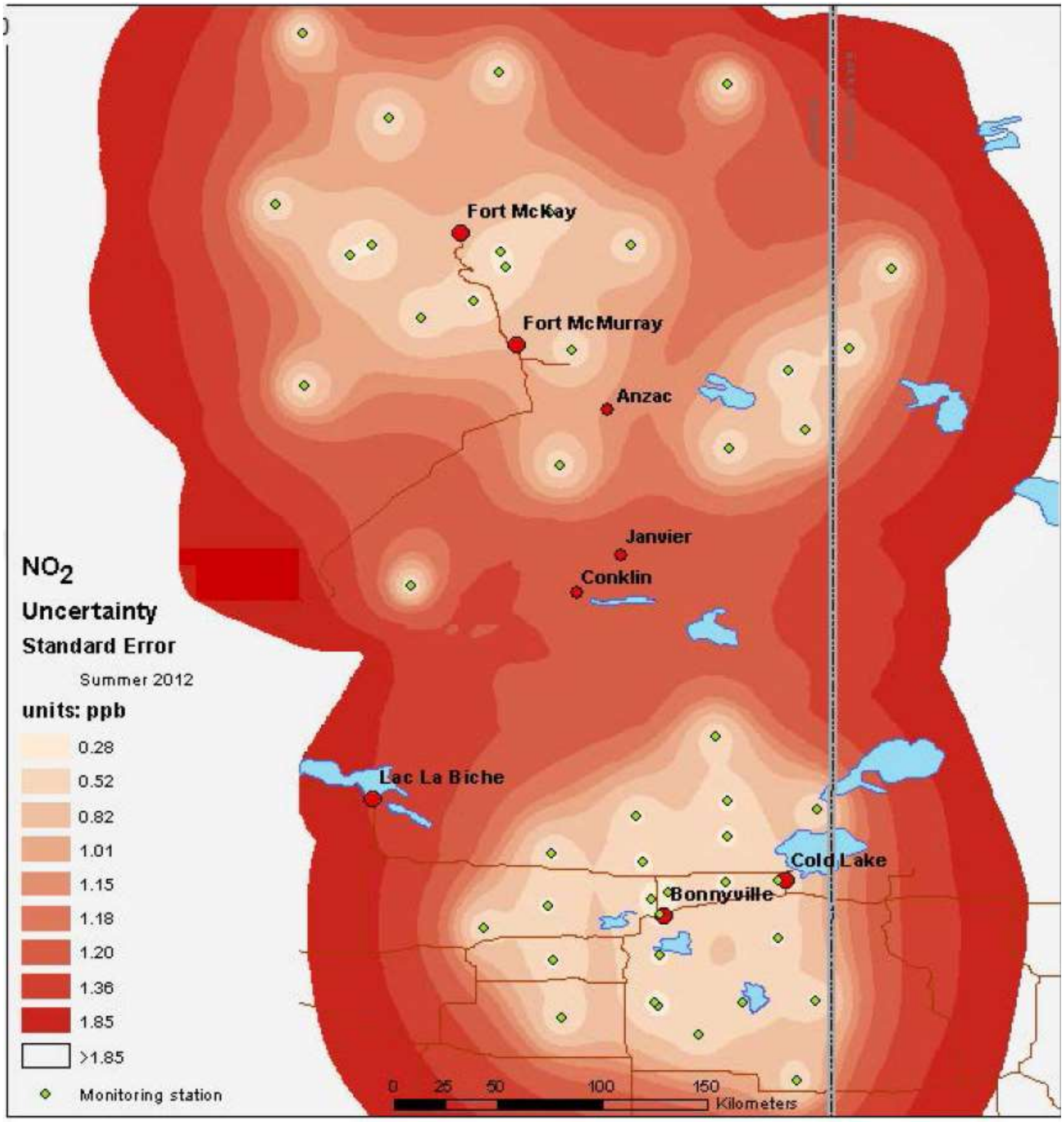

Figure 7. NO_2 Uncertainty Concentration Map - Summer 2012.

As a result of the geostatistical analysis, the following suggestions for optimization of the passive monitoring networks are proposed. There are several passive SO_2 monitoring stations operated by facility operators as of 2012 that might be considered for removal without compromising ambient concentrations trends measured by the passive sampling network.

a. With the exception of a single instance, none of the 5 stations (SCL – Leismer – passive – MO1-5) had any influence, or caused any change in the prediction for

SO_2 concentration. It is recommended to continue with one station from this cluster and this station should be located downwind of the emission sources.

b. The cluster of monitoring stations located to the east of Christina Lake (3 stations from MEG Energy Christina Lake Projects) can be reduced in size. The interpolation of SO_2 results based on a single station measurement was sufficient for trend mapping. It is recommended that two stations be eliminated.
c. The cluster of four stations (C1, C6, C10, and C11) located just to the south of Christina Lake provides 4 measured values of SO_2 concentration. From the perspective of optimizing the SO_2 monitoring network and long term trend mapping, two monitoring locations could be eliminated.

Some of the clusters from the passive SO_2 monitoring in the region indicate noticeable variation in concentrations over the area. In some cases, changes in concentration over a short distance (i.e. within 1 km) are observed. Because of these variations it is likely that unstable concentrations exist in the proximity of these clusters. Additional monitoring stations could improve the certainty of prediction for future trend mapping.

d. The cluster of stations at Conoco Phillips Surmont Project indicates a strong variation in concentrations; it would be beneficial, for improved reliability to add a new station to the south-east of the current cluster at a distance of 6-8 km.
e. A new station is proposed for the area south of Christina Lake. A new site approximately 20 km south from Christina Lake will increase confidence in concentration trend mapping for the region.
f. An additional station is proposed, to enhance the network, approximately 50 km north-east of Lac La Biche along highway 881. This site will increase confidence in concentration trend mapping for the region.

Emissions

Oil sands activities have the potential to affect the air quality in the region. The emission sources used in this assessment were based on MEG Energy Corp. Surmont Project Environmental Impact Assessment application (2012). The emission inventories presented are for existing and approved oil sands development and planned future development scenarios. While the existing and approved projects emission inventories are presented, it may take several years before construction is completed and operation of these facilities are fully functional and have emission levels as summarized here. The planned future development scenario includes emissions from existing and approved developments and publically disclosed projects as of December 4, 2011. These scenarios include projects that are in various stages of planning and have not received regulatory approval to operate and some projects which have not submitted its approval application.

Table 10 provides a comparison of emissions from existing and approved projects and planned future development scenarios as presented in the recent EIA application by MEG Energy for the Surmont Project.

Table 10. Summary of Emissions in the Southern Portion of the WBEA Airshed.

Description	Existing and Approved	Planned Future Development
SO_2 emissions (t/d)	47.17	67.83
NO_X emissions (t/d)	80.45	134.69
CO emissions (t/d)	78.81	156.87
PM2.5 emissions (t/d)	4.67	8.69
VOCs emissions (t/d)	6.58	11.06
TRS emissions (t/d)	0.21	0.35

Source: MEG EIA Application, 2012.

The emissions inventory for the Frontier Project, located north of the Fort McMurray, was filed by TECK Resources in 2011. It included some overlap of emissions from projects south of Fort McMurray. The emissions inventory used in the Frontier project is presented here solely in context of this report as a comparison of emissions in the WBEA Airshed. Table 11 provides an emissions summary used for the Frontier Project EIA application.

Table 11. Summary of Emissions for Northern Portion of the WBEA Airshed.

Description	Existing and Approved	Planned Future Development
SO_2 emissions (t/d)	351.2	370.14
NO_X emissions (t/d)	684.2	737.76
CO emissions (t/d)	804.4	880.68
PM2.5 emissions (t/d)	38.5	40.98
VOCs emissions (t/d)	627.0	768.74
TRS emissions (t/d)	10.9	11.77

Source: TECK EIA Application, 2011.

Figures 8 and 9 show maps of emission inventories used in the MEG Energy and Teck Resources in their respective EIA applications. For facilities in the southern region, EPEA approval numbers, milestone dates, production capacities and monitoring requirements are summarized in Table 12.

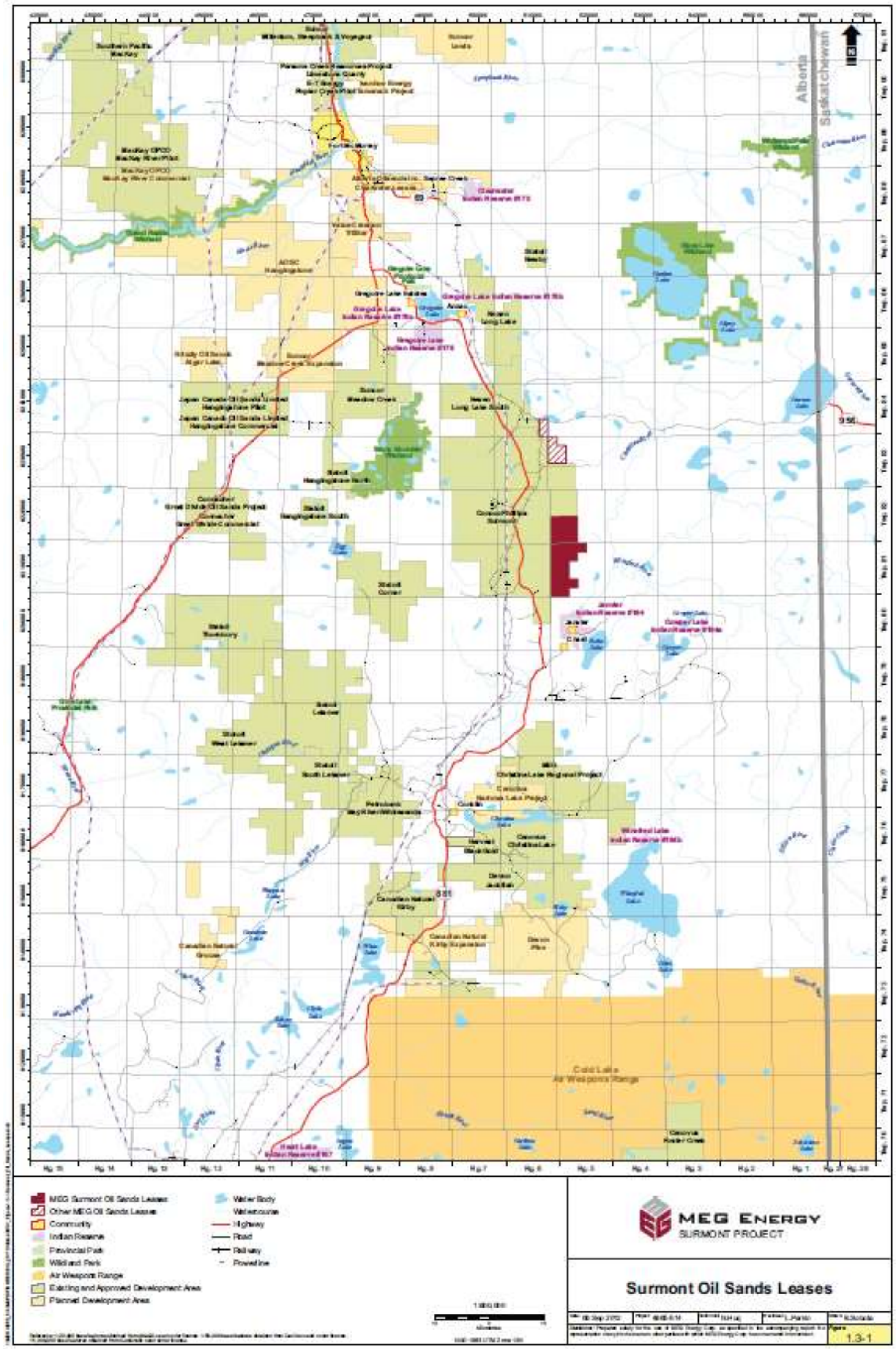

Figure 8. Major Emissions Sources used in the MEG Energy Application

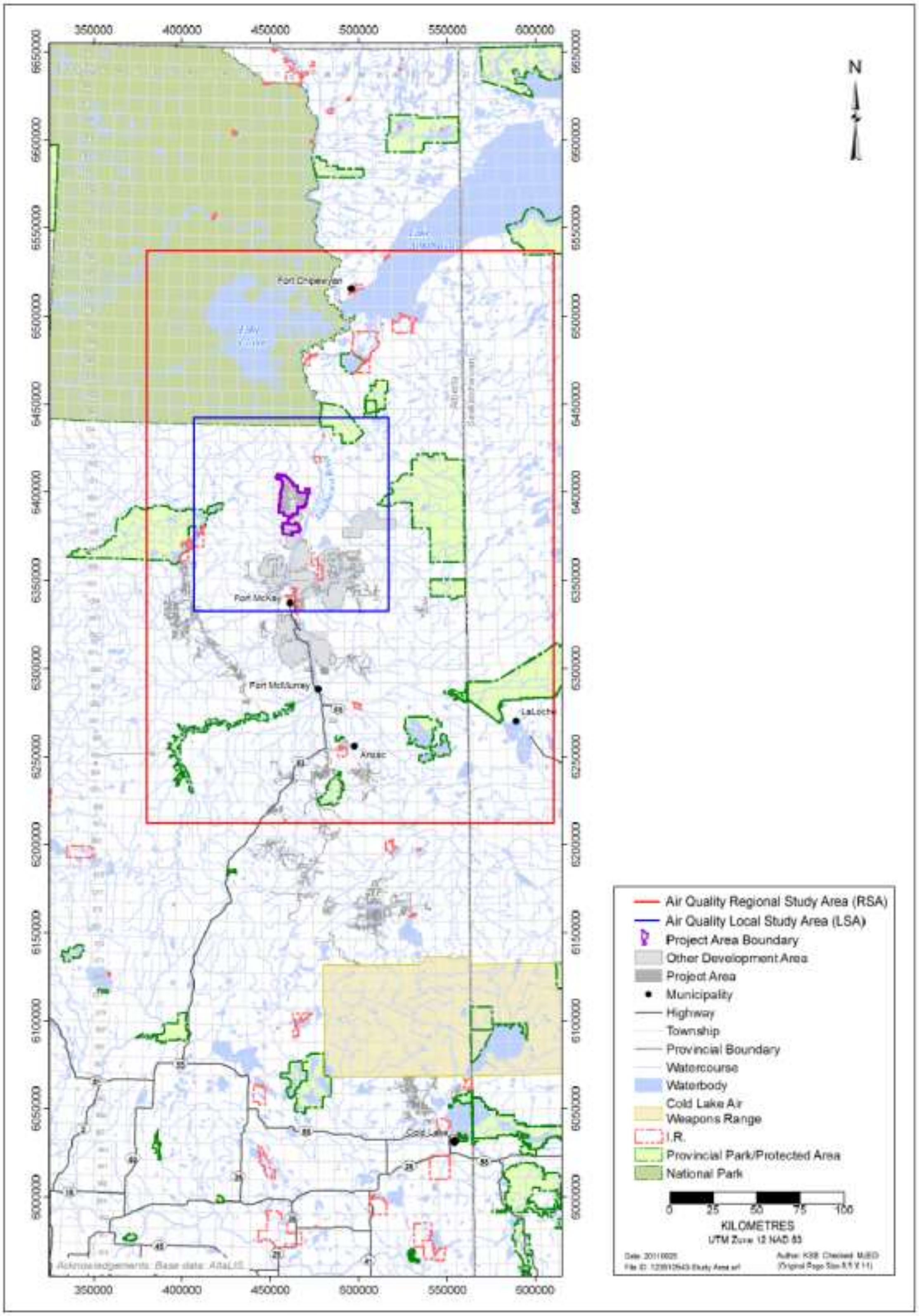

Figure 9. Major Emissions Sources used in the Frontier Project Application (2011)

Table 12. Project Development Information

Company Name	Facility Name and Phase	EPEA Approval No.	Timeline			Monitoring Requirements
			Construction Start	First Steam	Production	
Athabasca Oil Corporation	Hangingstone	289664-00-00	Operating	Q4 2014	12000 bbl/day	Passive – 4 station
Athabasca Oil Corporation	Hangingstone Expansion	Undergoing Regulatory Approval Review	2017/2018		70,000 bbl/ day	
CNRL	Kirby (KS1)	237382	Operating	Q4 2013	40000 bbl/day	
CNRL	Kirby (KN1)	250777	Approved	2017	40000 bbl/ day	
CNRL	Kirby (KN2)	250777	Application	2022	60000 bbl/day	
Cenovus FCCL Ltd.	Christina Lake Phases A -E	48522-01-00, 01, 02, 03, and 04	Operating	2002 -2013	138000 bbl/day	Continuous parameters – 12 months / yr Passives – 12 stations
Cenovus FCCL Ltd.	Christina Lake Phase F	48522-01-00, 01, 02, 03, and 04	2012	2015/2016	50000 bbl/day	
Cenovus FCCL Ltd.	Christina Lake Phases G	48522-01-00, 01, 02, 03, and 04	2014	2016/2017	50000 bbl/day	
Cenovus FCCL Ltd.	Christina Lake Phases H and Eastern Expansion	Undergoing Regulatory Approval Review		2019	50000 bbl/day	
Cenovus FCCL Ltd.	Narrows Lake	265959-00-00	2012	Q1 2017	130,000 bbl/day	Continuous parameters – 6 months / yr Passives – 4 stations

Company Name	Facility Name and Phase	EPEA Approval No.	Timeline			Monitoring Requirements
			Construction Start	**First Steam**	**Production**	
Conoco Phillips	Surmont1	48263-00-00	Operating	2007	27,000 bbl/day	Continuous parameters – 6 months / yr Passives – 4 stations
Conoco Phillips	Surmont2	48263-00-00	2010	2015	109,000 bbl/day	Continuous parameters – 6 months / yr Passives – 4 stations
Devon ARL	Jackfish	224816-00-03	Operating	2007	35,000 bbl/day	Continuous parameters – 12 months / yr Passives – 4 stations
Devon ARL	Jackfish 2	224816-00-03	Operating	2011	35,000 bbl/day	Continuous parameters – 12 months / yr Passives – 4 stations
Devon NEC	Jackfish 3	224816-00-03	Construction	2014	35,000 bbl/day	
MEG Energy Corp	Christina Lake Phase 1 - Pilot	216466-00-04	Operating	2008	3,000 bbl/day	Continuous parameters – 6 months / yr Passives – 4 stations
MEG Energy Corp	Christina Lake Phase 2A Phase 2B	216466-00-04	Operating Construction	2009 2013	22,000 bbl/day 35,000 bbl/day	Continuous parameters – 6 months / yr Passives – 8 stations

Company Name	**Facility Name and Phase**	**EPEA Approval No.**	**Timeline**			**Monitoring Requirements**
			Construction Start	**First Steam**	**Production**	
MEG Energy Corp	Christina Lake Phase 3A - C	216466-00-04	Approved	2016-2020	150,000 bbl/day	Continuous parameters – 6 months / yr Passives – 8 stations
MEG Energy Corp	Surmont	Undergoing Regulatory Approval Review	Application		41,000 bbl/day	
Connacher	Great Divide	240008-00-03	Operating	2007-2010	20,000 bbl/day	Continuous parameters – 6 months / yr Passives – 4 stations
Nexen Inc.	Long Lake Phase 1	137467-00-06	Operating	2007	58,500 bbl/day	Continuous parameters – 12 months / yr Passives – 12 stations
Nexen Inc.	Kinosis	236394-00-00	2009	Q3 2014	25,000 bbl/day	Continuous parameters – 12 months / yr Passives – 4 stations
Statoil	Corner	241311-00-02	Approved	2018	40,000 bbl/day	Continuous parameters – 3 months / yr Passives – 4 stations

Company Name	**Facility Name and Phase**	**EPEA Approval No.**	**Timeline**			**Monitoring Requirements**
			Construction Start	**First Steam**	**Production**	
Statoil	Leismer	241311-00-02	Operating	2010	10,000 bbl/day	Continuous parameters – 3 months / yr Passives – 4 stations

Sensitive Receptors in the Region

Figure 10 shows the map of the region with project lease boundaries and sensitive receptor locations based on previous EIAs submitted to AESRD.

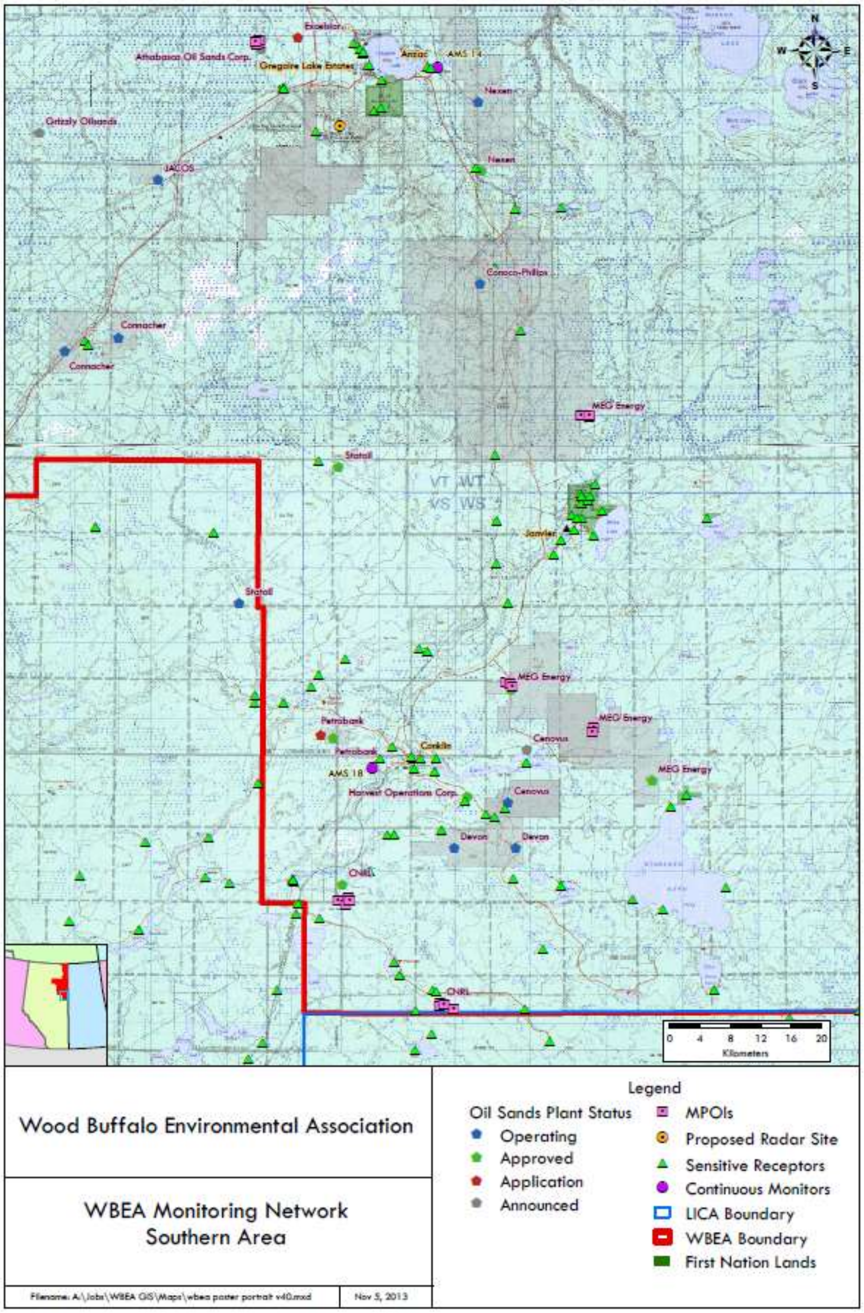

Figure 10. Sensitive Receptor locations

Operations and Data Management

The proposed southern monitoring plan would become part of the existing WBEA`s data and information management system which has developed over the last 15 years to meet user data and operational needs as well as regulatory requirements.

WBEA has comprehensive quality assurance and quality control programs in place to ensure data are accurate, reliable and fit for multiple objectives and all intended purposes. For full transparency, Standard Operation Protocols (SOP) for each parameter and individual site documentation have been copyrighted and are available publically at http://wbea.org/air-monitoring/standard-operating-procedures.

WBEA has implemented continual improvement of the ambient air monitoring program over the last 15 years to ensure data quality and continuity. Ambient air monitoring models from other monitoring jurisdictions and agencies were studied and reviewed for applicability in the Athabasca Oil Sands Region (AOSR). This region is comprised of a complex; dynamic mixture of natural and anthropogenic (fixed, mobile, fugitive) sources, requiring monitoring be conducted to support multi-pollutant control management.

After review of multiple monitoring models, the concept design for WBEA's air monitoring program resembles most closely with Ministry of Environment in New Zealand. The ambient air program establishes a comprehensive quality control procedures and planning and external audits for quality assurance and continuous improvement to the ambient air monitoring networks.

The conceptual ambient air monitoring model diagram is depicted in Figure 11:

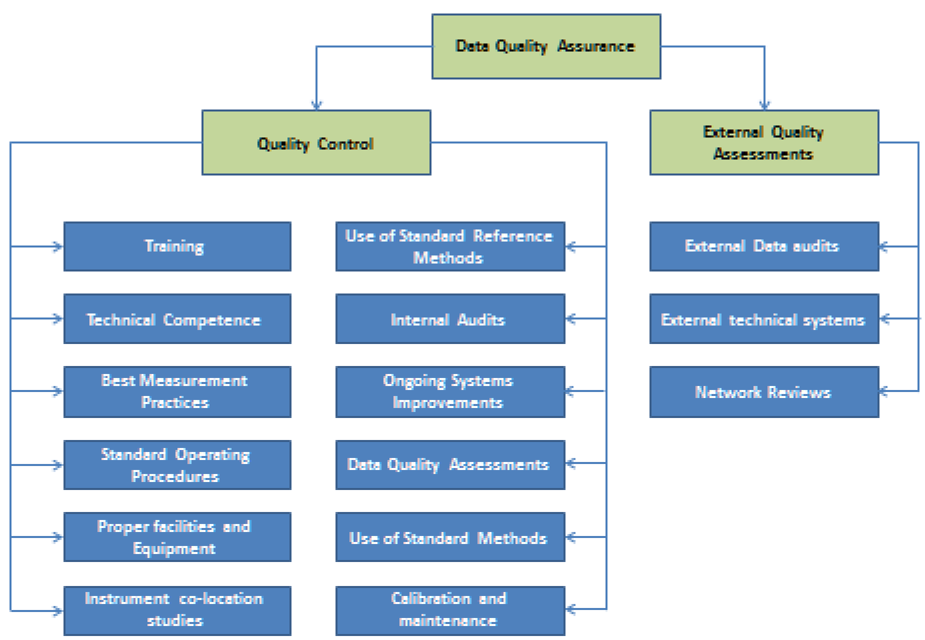

Figure 11. Ambient Air Monitoring Model Concept

For each component in this diagram, WBEA has designed and implemented procedures for daily, monthly and annual routines to ensure that operations and maintenance of the ambient air monitoring network are consistent with overall goals and objectives.

Operations and maintenance of the ambient air monitoring network and associated data collection generates a large amount of information which must be properly recorded for users, today and into the future. WBEA has developed two software systems for its web interfaced documentation systems. Specifically, these two programs are named *DOC-it* and *Sample-it*. *DOC-it* captures all daily routines and inspections of the network, and tracks events at each station. The *Sample-it* program is used to record information required for samples collected in the network and subsequently shipped to contracting laboratories for analyses. These two programs are similar to the chain of custody forms of yesteryears. The addition of information collection requirements ensures that current users or future reviewers can interpret the historical monitoring data with confidence.

The World Health Organization states that the ultimate purpose of monitoring is not merely to collect data, but to provide the information required by scientists, policymakers and planners to enable them to make informed decisions on managing and improving the environment. Monitoring fulfills a central role in this process, providing the necessary sound scientific basis for developing policies and strategies, setting objectives, assessing compliance with targets and planning enforcement action. (World Health Organization, 1989).

In keeping with the stated objectives of the World Health Organization and the WBEA's 2011-2015 Strategic Plan, we have developed a data management system (DMS) that ensures data are transmitted in near real-time to the WBEA website and raw data are validated and archived for future analysis. WBEA's validated data is available one week after the month in which they were collected. The validated data are then provided to stakeholders, regulators and the public to ensure information is available for informed decisions.

Figure 12 shows the flow of information from WBEA monitoring stations to various data repositories.

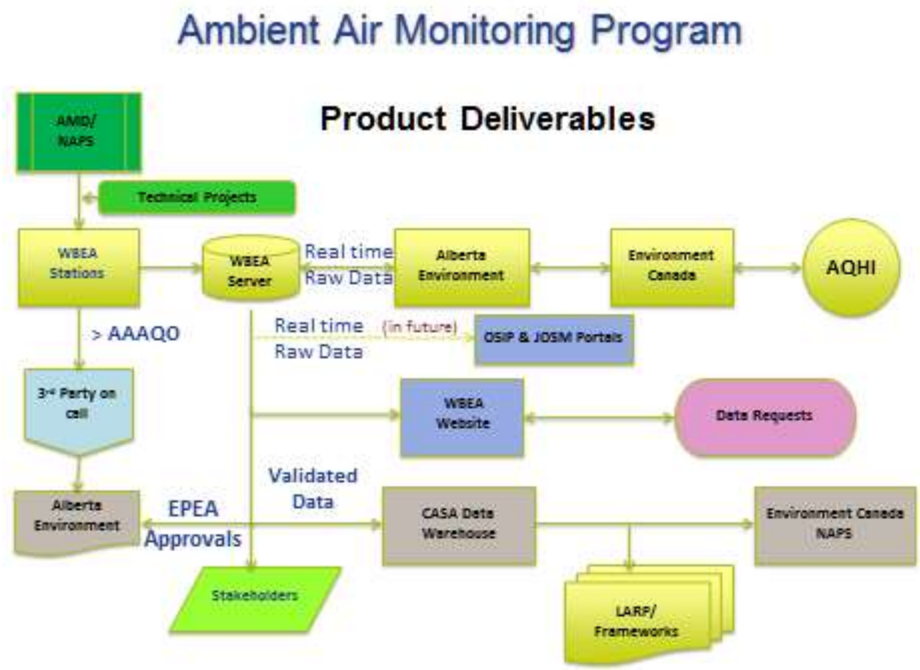

Figure 12. WBEA Flow of Data and Information System

Implementation Timelines

The timelines proposed for the development and implementation of the southern monitoring plan is as follows:

<u>July – December 2014</u>

1. Engagement, review and acceptance of the southern monitoring plan
2. Prepare a draft budget for southern monitoring plan
3. Complete monitoring site construction in the Communities of Conklin and Janvier
4. Begin planning and site selection for the southern boundary background/ transboundary air monitoring station.

<u>September - December 2014</u>

5. Deploy portable air monitoring stations at Conklin and Janvier until fixed air monitoring stations are purchased, integrated and commissioned in the field.
6. Begin planning and site selection for the network of meteorological towers at all SAGD facilities.
7. Identification of facilities with production greater than 100,000 bpd that will require fixed air monitoring stations and site selection to meet AMD criteria.

8. Identification of facilities with production less than 100,000 bpd that will require portable air monitoring stations and site selection to meet AMD criteria.
9. Begin planning and site selection for the network of passive or new technology monitoring at all SAGD facilities.

<u>January – March 2015</u>

10. Finalize site selection for monitoring activities in the region
11. Finalize implementation plan for operations and data management for the southern monitoring plan

<u>April – December 2015</u>

12. Construction of sites at the facilities for specified monitoring activities.
13. Deployment of meteorological towers and passive or new technology monitoring network.
14. Incorporation of any existing air monitoring station into the southern monitoring plan.
15. Deployment of the southern boundary fixed air monitoring station.

<u>January – March 2016</u>

16. Complete implementation of southern monitoring plan field activities.

<u>September – December 2017</u>

17. Initial review of the southern monitoring plan.

<u>September – December 2019</u>

18. Conduct dispersion modelling of emissions from the facilities in the region for cumulative effects; perform ambient air and meteorological data analysis for identification of monitoring gaps, elimination of redundancies and opportunities for efficiency.

Contingency Plans or Risk Management for Ongoing Operations

WBEA has performed a continual improvement of the ambient air monitoring program over the last 15 years to ensure that data quality and continuity are key deliverables. Knowledge, thoughtful planning and attention to detail have contributed to the highly reliable air monitoring network that WBEA operates today. As an indication of the success of this systematic and precise approach, WBEA's network runs at an overall performance of 98-99 % operational up-time.

With the introduction of Joint Oil Sands Monitoring Plan (JOSM) and the new Alberta Environmental Monitoring, Evaluation and Reporting Agency (AEMERA), WBEA's role has changed with respect to management, design, implementation and oversight of monitoring activities in the region. With the introduction of these new agencies by the regulatory bodies, it is uncertain how the roles and responsibilities of WBEA and its membership will evolve in the future.

Monitoring schedule for the Portable Stations

Upon acceptance of the concepts and objectives presented in this monitoring plan, a list of monitoring locations, map and schedule for portable monitoring will be forwarded to all stakeholders.

Summary of the last Monitoring Plan Overview

WBEA has conducted a number of third-party reviews for its ambient air monitoring program over the past 15 years. The last review of the network was conducted in 2011.

The 2011 WBEA Network Assessment report recommended a continuous air monitoring station to be deployed in the community of Conklin and subsequent Particulate Matter Monitoring workshop identified a need for baseline data for the determination of trends and background data for understanding transports into the airshed. A monitoring location near the southern border of the airshed operating in parallel with the Fort Chipewyan Station, which is near the northern border of the airshed would provide information for background and transboundary monitoring objectives.

WBEA has 2010 – 2015 Strategic Plan which also sets a goal to develop a monitoring plan for the South Wood Buffalo area, extension of the current passive monitoring network to the southern region and continuous ambient air monitoring stations for background and downwind transport.

Copies of the complete document for 2011 WBEA Network Assessment and the 2010 – 2015 Strategic Plan is posted on the WBEA website at www.wbea.org.

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