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The Wood Buffalo Environmental Association's (WBEA's) regional air monitoring network comprises eight ambient monitoring stations housing 42 continuous air-monitoring instruments. The operation focuses on collecting credible information and making this information readily available to everyone. One powerful vehicle for data distribution is the Internet. At our Website (www.wbea.org), hourly data from all stations is accessible 365 days a year. For those without Internet access, a telephone hotline connecting Fort McMurray, Fort McKay and Fort Chipewyan provides instant air quality information in French and English.

Air quality in the Wood Buffalo region was similar in 1999 to that recorded in 1998. Average SO_2 concentrations were within 0.1 parts per billion (ppb) of the 1998 values at six air monitoring sites. At the Mildred Lake site, SO_2 concentrations averaged 0.4 ppb higher than in 1998, and at the Lower Camp monitoring site, they were 0.4 ppb lower than in 1998. For the most part, SO_2 readings were within the Alberta Clean Air Guidelines. Hydrogen sulphide concentrations at sites close to the plants, Lower Camp, Mannix, Buffalo Viewpoint, and Mannix, exceeded the hourly guideline value 34 times and the daily guideline value 4 times. This is similar to the number of exceedences reported at these sites in 1998. Continuous monitoring of $PM_{2.5}$ at the Fort McKay, Athabasca Valley and Patricia McInnes sites showed infrequent short periods of high concentrations, up to a maximum of 180 ug/m^3 at the Patricia McInnes station. Forest fires in the region contributed to these elevated $PM_{2.5}$ readings. A map indicating the locations of each site may be found on page 8.

Communication: Loud and clear

The Terrestrial Environmental Effects Monitoring (TEEM) program has been designed to detect possible effects of oil sand plant emissions on terrestrial ecosystems and on traditional resources. Specific programs address changes in soil chemistry and tree growth resulting from acid deposition, trace metals in soil, vegetation, small mammals and materials harvested locally for consumption. Other programs deal with stress to forest vegetation from direct exposure to emissions, as well as certain other indicators of environmental stress. Air quality monitoring using passive sulphur dioxide, nitrogen dioxide and ozone monitors are in use at ten terrestrial effects monitoring field sites to assist in validating model-based estimates of acid deposition.

A Ground Level Ozone Modeling Working Group formed in 1998 has commissioned further refinement of ozone modeling for the region.

A list of reports submitted by these and other groups relating to the environment in the Wood Buffalo region may be found in Appendix VII. Copies are available to all interested parties.

1.1 Introduction

The second Annual Report of the WBEA reflects the spirit of co-operation on which the WBEA is founded. We are a diverse group of organizations and individuals united in our concern for the protection of the environment. At each meeting, every member has an opportunity to have their voice heard, each opinion considered and all information shared, with decisions being reached through achieving consensus of the group. Through this co-operation, we have been able to design an environmental monitoring system that can serve as a model for many other communities throughout the world.

The chief objective of the WBEA is to monitor the environment in a manner that is transparent and open to scrutiny by all interested stakeholders. This produces credible monitoring results allowing for effective environmental management of emissions in the Wood Buffalo region.
In consultation with all interested parties, the following items have been recognized as high priority issues for the region.

- Human Health Effects
- Odours
- Soil and Water Acidification
- Data Validity, Management and Dissemination
- Ground-Level Ozone
- Direct Impinging Effects on Vegetation
- Heavy Metal Deposition and Accumulation
- Smoke and Dust
- Global Warming / Greenhouse Gases (i.e., carbon dioxide, methane)

Hollywood North, WBEA video in the making

The information gathered concerning these issues is made available to all through an air quality information phone line and on our Website. Additional information about the WBEA is presented in quarterly newsletters to the community, an educational video targeted for elementary school age children and at various trade shows, science fairs and presentations.

None of this would be possible without the complete co-operation of all parties and the abiding interest of the communities of the Wood Buffalo region. As our organization gains momentum and enters new areas of environmental monitoring, we welcome the input of new members and look forward to the continued evolution of our comprehensive system of monitoring our region.

1.2 Organization

The WBEA is a not-for-profit society registered under the Societies Act of Alberta. The ambient air program of the WBEA was the second regional airshed management zone to be developed in the province.

The WBEA currently consists of a governing Board of Directors and a number of committees. The major committees are the Air Quality Monitoring Technical Committee; the Terrestrial Environmental Effects Monitoring Committee; the Ozone Modeling Working Group; and the Communications Committee.

The Association's Board of Directors meets at least quarterly. It is supported by a Management Committee, which carries out the decisions of the Board and by a full-time Executive Director. The Board makes decisions by consensus thus ensuring that every member has an equal voice at the table.

A full list of WBEA committee members is provided in Appendix III.

Members of the Management Committee for 1999 were:

President	Bruce Friesen *Manager, Environmental Affairs, Syncrude Canada*
Vice President	Gordon Kemp *Manager, Environmental Affairs, Suncor Energy*
Secretary Treasurer	Tony Punko *Project Manager, Athabasca Chipewyan First Nation*
Director	Ken Shipley *Director, Fort McKay Industry Relations Corporation*
Director	Ann Dort-Maclean *Vice President, Fort McMurray Environmental Association*
Executive Director	Robert Scotten, *WBEA*

The 1999 annual direct budget was approximately $2 million, including a number of in-kind contributions, but actual costs of operating the WBEA are substantially greater than this figure. Time contributed by community representatives to the organization has been immeasurable. Based on a formula relative to emissions, Syncrude and Suncor provided ongoing operating and capital funding, while Mobil and Shell contributed to administrative costs.

Membership in the Association grew from fifteen to seventeen. In 1999, the new members are Mikisew Cree First Nation and Fort McMurray First Nation.

1.3 Purpose

The Wood Buffalo Environmental Association is a cooperative endeavour. As such it must reflect the concerns of the community at large and balance them with the needs of industry. The objectives of the WBEA are to:

1. promote and foster cooperative effort among government, community, native groups and industry directed at establishing and maintaining a program for environmental monitoring and research in the Wood Buffalo Region of Alberta,

2. generate research and development projects, including application of traditional knowledge and expertise, to ensure that environmental protection practices used by resource developers can be implemented effectively,

3. establish and maintain a program for environmental monitoring and research in the Wood Buffalo Region,

4. act as a liaison among industry, government, native groups, communities and the public in matters pertaining to the monitoring of environmental conditions, and

5. cooperate with government, native groups and the public in establishing needs and priorities pertaining to the monitoring of environmental conditions.

From dragline to trapline: Industry executives experience the traditional way of life

2.1 President's Report

Bruce Friesen

Welcome to the 1999 Annual Report of the Wood Buffalo Environmental Association. It was an exciting year for the Association as we worked together to consolidate our organization as a meaningful part of the Wood Buffalo regional environmental management system.

Collaboration among the various parties concerned about the environment in our region was evident throughout our activities. As President of the Association, I was most appreciative of the work of our Management Committee made up of the Officers of the Association. Our five Officers included two representatives of local First Nations and a Metis Local, one representative of a local environmental association, and two representatives of industrial operators. This mix of perspectives ensured the work of the Committee was a true collaboration towards common objectives.

Growing industrial activity in the region made cooperation essential to ensure protection of the regional environment. Following a number of development application reviews, the WBEA was able to offer each new participant a role in the multi-party consensus based environmental management system we are building. This includes new members from industry, the community and government. The WBEA is proud of its pioneer role in this regard, having already taken responsibility for regional monitoring programs on this multi-party model. We are also proud that we have been able to cooperate with the project approval processes and the new groups now forming to tackle further elements of our regional environmental management system. The result is that our Association has been recognized and re-energized in its monitoring mandate. Regulatory agencies have endorsed our role, and new industrial operators are collaborating with the WBEA to discharge their monitoring obligations.

The Association membership grew during 1999. I would like to formally welcome the Mikisew Cree First Nation and the Fort McMurray First Nation. The most obvious effect of this growth is geographical. The Association membership has expanded southwards, and now encompasses the entire Regional Municipality of Wood Buffalo. This brings with it new challenges, and I am sure 2000 will be just as interesting and satisfying as was 1999.

Bruce Friesen
President

2.2 Executive Director's Report

Robert Scotten

In our second full year of operation, we find the association continuing to grow. In the collaborative format of the organization we have designed, we have seen our membership increase by two as we welcomed the Mikisew Cree First Nation and the Fort McMurray First Nation. This brings the total membership to 17, which is almost double that of 1997. New members continue to add depth to the association by sharing information, discussing issues and participating in the operation of our different monitoring programs.

In this exciting year, we were able to further spread the word of our work to the community at large as our communication plan was put into action. This included participation in two trade shows in Fort McMurray where we spoke with over 1400 visitors. We also accepted invitations to speak to a number of environmental and government groups. To further increase awareness in the community, we upgraded our Website, purchased billboard space, launched a series of radio announcements, produced a new brochure and a video for presentation in schools and future trade shows. In October, we instigated an eco-tour of a local trapline for a number of oil company executives to increase their understanding of the impact of industrial expansion. May found us holding our business meeting and hosting an open house in Fort Chipewyan.

The year did bring challenges. Lightning strikes at two different stations caused some down time, but no analysers were destroyed and all equipment was up and operating within hours. With a recovery plan in place for the Y2K disaster that never was, the only problem on December 31 was an errant garbage truck that took out a telephone line. We were up and running within 4 hours. Despite these incidents and the return of an SO_2 analyser to the factory for repair, our in-service time for the year was 97.8%.

We received 4 new analysers and numerous spares to ensure that the reliability of the system as a whole is constant. In anticipation of increased oil sand activity, we expect to install two new air monitoring systems and at least one new station for the Albian Sands project (formerly known as the Shell Muskeg River Project).

The success of the association thus far is proof that the collaborative process between member groups, government, industry and the community is working well and we look forward to an equally bright 2000.

Robert Scotten
Executive Director

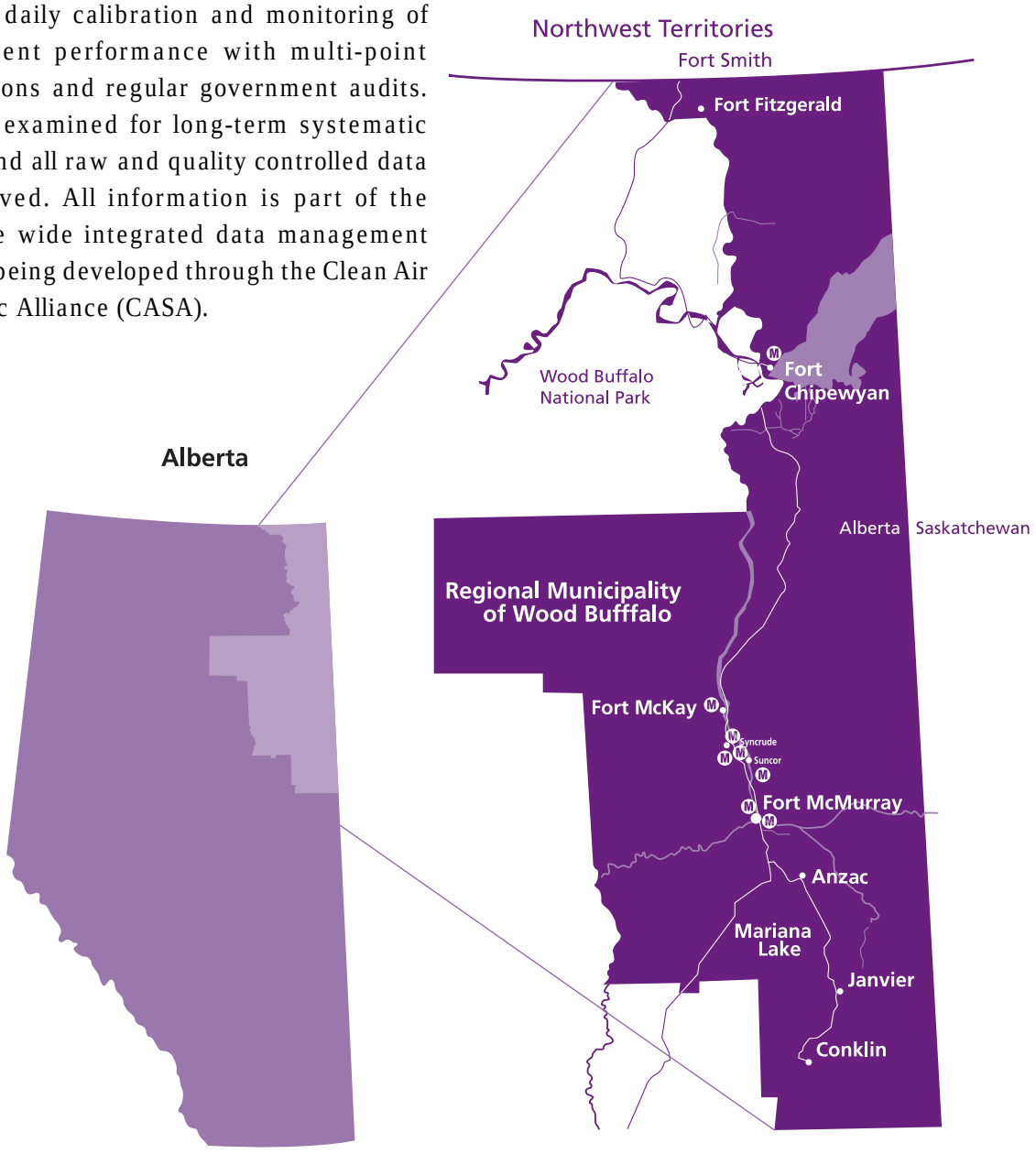
3.1 Air Monitoring Program

The WBEA air quality monitoring program focuses on air quality, as it relates to human and ecological health. The emphasis is to provide scientifically credible data.

The Association has a network of eight air quality monitoring stations currently in operation in the Wood Buffalo region. They are located in the communities of Fort McKay and Fort Chipewyan, near the plantsites of Syncrude Canada Ltd. and Suncor Energy Inc., and two in the City of Fort McMurray.

In order to provide the highest quality data, quality control and assurance programs include daily calibration and monitoring of instrument performance with multi-point calibrations and regular government audits. Data is examined for long-term systematic errors and all raw and quality controlled data is archived. All information is part of the province wide integrated data management system being developed through the Clean Air Strategic Alliance (CASA).

Custom built Data Acquisition System developed by RSL Systematic Ltd



The following sections discuss in detail the results of the air quality monitoring program during 1999. Each air contaminant is discussed in turn. Numerical monitoring data as collected at each WBEA monitoring station is provided in Appendix I.

3.1.1 Sulphur Dioxide (SO_2)

Characteristics

Sulphur dioxide is formed during the processing and combustion of fossil fuels containing sulphur. A colourless gas with a pungent odour, it can be detected by taste and odour at concentrations as low as 300 parts per billion (ppb). Sulphur dioxide reacts in the atmosphere to form sulphuric acid and acidic aerosols, which contribute to acidic deposition. Sulphur dioxide also combines with other atmospheric gases to produce fine particles, which may reduce visibility.

Brief exposure to high concentrations of sulphur dioxide and its products can irritate the upper respiratory tract and aggravate existing cardiac and respiratory disease. Long-term exposure may increase the risk of chronic respiratory disease.

Sensitive vegetation may be injured by exposure to high sulphur dioxide concentrations. Symptoms include a bleached appearance of the leaf with silvering or bronzing of the underside. Sulphur emissions also contribute to acidifying emissions that may affect water bodies, soil and vegetation.

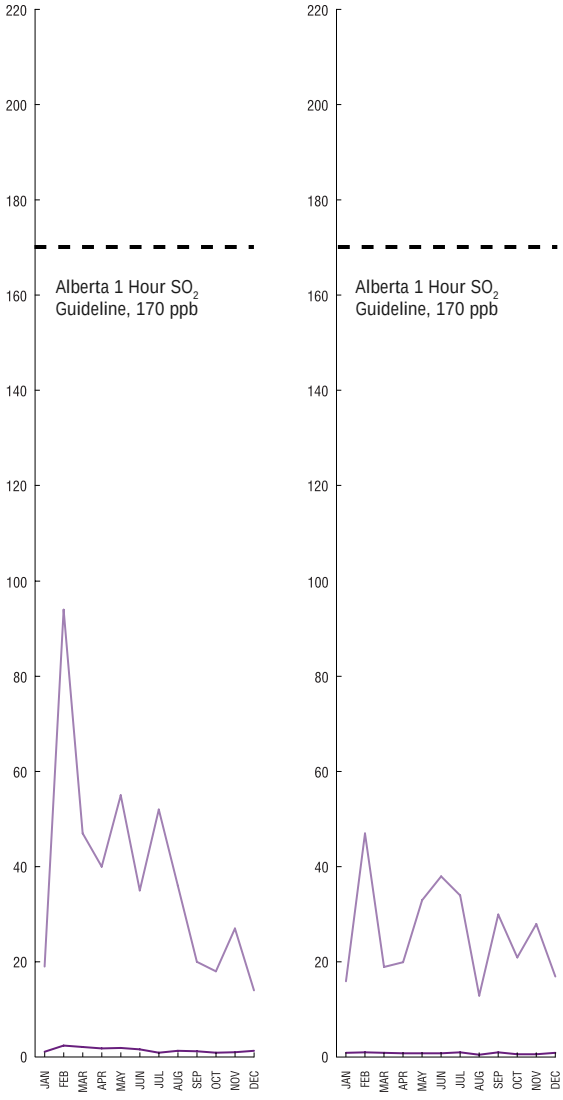
Sources

Sulphur dioxide emissions within the Wood Buffalo Zone averaged 272.2 tonnes per day in 1999. Suncor and Syncrude were the major sources in the region, emitting approximately 63.2 and 209 tonnes per day respectively in 1999.

Alberta Guidelines

Alberta Environment has adopted Environment Canada's most desirable objectives for sulphur dioxide as Alberta guidelines. The Alberta guidelines for ambient air are:

- 1 hour average of 170 ppb
- 24 hour average of 60 ppb
- Annual average of 10 ppb



Maximum and Average Sulphur Dioxide Concentration for Each Month in 1999

Monitoring Results

In 1999, the average sulphur dioxide concentration in the ambient atmosphere was highest at the Mildred Lake and Mannix sites, 2.4 and 2.2 ppb, respectively, and lowest at Fort Chipewyan, 0.41 ppb (Table 1). This range of concentrations is consistent with the location of the monitoring stations. The Mannix site is located within the boundary of the Suncor Lease, while Fort Chipewyan is remote from major sources of pollutants. Concentrations at Fort Chipewyan, averaging 0.41 ppb in 1999 and 0.29 ppb in 1998, are similar to the 0.40 ppb measured at a site north of Hinton. This site north of Hinton is also remote from major industrial sources of pollution. The 1999 yearly average concentration at the Athabasca Valley site in Fort McMurray was 0.9 ppb, and 1.4 ppb at Fort McKay. These values are similar to the averages of 0.8 ppb and 1.4 ppb recorded at the two sites in 1998.

The Alberta guideline for one-hour average SO_2 concentration of 170 ppb was not exceeded in the population centers of Fort McMurray, Fort McKay, or Fort Chipewyan nor at the monitoring sites located close to the plants. The maximum values reached in the town sites were 93.7 ppb at Fort McKay, 69.3 ppb at the Patricia McInnes site in Fort McMurray, and 17.7 ppb at Fort Chipewyan (Table 1). Closer to the plants, a maximum of 168 ppb was reached at the Mannix site. This is considerably lower than the maximum one-hour concentration of 294 ppb recorded in 1998.

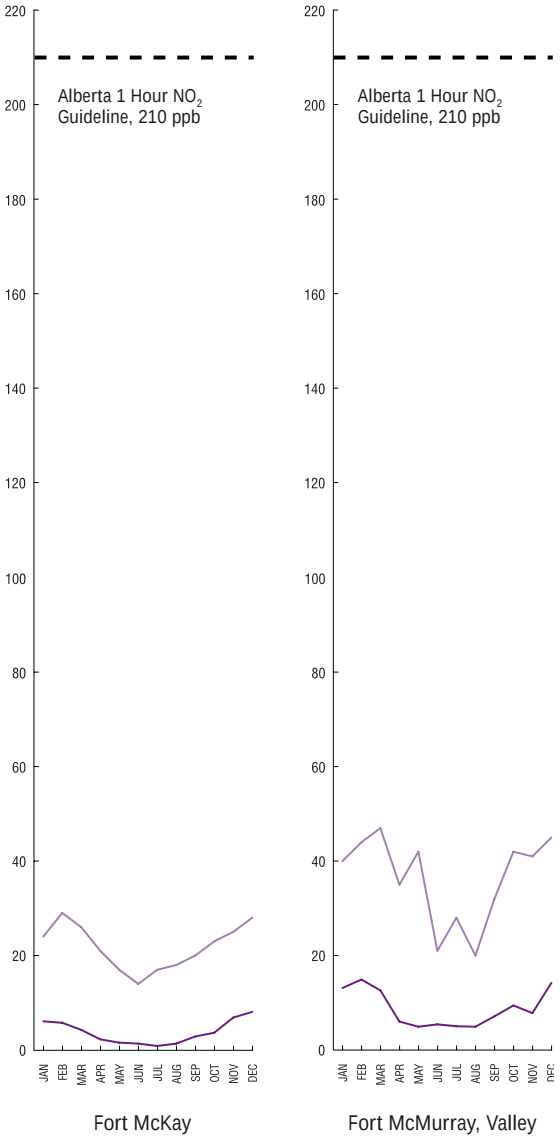
3.1.2 Oxides of Nitrogen (NO_x)

Characteristics

Oxides of nitrogen, mostly in the form of nitrogen oxide (NO) and nitrogen dioxide (NO_2), are produced by the high temperature combustion of fossil fuels. Nitrogen oxide is the predominant species emitted by combustion sources and is rapidly changed to nitrogen dioxide in the atmosphere.

A reddish-brown gas with a pungent, irritating odour, it has been linked to respiratory disease and acid deposition. It plays a major role in atmospheric photochemical reactions and ground level ozone formation and destruction.

Exposure of vegetation to high concentrations of nitrogen oxides results in silvering of the lower leaf surface. A waxy appearance emerges shortly after exposure



Maximum and Average Nitrogen Dioxide Concentration for Each Month in 1999

followed within a few days by bronzing. Oxides of nitrogen contribute to acidification and at low levels, nitrogen tends to fertilize plant growth.

Sources

Emissions of nitrogen oxides within the Wood Buffalo zone were calculated to be 38.16 kilotonnes in 1999. Major sources were the oilsands extraction and processing plants followed by local vehicle use and light industry.

Alberta Guidelines

Alberta Environment guidelines are based on the prevention of human health effects. They are equal to Environment Canada's most rigorous ambient air quality objectives. The Alberta guidelines for maximum concentrations of nitrogen dioxide, the major component of nitrogen oxides in the ambient atmosphere are:

- 1-hour average of 210 ppb,
- 24-hour average of 110 ppb, and
- an annual average of 30 ppb.

Monitoring Results

Ambient atmospheric concentrations of nitrogen dioxide (NO_2) are monitored at four locations in the Wood Buffalo zone. The average annual concentration of nitrogen dioxide in 1999 ranged from a low of 1.1 ppb at Fort Chipewyan to a high of 8.8 ppb at the downtown (Athabasca Valley) air monitoring station in Fort McMurray. The 1999 average at the downtown site was similar to that measured in 1998, 9.3ppb, and as reported by Alberta Environment in 1994, 1995, and 1996. Nitrogen dioxide concentrations at this location reflect emissions from nearby motor vehicle traffic. At the residentially located Patricia McInnes monitoring station and at Fort McKay, the average concentrations were 4.5 and 3.7 ppb respectively. These values are well below the Alberta guideline of 30 ppb for an annual average NO_2 concentration in ambient air. They are also low compared to the annual averages of 25 ppb and 30 ppb measured by Alberta Environment in downtown Edmonton and Calgary.

The maximum 1-hour value of 47 ppb at the Athabasca Valley site was lower than the maximums of 51 ppb reported in 1998 and 60 ppb in 1997. This value is about 25% of the Alberta guideline of 210 ppb for $NO_{2,}$ as a 1-hour average. At Fort McKay, the maximum of 29 ppb was similar to the value of 28 ppb measured 1998.

3.1.3 Hydrocarbons

Characteristics

Hydrocarbons are divided into categories according to the method by which they are analyzed and their molecular weight. The more volatile compounds or "total hydrocarbons" are separated by gas chromatography into two broad categories, "non-reactive" and "reactive" hydrocarbons. The major "non-reactive" hydrocarbon in the atmosphere is the colourless, odourless gas, methane, which is a major contributor to the greenhouse effect. The "reactive" hydrocarbons consist of many volatile organic compounds (VOCs). Some VOCs react with the oxides of nitrogen in the atmosphere to form ozone. These include ethylene, propane, butane, benzene, a-pinene and a host of other hydrocarbons. Among these "reactive" VOCs are the aromatic compounds benzene, toluene, ethylbenzenes, and xylenes (BTEX). When present in sufficient quantities, these compounds affect human health.

Polycyclic aromatic hydrocarbons (PAH's) are of higher molecular weight and are less volatile. Some are known to be carcinogenic.

Sources

Large amounts of methane are produced naturally through the decay of vegetation. Trees and plants are major natural emitters of reactive hydrocarbons, with other major sources being motor vehicle exhaust, gasoline handling and the petroleum and chemical industries. Combustion processes, both natural such as forest fires, and human influenced, such as industrial activities and the use of motor vehicles, result in the formation of PAH's.

The tailings ponds, extraction plant vents, mine faces and fugitive emissions from the oil sands industries are the single most significant anthropogenic sources of reactive hydrocarbons and methane in the region. Exact VOC emission numbers from the oil sands plants are unknown but estimated to be in the 40 to 80 tonne per day range (excluding methane).

Alberta Guidelines

There are no Alberta guidelines for ambient hydrocarbon concentrations.

Monitoring results

The WBEA total hydrocarbon monitors record the reactive or non-methane hydrocarbons only. Total hydrocarbons are monitored at all Wood Buffalo sites except Fort Chipewyan. Mildred Lake had the highest average ambient atmosphere concentration at 2.3 parts per million (ppm), Buffalo Viewpoint and Lower Camp had averages of 2.1 ppm. The average concentration at the other five sites in 1999 was 2.0 ppm. These values are similar to those measured in 1998 that ranged from 1.9 ppm at the Fort McKay and Patricia McInnes sites to 2.2 ppm at Mildred Lake and are similar to other rural locations in the province. Maximum values of 19.9 ppm at Buffalo Viewpoint and 13.5 ppm at Mildred Lake are indicative of emissions from nearby industrial sources.

Samples were collected at the Athabasca Valley, Patricia McInnes and Fort McKay stations for detailed analysis of volatile organic compound (VOC's) and polynuclear aromatic compounds (PAH's). The most abundant VOC's were the aliphatic hydrocarbons isopentane and isobutene followed by the aromatic hydrocarbons benzene, toluene, and xylenes. Ambient atmospheric concentrations of benzene averaged 0.9 ppb at the Fort McKay and Patricia McInnes sites and 1.0 ppb at the Athabasca Valley site. The annual BTEX (Benzene, Toluene, Ethylbenzene and Xylene) concentrations were 2.0 ppb at Fort McKay and Patricia McInnes sites and 2.8 ppb at the Fort McMurray Valley site.

Phenanthrene and pyrene were the PAH's most commonly detected in ambient air samples. Concentrations of phenanthrene averaged 0.017 micrograms per cubic meter (ug/m^3) at Athabasca Valley, 0.022 ug/m^3 at Patricia McInnes, and 0.009 ug/m_3 at Fort McKay. Pyrene concentrations averaged 0.05 ug/m^3 at the Fort McKay and Athabasca Valley sites and 0.08 ug/m^3 at the Patricia McInnes site. Other PAH's were generally at concentrations below detection limits.

3.1.4 Total Reduced Sulphur Compounds

Characteristics

The term total reduced sulphur compounds (TRS) is used to collectively describe hydrogen sulphide and mercaptans. Both have characteristic odours detectable by people at very low concentrations. The major component is hydrogen sulphide (H_2S). It is a colourless gas with a characteristic rotten egg odour and is toxic to humans and animals at high concentrations.

Sources

Hydrogen sulphide is produced both naturally and through industrial processes. It is found naturally in coal, natural gas, oil, sulphur hot springs, sloughs, swamps, and lakes. The decomposition of organic matter by bacteria

with no oxygen present results in the release of H_2S. This produces the characteristic odour commonly associated with sewers, sewage lagoons, and swamps. Industrial sources are primarily petroleum refining, petrochemical complexes, and pulp and paper mills.

Sulphur is removed from bitumen by oil sand industries, first as H_2S and then converted into elemental sulphur or burned to produce SO_2. However, some H_2S does escape from fugitive sources within the plant areas. H_2S has been released from the tailings ponds on an intermittent basis as well.

Alberta Guidelines

The guidelines for maximum permissible concentrations of H_2S are based on the odour threshold, although many individuals can smell H_2S at levels below the ambient guidelines. Alberta has adopted Environment Canada's most rigorous ambient objectives for maximum permissible H_2S concentrations.

The Alberta guidelines are:

- 1-hour average of 10 ppb, and
- 24-hour average of 3 ppb.

Monitoring results

Hydrogen sulphide is monitored at four WBEA stations and TRS at three additional sites. There is no monitoring of H_2S or TRS at Fort Chipewyan.

The highest annual average concentration recorded was at the Lower Camp, 1.12 ppb H_2S, up significantly from the 0.73 ppb measured in 1998. Concentrations at the Mannix site remained about the same as 1998, 0.57ppb as compared to 0.56 ppb H_2S in 1998. These values reflect emissions from the Suncor site. Lowest averages were at the Patricia McInnes and Athabasca Valley sites in Fort McMurray averaging 0.25 ppb H_2S and at Fort McKay with a concentration of 0.42 ppb TRS.

The one-hour Alberta Environment guideline for H_2S of 10 ppb was exceeded 22 times at the Lower Camp site with the maximum one hour measurement being 24 ppb. At the Mannix site, the guideline value was exceeded for 8 one-hour periods, with the maximum being 18 ppb. At the Buffalo Viewpoint site, the guideline was exceeded three times with the maximum value recorded as 61 ppb. At Mildred Lake, there was one exceedence. There were 4 exceedences of the Alberta Environment guideline for a 24-hour average H_2S concentration.

3.1.5 Ozone

Characteristics

Ozone is both a natural component of the atmosphere and a major constituent of photochemical smog. At normal atmospheric concentrations, it is an odourless, colourless gas but at high concentrations (near photocopier machines, laser printers and electrical discharges), it has a sharp odour.

Ozone is a strong oxidizer and can irritate eyes, nose and throat and decrease athletic performance. High concentrations can increase susceptibility to respiratory disease and reduce crop yields.

Sources

Unlike other pollutants, ozone is not emitted directly into the atmosphere but is produced in the atmosphere through a series of complex chemical reactions. Concentrations are controlled largely by emissions of nitrogen oxides and reactive hydrocarbons. These reactions may lead to an increase in ozone concentrations or a decrease, as in the case of Alberta cities. Ozone is also a natural component of the upper atmosphere and may be transported to ground level by meteorological processes.

Alberta Guidelines

Alberta Environment guidelines for ozone are:

- a 1-hour average of 82 ppb, and
- a 24-hour average of 25 ppb.

Provincial and Federal guidelines are presently under review.

Monitoring Results

Ozone is monitored at four sites in the Wood Buffalo zone: Fort McKay, Patricia McInnes, Athabasca Valley, and Fort Chipewyan. The highest hourly concentration measured in 1999 was 66.1 ppb at the Athabasca Valley site in June (Table 5). This is well below the Alberta guideline value of 82 ppb. Annual average ozone concentrations ranged from 20.5 ppb at the Athabasca Valley site to 27.1 ppb at the Patricia McInnes site. These average values are higher than in downtown Edmonton (16.4 ppb) and Calgary (14.0 ppb) where ozone concentrations are depressed by motor vehicle emissions of the oxides of nitrogen, but are consistent with other rural location in Alberta.

3.1.6 Carbon Monoxide

Characteristics

Carbon monoxide (CO) is a colourless, odourless, and tasteless gas produced by the incomplete combustion of carbon based fuels. It has a strong affinity for haemoglobin and thus reduces the ability of blood to transport oxygen. Exposure to concentrations of 400 to 500 ppm for periods of one hour may not produce an appreciable effect, while concentrations in excess of 4,000 ppm may cause asphyxiation. Long-term exposure to low concentrations may cause adverse effects in people suffering from cardiovascular disease.

Sources

Transportation is the major source of carbon monoxide, with elevated concentrations during the morning and evening rush hours. Other sources include building heating systems, boilers, and industrial operations.

Alberta Guidelines

The Alberta Environment guidelines for the maximum permissible concentrations of carbon monoxide are based on the prevention of adverse human health effects. The maximum permissible concentrations are:

- 1-hour average of 13.0 ppm, and
- 8-hour average of 5.0 ppm.

Monitoring Results

Carbon monoxide is monitored at the WBEA's Athabasca Valley station in Fort McMurray. The maximum 1-hour average concentration measured in 1999 was 3.9 ppm and the yearly average was 0.27 ppm. Concentrations are well below the Alberta Environment guideline values. The one-hour maximum of 3.9 ppm is higher than the 3.0 ppm measured in 1998 but the yearly average of 0.27 ppm is slightly lower than the 0.30 ppm measured in 1998. Downtown Edmonton had an average concentration of 0.86 ppm with a maximum of 14.7 ppm.

3.1.7 Particles

Characteristics

Ambient particulate matter consists of a mixture of particles of varying size and chemical composition. Particles less than 10 micrometers in diameter (PM_{10}) can be inhaled. Particles that are less than 2.5 micrometers in diameter ($PM_{2.5}$) can be trapped in the airways and lungs and

are believed to cause adverse health effects. Fine particles ($PM_{2.5}$) also reduce visibility and can contribute to acidification of soils and metal concentrations. Measurements of the PM_{10} size particles include the $PM_{2.5}$ size fraction.

Sources

Sources of PM_{10} size particles include windblown soil, road dust, and industrial activities. $PM_{2.5}$ size particles are formed from gases released to the atmosphere by combustion processes from motor vehicles, power plants, gas processing plants, compressor stations, household heating, and forest fires.

Alberta Guidelines

Guidelines for ambient atmospheric concentrations of PM_{10} and $PM_{2.5}$ size particles are under consideration by the Alberta and the Federal governments.

Monitoring Results

Concentrations of particles are measured both by collection on a filter followed by weighing and by continuous monitoring. Particles collected on filters can then be analyzed for chemical composition. In the Wood Buffalo zone PM_{10} and $PM_{2.5}$ size particles are collected at the Athabasca Valley, Patricia McInnes, and Fort McKay monitoring stations. Concentrations of $PM_{2.5}$ size particles are also continuously monitored at these sites.

Concentrations of PM_{10} particles at the WBEA Athabasca Valley site in Fort McMurray averaged 11.4 ug/m^3 during 1999 of which about 40% were $PM_{2.5}$ size particles (Table 6). Slightly lower average PM_{10} concentrations were recorded at the Fort McMurray Patricia McInnes monitoring station, 9.5 ug/m^3, and at Fort McKay 9.3 ug/m^3. These values are comparable to the yearly average recorded by Alberta Environment in Edmonton, 15.9 ug/m^3, and in Calgary, 13.1 ug/m^3, in 1996. Particles are derived from industrial emissions of SO_2 and $NO_{x,}$ as well as from wind blown dust. The higher calcium content of the PM_{10} size fraction at the river valley site in Fort McMurray is indicative of road dust (Table 7).

Continuous monitoring of $PM_{2.5}$ showed average concentrations ranging from 5.9 ug/m^3 at Fort McKay to 7.3 ug/m^3 at the Athabasca Valley. Maximum one-hour average concentrations were much higher, up to 180 ug/m^3 at the Patricia McInnes site. This maximum value was reached at 11pm June 22nd at the same time a maximum of 117 ug/m^3 was recorded at the Athabasca Valley site. This episode was short lived, lasting less than two hours, and there was no increase in SO_2 or other pollutants. There was a forest fire north of Fort McMurray during this occurrence.

3.1.8 Meteorology and Air Quality

Influence of Meteorology

Air quality is dependent on the rate that pollutants are emitted to the atmosphere and the rate at which these pollutants are dispersed away from the sources. Air pollution transport and dispersion are influenced by wind speed and direction, the temperature structure of the atmosphere, the solar cycle, turbulence, precipitation and changes in these elements induced by local topography.

Precipitation may remove pollutants from the atmosphere, depositing them on soils and vegetation. Rates of deposition of pollutant gases are highest when vegetation and soils are wet. Vegetation is more susceptible to damage during periods of highest growth.

Monitoring Program

Meteorological parameters measured in support of the Wood Buffalo Environmental Association air quality monitoring programs are:

- wind speed and direction
- temperature
- difference in temperature at two heights
- solar radiation
- amount of precipitation
- relative humidity
- surface wetness

Precipitation samples are also collected and chemically analyzed for acidity and major constituents.

Monitoring Results

Temperatures in Fort McMurray ranged from a low of –36.6^{0}C to a high of 33.9^{0}C in 1999. At Fort McKay the range was –39.8^{0}C to 34.4^{0}C and at Fort Chipewyan –35.5^{0}C to 31.9^{0}C.

Winds at the Fort McMurray Athabasca Valley site averaged 9.4 kilometers per hour. They were predominantly from the SE 31% of the time, reflecting the orientation of the river valley. At the Patricia McInnes site the winds were from the SE 20% of the time but were generally from the W, SW, and S. Winds were from the north 16% of the time in the valley and 9% of the time at the higher Patricia McInnes site. At Fort McKay, winds were lighter averaging 8.0 kilometers per hour and were from the S or SE 38% of the time. At Fort Chipewyan, winds were from the east or northeast 37% of the time and from the west or northwest 27% of the time. They were from the south, the direction of the oil sands plants, 8% of the time. Wind speeds were much higher than at the other sites, particularly when blowing off the lake to the east. The annual average wind speed was 17.8 kilometer per hour.

Eleven precipitation samples were collected in 1999 at the Athabasca Valley station and their chemical composition and acidity measured. The lowest pH recorded was 4.50 and the volume weighted pH for the 11 samples was 4.81. These values were similar to those reported in 1998. They are lower than the long term average pH measurements reported by Alberta Environment for other Alberta locations. The major constituents of the precipitation were sulphate, nitrate, calcium and ammonium.

Please refer to Appendix II for additional detail on meteorological observations at each WBEA station.

3.1.9 Passive Monitoring

Characteristics

Passive monitoring systems are useful adjuncts to continuous air monitoring networks. They require no expensive shelters or power, and can be deployed in remote locations. They provide average concentrations of pollutants over a previously selected monitoring period, usually one to three months.

Monitoring Program

The WBEA uses a network of passive monitors to measure concentrations of sulphur dioxide, ozone, and nitrogen dioxide at remote forestry locations. The network consists of 10 sites, as shown on the map in Figure 3. Passive samplers are affected by meteorological conditions and their location in relation to the forest canopy. A survey of the monitoring locations showed that not all samplers are ideally situated and in some cases, the results may be affected by their proximity to the forest canopy.

A program to validate the passive monitoring system was carried out at the Fort McKay and Patricia McInnes continuous air monitoring stations by co-locating a passive monitor with a continuous analyser.

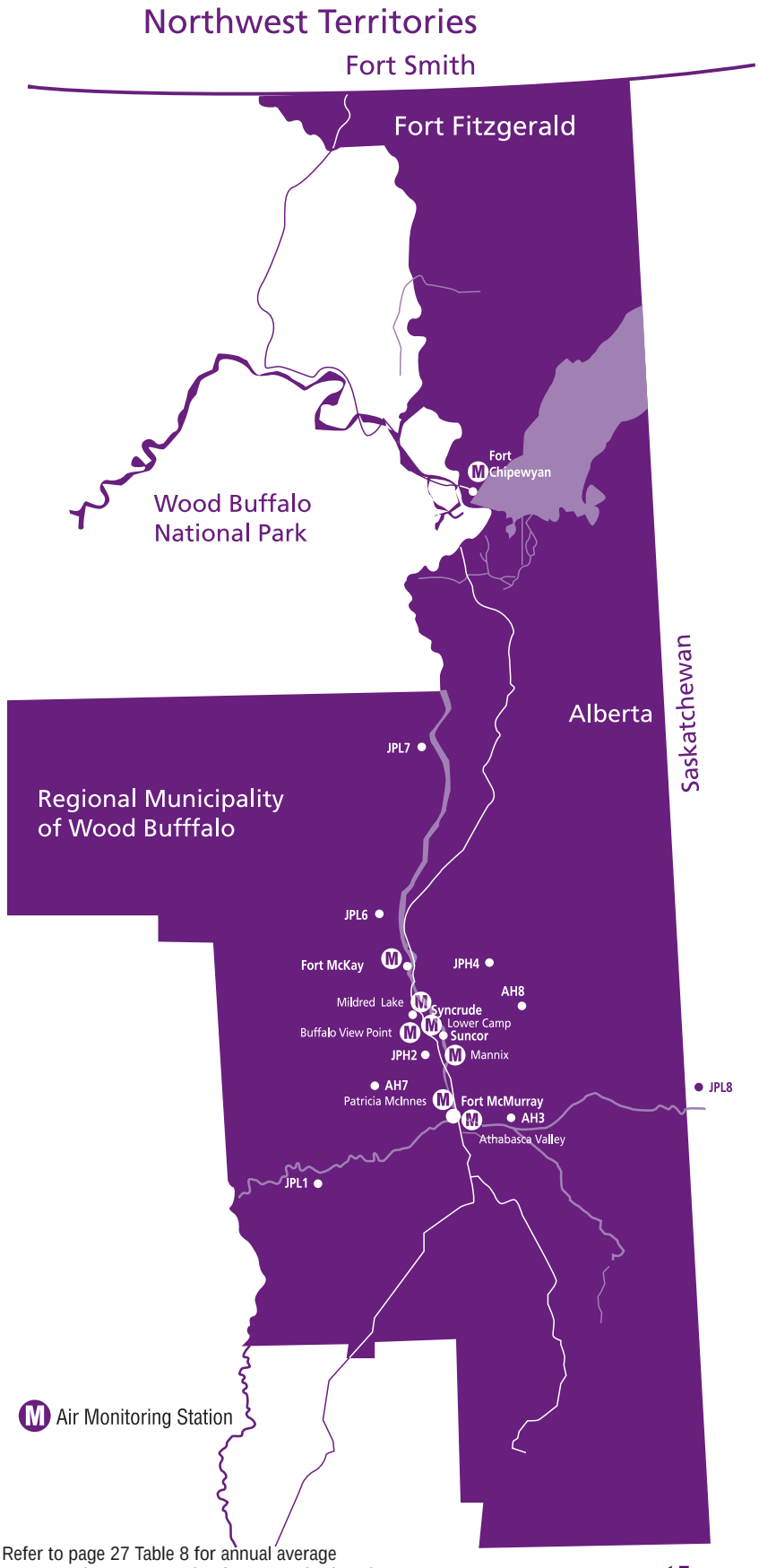
Monitoring Results

The validation program showed average concentrations measured by the passive monitors and continuous air quality monitors agree, while individual measurements varied considerably. The two methods gave identical

average concentrations of both SO_2 and NO_2 at the Patricia McInnes site. Similarly, the two methods gave consistent NO_2 and O_3 measurements at the Fort McKay site. At Fort McKay, the SO_2 passive sampler gave average concentrations that were 0.4 ppb higher than recorded by the continuous monitor. This difference is equivalent to the precision of the continuous monitor. Individual SO_2 measurements varied on average by 35% between the two methods whereas O_3 measurements varied by an average of only 5%.

The average concentrations of sulphur dioxide, nitrogen dioxide, and ozone were measured at each remote site over the year, with the exception of the period July 15 to August 16. Concentrations are shown in Table 8.

The sulphur dioxide measurements are consistent with the continuous monitoring data from Fort McKay and Fort McMurray. Highest sulphur dioxide values were measured at sites closest to the oil sands plants with the highest average concentration being 2.2 ppb at site JPH2. Sites located at greater distances from the sources had the lowest concentrations. The average sulphur dioxide concentration at a station near the Saskatchewan border was 0.3 ppb. Nitrogen dioxide showed the same general trends with the highest concentration being found at the jack pine monitoring site designated JPH4. In comparison with continuous monitoring results from the Patricia McInnes and Fort McKay stations, the passive NO_2 results appear low. Ozone results from a new type of passive sampler were similar to those from continuous monitors and varied little among the sites. The highest average concentration was 25 ppb, measured at AH7 which is located south-east of the oil sands plants.



Refer to page 27 Table 8 for annual average concentrations measured at forest monitoring sites

3.2 Terrestrial Environmental Effects Monitoring Program

The TEEM program took shape through various workshops and stakeholder meetings in 1994, 1995, and early 1996. Implementation began in the summer of 1996. The initial program consisted of:

- monitoring acidification effects on soil and vegetation at 10 permanent jack pine and aspen plots located across the acid deposition gradient at distances ranging from 12 to 106 km from the oil sand emission sources,
- monitoring trace metals in soil, vegetation and small mammals across the trace metal concentration gradient originating at the oil sand emission sources,
- aerial infrared photography to assess forest overstory vegetation stress near the oil sand emission sources,
- monitoring of the spring acid pulse in local streams,
- monitoring of trace metals in locally harvested traditional food resources, and
- passive monitoring of regional air quality to confirm dispersion model results..

There has been further evolution and development of the monitoring program. A scientific workshop was conducted in June, 1999. Invited guests, science advisors, contractors, and some members of the TEEM Committee met to review issues that have arisen in connection with the monitoring program subsequent to 1996. Based on recommendations from that workshop, the TEEM committee made the following changes to the program:

- the addition of a jack pine stand edge monitoring pilot study to compare contaminant, loading and foliar nutrients in stand edge and stand interior plots,

L to R: Jerry Scott (Fort McKay Environment), Eric Peake (EPCM Associates) and Anj Armstrong (Fort McKay Environment) return from a day among the jackpines

- the addition of 5 interior jack pine stand plots to the current 10 to better enable detection of potential acid deposition impacts,
- a pilot study on historical effects of nitrogen deposition to oligotrophic bogs, before and after oil sand development occurred in the region, and
- a scaling back of the annual tree condition survey on the jack pine plots to a visual inspection.

Programs active in 1999 were:

- jack pine acidification monitoring,
- jack pine stand edge pilot study,
- acid pulse monitoring,
- passive air quality monitoring, and
- traditional resource use (monitoring for metals in plants and animals traditionally used by people living in the region).

Field data and sample collection of soils and vegetation on the jack pine acidification monitoring plots was completed in 1998. This study focused on chemical changes in soil known to be associated with acidification such as pH, base saturation, and the calcium to aluminum ratio. It was also concerned with the nutrient status of foliage that may be indicative of soil acidification and on tree growth. During 1999, laboratory analysis of samples was completed. Substantial delay resulted from the need to test various methods of determining base saturation reliably. Report preparation will be completed in 2000. The annual visual inspection of tree conditions on the jack pine plots was completed.

Flow rate, pH, and chemical composition were monitored in the headwaters of the Steepbank, Firebag, and Muskeg Rivers during the spring snowmelt. This is an ongoing study to determine whether an acid pulse, damaging to aquatic organisms occurs during the spring snowmelt, and if so, to assess the contribution of deposition to the acid pulse. The study is conducted by Alberta Environment with the TEEM program providing support in the form of helicopter transportation to the monitoring sites. Alberta Environment will be preparing a report on this study.

Field data and sample collection for the jack pine stand edge pilot study was completed at five sites selected to span the range from relatively high to relatively low regional acidic deposition. Sample analysis and data collection will be completed in the year 2000.

In cooperation with Fort McKay and Fort Chipewyan community members, samples of selected traditional plant foods were collected near Fort McKay, the Birch Mountains, and Fort Chipewyan for trace metal analysis. The objective of this study is to address concerns regarding uptake by vegetation, fish, and mammals of trace metals emitted by the oil sand industry. Animal and fish tissues will be collected in early 2000. If elevated trace metals are found in this first phase of the study, additional studies will be implemented to assess possible health implications. The first phase will be completed in the year 2000.

TEEM program reports are issued annually under separate cover. Please refer to the list of reports in Appendix VII or visit our Website for the most recent listing and request reports of interest.

3.3 Ozone Modeling Working Group

The Ozone Modeling Working Group was established by the Association to enhance the understanding and forecasting of ground level ozone in the region.

Ground level ozone is an air contaminant of concern in that elevated levels are known to affect both vegetation and human health, as discussed in Section 3.1.5. For that reason, the Association has included monitoring of ozone as an important component of its activities. Continuous monitoring of ambient levels takes place at four WBEA monitoring stations, and passive monitoring is done at 13 locations.

WBEA members recognize that monitoring efforts can be augmented by modeling. Monitoring is confined to a manageable number of locations and to current circumstances. Modeling can add some understanding of likely ozone levels and can build on the foundation provided by monitoring data. Model results will help to direct field monitoring by indicating likely times and locations of where elevated ozone levels may occur.

The Ozone Modeling Working Group is building on previous modeling conducted for the Syncrude Aurora Mine Project EIA in 1995, and collectively by Shell, Suncor and Syncrude in support of their respective project applications in 1997. During 1998, the Working Group commissioned further sensitivity testing of this modeling work to better understand how well the model represents conditions in the Wood Buffalo region.

In 1999, the Working Group assessed the results of the sensitivity testing and based on that information, adopted a set of model input conditions and assumptions which are expected to best support modeling of current and future conditions. That input set was then applied to further model runs. Two historical periods of warm weather were selected, covering a total of 10 days in May and July. Emissions inventories were established for the historical, near future and distant future cases.

Model runs were completed by the end of the year, and a draft report is expected in the first quarter of 2000. This information will be used by the WBEA in the siting and interpretation of ozone monitoring. It will also be used by the new multi-stakeholder Cumulative Environmental Management Association, in its work on the other components of the management system for emissions in the region.

3.4 Summary of Data Interpretation

A review of continuously and intermittently collected ambient air data was commissioned by the WBEA in 1999. The WBEA Data Interpretation Report was prepared by Conor Pacific Environmental Technologies and reviewed by Dr. Warren Kindzierski.
The data were collected at the community super-stations from December 1997 to September 1999. The data are compared to air quality guidelines and compared to similar data collected in Alberta and elsewhere in Canada as an indication of the potential for adverse exposures for the local population due to ambient levels in the communities.

The review of continuously monitored data indicated:

- All peak concentrations are episodic in nature and occur infrequently.
- Levels of sulphur dioxide, nitrogen dioxide, total reduced sulphur compounds, ozone and carbon monoxide at the three community stations are below ambient guidelines in Alberta or other jurisdictions and are similar to or less than levels at other rural sites in Alberta.
- The WBEA maximum total hydrocarbon values are slightly less than at other rural sites.
- The WBEA maximum and average continuous $PM_{2.5}$ levels (particles smaller than 2.5 mm in diameter – 1 mm is one millionth of a metre) are lower than at urban sites. Extremely high levels occasionally observed are attributable to forest fires.

Data from the intermittent sampling program showed:

- The highest PM_{10} and $PM_{2.5}$ levels at the WBEA stations are similar to levels in urban and rural Alberta locations.
- Major water-soluble ion concentrations in rainwater are, on average, only slightly higher than levels in background air.
- Many of the polycyclic aromatic hydrocarbon target compounds are not detectable in the samples with the method used for analysis by the WBEA. Limited data generated before the WBEA measurements began indicate that levels are a factor of two or more lower than in urban centres.
- Measurements for two volatile organic compounds (benzene and 1,3 butadiene) indicate that levels in the region are lower than levels in urban areas in Alberta, but higher than levels in pristine locations. The average concentrations in Edmonton from 1991-1997 are benzene, 2.65 ppb and 1,3 butadiene, 0.41 ppb.
- Numerous metals are typically not detectable in air samples with the analytical method used by the WBEA. Concentrations of those metals detected are well below ambient air quality guidelines.

In summary, maximum concentrations of all compounds measured in the WBEA, except $PM_{2.5}$, are below the ambient air quality guidelines for Alberta or other jurisdictions. The highest $PM_{2.5}$ concentrations are directly attributable to natural causes such as forest fires. As ambient air quality guidelines are designed to protect public health, air quality at the three community stations would be recognized as being safe for the public.

Fall Trade Show in Fort McMurray with Gordon Kemp (Suncor Energy) and Bob Scotten (WBEA) promoting environmental awareness

The work begun last year by the Communications Committee continued in earnest in 1999. The Committee is guided by these Communication Objectives:

- Create an awareness of the work the WBEA.
- Promote awareness in industry of native culture and lifestyle as it relates to the environment.
- Promote community awareness of the environmental efforts of industry.
- Familiarize the community with fundamentals of environmental protection.
- Demonstrate the need to establish a workable balance between economic viability and environmental responsibility.
- Provide the interpretation of scientific data to the community in an easy to understand format.

To achieve these objectives the WBEA implemented several initiatives.

Our WBEA billboard on Highway 63, just south of Fort McMurray, is reaching a wide audience. It provides the Air Quality Information Phone Line and the Website location, both of which provide current information on the air quality at each monitoring station in the region.

The public interest in our WBEA information booth at this year's two local Trade Shows clearly demonstrated that the people of Wood Buffalo are interested, curious and appreciative of the work we are doing. This was made clear by the gratifying number of people who filled in our questionnaire, a total of over 1,400.

The WBEA also began production of our first informational video. We thank Ecole Dickinsfield School principal, Sharon Turner, and teacher, Martin Theriault for lending their support to the project, and to the Grade 4/5 French Immersion class for being the stars of this production. At the time of this writing, the video is in the process of being edited with

the final production distributed to schools soon. It will prove to be a valuable tool in explaining the activities of the WBEA.

One of the most important and comprehensive communication tools an organization has is the Annual Report. WBEA's 1998 Annual Report gave an update on the work of each committee, graphs indicating levels of pollutants found at each air monitoring station and provided an overview of where we expect to be in the coming years. Last year's report was distributed to relevant departments of the federal, provincial and municipal governments and directly to the ministers of each. It was also sent to regional native communities, industry (oilsands, oil and gas, and forest industries), and non-government organizations. The public had access to the document through distribution to the Oil Sands Interpretive Center, local hotels, two local trade shows and at the Fort McMurray Visitor's Bureau.

One of our communication objectives is to provide industry with an understanding of their impact on traditional ways of life. To help achieve this, about 25 leaders of industry from various oils sands, forestry and related companies were invited to spend the day with Fort McKay's Bertha Ganter on her trapline near Fort McKay. Bertha, and Elder Arthur Boucher directed a tour, explained the changes that had occurred over the years as a direct result of industrial development, answered questions and provided a traditional meal. Comments offered by the participants indicated that the trip was well worth a day away from the boardroom.

To support name recognition of the WBEA, two initiatives were implemented. First, an agreement was reached with the OK Radio Group to sponsor the local weather. WBEA's involvement also meant the expansion of weather reports to include the Suncor and Syncrude plants sites, Fort McKay and Fort Chipewyan. Secondly, the WBEA implemented its Visual Identity System, which the Communications Committee developed in 1998. Both initiatives will help ensure that the name Wood Buffalo Environmental Association becomes synonymous with environmental monitoring and credible scientific data collection.

I want to take this opportunity to thank the members of the Communications Committee. Their willingness to participate and focus on the needs of the WBEA made 1999 a very successful year. This group, comprised of industry, native and WBEA representatives, worked well together to achieve common goals. I thank them, and congratulate them on a very successful year.

Ken Shipley
Chair

STATEMENT OF OPERATIONS

For the year ended December 31, 1999

		1999	1998
CONTRIBUTIONS			
Suncor		$ 714,664	$ 848,453
Syncrude		1,129,811	1,091,002
Other Contributions		127,162	
Less: GST included in contributions		(116,653)	(126,789)
Contributions, net of GST		1,854,984	1,812,666
Other income		3,277	2,749
		1,858,261	1,815,415
DIRECT COSTS			
Contracts: operation & maintenance	(Schedule A)	420,921	472,035
Contracts: analytical		266,792	256,715
Contracts: QAQC		65,812	108,034
Equipment repair or replacement		5,120	-
Technical consulting		-	52,680
Telephone voice information			
Station costs	(Schedule B)	12,849	24,980
TOTAL DIRECT COSTS		771,494	914,444
ADMINISTRATION & OTHER COSTS			
Advertising & promotion		2,735	27,990
Conferences & meetings		5,804	2,367
Insurance		1,080	800
Office expenses	(Schedule C)	22,325	18,134
Project management		100,000	103,183
Professional fees		2,798	6,431
Telephone & fax		5,350	6,647
Travel & mileage		4,273	11,729
Technical consultant		50,772	
		195,137	177,281
OTHER PROJECTS	(Schedule D)	602,706	349,321
TOTAL OPERATING EXPENDITURES		1,569,337	1,441,046
CAPITAL EXPENDITURES			
Buildings & trailers		-	44,724
Construction		-	46,642
Environmental equipment		238,513	226,088
Site preparation		-	11,184
Office furniture & equipment		4,516	19,117
CAPITAL EXPENDITURES		243,029	347,755
TOTAL EXPENDITURES		1,812,366	1,788,801
EXCESS OF CONTRIBUTIONS OVER EXPENDITURES, BEFORE TRANSFER TO RESERVE		45,895	26,614
Transfer to reserve for future expenditures	(Note 4)	(45,895)	(26,614)
SURPLUS FOR YEAR		$ NIL	$ NIL

A full set of audited financial statements is available on request.

Appendix I – Ambient Air Monitoring Data - 1999

Table 1. Sulfur dioxide concentrations at WBEA monitoring sites

1-hour average concentrations for 1999, ppb.

Site	Avg	Standard Deviation	Min	P1	P10	P25	P50	P75	P90	P99	MAX
Fort McKay	1.4	3.5	0	0	0	0.2	0.6	1.2	3.0	15.4	93.8
Mildred Lake	2.4	7.1	0	0	0	0.2	0.5	1.6	5.3	31.9	139.0
Lower Camp	1.9	4.2	0	0	0	0.2	0.7	1.7	4.3	21.0	80.2
Buffalo Viewpoint	1.1	3.9	0	0	0	0.1	0.3	0.6	1.8	18.0	71.8
Mannix	2.2	5.2	0	0	0.1	0.4	0.8	1.7	4.8	23.3	168.0
Patricia McInnes	1.2	2.9	0	0	0	0.1	0.4	1.1	2.5	14.0	69.3
Athabasca Valley	0.9	2.1	0	0	0.2	0.2	0.4	0.7	1.7	10.8	46.9
Fort Chipewyan	0.4	1.0	0	0	0	0.0	0.1	0.3	1.0	4.8	17.7

Table 2. Nitrogen dioxide concentrations at WBEA monitoring sites

1-hour average concentrations for 1999, ppb.

Site	Avg	Standard Deviation	Min	P1	P10	P25	P50	P75	P90	P99	MAX
Fort McKay	3.7	5.1	0	0	0.1	0.4	1.1	5.1	11.6	21.4	28.7
Patricia McInnes	4.5	5.7	0	0.1	0.4	0.8	2.3	5.7	11.2	27.8	47.3
Athabasca Valley	8.8	7.7	0	0.2	1.5	3.0	6.2	12.6	19.7	34.1	47.4
Fort Chipewyan	1.1	1.9	0	0	0	0.1	0.5	1.4	3.0	9.4	29.3

Table 3. Total hydrocarbon concentrations at WBEA monitoring sites.

1-hour average concentrations for 1999, ppm.

Site	Avg	Standard Deviation	Min	P1	P10	P25	P50	P75	P90	P99	MAX
Fort McKay	2.0	0.2	1.5	1.6	1.8	1.8	1.9	2.1	2.3	2.7	4.0
Mildred Lake	2.3	0.7	1.5	1.7	1.8	1.9	2.1	2.4	3.0	5.2	13.5
Lower Camp	2.1	0.4	1.6	1.7	1.8	1.8	2.0	2.2	2.4	3.3	10.0
Buffalo Viewpoint	2.1	0.7	1.5	1.7	1.8	1.8	1.9	2.1	2.6	4.7	19.9
Mannix	2.0	0.3	1.7	1.7	1.8	1.8	1.9	2.0	2.2	3.3	7.7
Patricia McInnes	2.0	0.2	1.7	1.7	1.8	1.8	1.9	2.0	2.2	2.7	4.7
Athabasca Valley	2.0	0.2	1.6	1.8	1.8	1.9	1.9	2.0	2.2	2.5	3.5

Table 4. Concentrations of reduced sulphur compounds (TRS) and hydrogen sulphide (H_2S) at WBEA monitoring stations.

1-hour average concentrations for 1999, ppb.

Site		Avg	Standard Deviation	Min	P1	P10	P25	P50	P75	P90	P99	MAX
Fort McKay	H_2S	0.4	0.4	0	0	0.1	0.2	0.3	0.5	0.9	1.9	5.1
Mildred Lake	H_2S	0.6	0.6	0	0	0.1	0.2	0.4	0.7	1.2	2.8	12.6
Lower Camp	H_2S	1.1	1.4	0	0	0.1	0.3	0.7	1.4	2.5	6.5	24.1
Buffalo Viewpoint	H_2S	0.3	0.9	0	0	0	0	0.1	0.3	0.6	2.6	60.5
Mannix	TRS	0.6	0.9	0	0	0	0.1	0.3	0.7	1.4	4.4	18.5
Patricia McInnes	TRS	0.3	0.2	0	0	0.1	0.1	0.2	0.3	0.5	1.2	4.5
Athabasca Valley	TRS	0.2	0.3	0	0	0	0.1	0.2	0.3	0.5	1.3	3.0

Table 5. Ozone concentrations at WBEA monitoring sites

1-hour average concentrations for 1999, ppb.

Site	Avg	Standard Deviation	Min	P1	P10	P25	P50	P75	P90	P99	MAX
Fort McKay	21.0	11.1	0.5	1.3	6.6	12.8	20.5	28.0	36.7	48.1	59.9
Patricia McInnes	25.0	11.5	0.4	2.6	9.6	16.7	24.8	33.1	40.3	50.6	59.0
Athabasca Valley	20.5	12.5	0.1	1.1	4.3	10.5	19.5	29.3	37.6	50.9	66.1
Fort Chipewyan	27.1	8.6	2.4	9.7	16.0	21.0	26.8	32.4	38.9	47.6	60.3

Table 6. The 24h PM_{10} and $PM_{2.5}$ concentrations during 1999 (ug/m^3)

	PM_{10}		$PM_{2.5}$	
Site	Average	Maximum	Average	Maximum
Athabasca Valley	11.4	34.3	4.5	18.4
Patricia McInnes	9.3	31.2	4.1	16.6
Fort McKay	9.5	28.6	3.7	11.8

Table 7. Average concentrations of chemical species in $PM_{2.5}$ and PM_{10} size particles in 1999

		(ug/m^3)			
Location	Species	NO3	SO4	NH4	Ca
Athabasca Valley	$PM_{2.5}$	0.07	0.71	0.20	0.06
	PM_{10}	0.13	0.98	0.30	0.11
Patricia McInnes	$PM_{2.5}$	0.08	0.73	0.22	0.06
	PM_{10}	0.11	0.82	0.26	0.08
Ft. McKay	$PM_{2.5}$	0.04	0.60	0.18	0.06
	PM_{10}	0.12	0.95	0.30	0.07

Table 8. Average concentration of SO2, NO2, and O3 for 1999 measured at forest monitoring sites
by passive sampling, ppb

Station	Sulphur dioxide	Nitrogen dioxide	Ozone
PL7	0.7	0.7	22.9
PH6	1.3	1.2	21.3
AL8	0.6	0.9	20.1
PH4	2.0	2.1	20.3
AH8	1.9	1.4	23.5
PH2	1.3	2.2	22.7
PL8	0.5	0.3	19.1
AH3	0.6	0.8	23.8
AH7	1.5	1.2	24.6
PL1	0.8	0.7	22.7

Appendix II – Meteorological Observations – 1999

Table 9. Temperature measurements at WBEA monitoring sites in 1999 (degrees Celsius).

Station	Annual average	One-hour maximum	One-hour minimum
Fort McKay (AMS 1)	1.9	34.4	-39.8
Mildred Lake (AMS 2)	*	34.8	-30.4
Lower Camp (AMS 3)	3.1	31.9	-32.8
Buffalo Viewpoint (AMS 4)	*	29.7	-33.4
Mannix (AMS 5)	2.8	37.5	-35.5
Patricia McInnes (AMS 6)	2.2	31.9	-38.4
Athabasca Valley (AMS 7)	3.1	33.9	-36.6
Fort Chipewyan (AMS 8)	1.3	31.9	-35.5

** not in operation for a full year*

Table 10. Wind speed measurements at WBEA monitoring sites in 1999 (kilometres/hour)

Station	Annual average	One-hour maximum	One-hour minimum
Fort McKay (AMS 1)	8.0	36.0	0.0
Mildred Lake (AMS 2)	9.1	33.0	0.0
Lower Camp (AMS 3)	8.2	35.0	0.0
Buffalo Viewpoint (AMS 4)	14.0	54.0	0.0
Mannix (AMS 5)	10.9	40.0	0.0
Patricia McInnes (AMS 6)	9.1	39.0	0.0
Athabasca Valley (AMS 7)	9.4	57.0	0.0
Fort Chipewyan (AMS 8)	17.8	58.0	0.0

Table 11. Relative humidity measurements at WBEA monitoring sites in 1999 (percent).

Station	Annual average	One-hour maximum	One-hour minimum
Fort McKay (AMS 1)	69.1	100.0	13.5
Fort Chipewyan (AMS 8)	76.5	100.0	22.5

Meteorological Observations – 1999

Table 12. Solar radiation measurements at WBEA monitoring sites in 1999 (watts per square meter).

Station	Annual average	One-hour maximum	One-hour minimum
Fort McKay (AMS 1)	112	886	0
Fort Chipewyan (AMS 8)	127	859	0

Table 13. Wind direction at WBEA monitoring stations in 1999 (percent of time from each direction).

Station	North	NE	East	SE	South	SW	West	NW
Fort McKay (AMS 1)	18.3	4.7	3.2	10.9	27.5	10.2	11.2	13.2
Mildred Lake (AMS 2)	19.8	7.1	4.6	21.5	18.3	11.0	10.7	6.8
Lower Camp (AMS 3)	17.9	3.6	2.7	38.4	7.3	5.4	10.2	11.3
Buffalo Viewpoint (AMS 4)	17.1	5.6	2.9	25.0	17.6	8.9	14.2	8.6
Mannix (AMS 5)	13.0	8.0	4.0	20.0	24.6	7.9	13.9	8.5
Patricia McInnes (AMS 6)	9.0	8.6	5.5	19.9	10.8	15.3	17.9	13.0
Athabasca Valley (AMS 7)	15.6	3.6	5.0	30.8	9.5	13.6	10.5	9.5
Fort Chipewyan (AMS 8)	10.4	13.8	23.0	9.5	7.7	9.0	14.5	12.0

Appendix III

WBEA Committee Members

Management Committee

Bruce Friesen (President)	Syncrude Canada Ltd.
Gordon Kemp (Vice President)	Suncor Energy Inc.
Tony Punko (Secretary Treasurer)	Athabasca Chipewyan First Nation
Ken Shipley (Director)	Fort McKay Industry Relations Corporation
Ann Dort-Maclean	Fort McMurray Environmental Association
Robert Scotten	WBEA Executive Director

Communications Committee

Ken Shipley (Chair)	Fort McKay Industry Relations Corporation
Mark Kruger	Syncrude Canada Ltd.
Madeline Delisle	Fort McKay Industry Relations Corporation
Bertha Ganter	Fort McKay Industry Relations Corporation
Gordon Kemp	Suncor Energy Inc.
Robert Scotten	WBEA Executive Director

Terrestrial Environmental Effects Monitoring Committee

Bruce Friesen(Chair)	Syncrude Canada Ltd.
Ron Pauls	Syncrude Canada Ltd.
Sheila Chernys	Suncor Energy Inc.
Ian MacKenzie	Mobil Canada
Ken Foster	Alberta Environment
Chris Hale	Alberta Environment
Adam Grant	Regional Health Services
Gail MacCrimmon	Pembina Institute for Appropriate Development
Judith Smith	Shell Canada Limited.
Yves Richard	Regional Municipality of Wood Buffalo
Bryan Kemper	Fort McKay Industry Relations Corporation
Bertha Ganter	Fort McKay Industry Relations Corporation

Ozone Modeling Working Group

Bruce Friesen (Chair)	Syncrude Canada Ltd.
Laurence Cheng	Alberta Environment
Dave Fox	Environment Canada
Gordon Kemp	Suncor Energy Inc.
Ian Mackenzie	Mobil Canada
Tony Punko	Athabasca Chipewyan First Nation
Dan Smith	Pembina Institute
Judy Smith	Shell Canada Limited
Bryan Kemper	Fort McKay Industry Relations Corporation

Ambient Air Technical Committee

Gordon Kemp (Chair)	Suncor Energy Inc.
Diane Phillips	Syncrude Canada Ltd.
Robert Scotten	Wood Buffalo Environmental Association

Staff

Robert Scotten, Rebecca Starr,
Vicki Knox

Appendix IV

LINKS TO THE CLEAN AIR STRATEGIC ALLIANCE

The Wood Buffalo Environmental Association was endorsed as a regional airshed management zone by the Clean Air Strategic Alliance (CASA) in 1996. The WBEA is an independent entity that provides on-going progress updates to the Alliance, shares some common members and directors, and contributes to related CASA processes. The Association has adopted the CASA principles for consensus-based multi-party organizations and its Air Quality Management Guidelines. The WBEA actively shares research information with other regional airshed management zones as they establish their management plans and develop their programs. (West Central Zone, Parkland Airshed Management Zone).

With human health having been identified as a high priority by CASA, the WBEA expects to strengthen its links with health-related activities by sharing data and information.

Appendix V

Contractors for the WBEA (1999)

AGRA Earth and Environmental Ltd.
Alberta Research Council
Aerial Recon
EPCM Associates Ltd.
Fort McKay Environmental Services
Jacques Whitford Environmental Ltd.
Maxxam Analytics Inc.
Melody Hopkinson, Communications Consultant
R.S.L. Systematic Ltd.
Studio 3 graphics

Appendix VI

Members of the WBEA

Alberta Environment
(Kem Singh)

Alberta Health
(Alex MacKenzie)

Athabasca Chipewyan First Nation
(Tony Punko)

Fort McKay First Nation
(Ken Shipley, alternate - Bertha Ganter)

Fort McKay Metis Local 122 (Ken Shipley, alternate - Bertha Ganter)

Fort McMurray Environmental Association
(Ann Dort-Maclean)

Fort McMurray First Nation
(Robert Cree)

Mikisew Cree First Nation
(Matthew Lepine)

Mobil Canada
(Ian Mackenzie)

Northern Lights Regional Health Authority
(Jim McCaul)

Northland Forest Products Ltd.
(Howard Ewashko)

Nunee Board of Health
(Donna Cyprien)

Pembina Institute for Appropriate Development
(Dan Smith)

Regional Municipality of Wood Buffalo
(Yves Richard)

Shell Canada Limited
(Judith Smith)

Suncor Energy Inc.
(Gordon Kemp)

Syncrude Canada Ltd.
(Bruce Friesen, alternate, Gary Burns)

Observers
Alberta Energy and Utilities Board
(Frank Sagan)

Appendix VII

Reports (1999)

Terrestrial Environmental Effects Monitoring

TEEM. 1996. Environmental effects of oil sands emissions in northeastern Alberta: Monitoring Program Design. Prepared by the Environmental Effects Working Group of the Northeast Alberta Regional Air Quality Coordinating Committee. Report No. TEEM-1996-01.

BOVAR Environmental, Landcare Research & Consulting Inc. and AGRA Earth & Environmental Limited. 1997. Environmental effects of oil sands plant emissions in northeastern Alberta: Regional effects of acidifying emissions - 1996 annual report. Prepared for Environmental Effects Subcommittee: Southern Wood Buffalo Regional Air Quality Coordinating Committee. 69 pp. + appendices. Report No. TEEM-1996-02.

Conor Pacific Environmental and Landcare Research Consulting Inc. 1997. Environmental effects of oil sand plant emissions in northeastern Alberta, regional effects of acidifying emissions: 1997 annual report - aspen site selection. Prepared for Southern Wood Buffalo Regional Air Quality Coordinating Committee. Calgary, Alberta. Report No. TEEM-1997-01

AGRA. 1999. Review of the terrestrial environmental effects monitoring program. Report of the workshop of June 25 and 26, 1999 and recommendations for program changes. Prepared by Agra Earth & Environmental Limited for the Terrestrial Environmental Effects Monitoring Committee of the Wood Buffalo Environmental Association. Report No. TEEM-1999-01

EPCM. 1999. Evaluation of passive sampling systems at TEEM jack pine monitoring sites: Part 1. Field evaluation. Prepared by EPCM Associates Ltd. for the Terrestrial Environmental Effects Monitoring Program of the Wood Buffalo Environmental Association. Report No. TEEM-1999-02.

Glossary of Terms

ABBREVIATIONS

BTEX – Benzene, Toluene, Ethylbenzene and Xylene are aromatic volatile aromatic compounds. When found in sufficient quantities can affect human health.

CASA - Clean Air Strategic Alliance is a multi-stakeholder society sponsored by the Departments of Health, Energy, and Environmental Protection which provides a forum to discuss and address issues related to air quality in the province.

CH_4 - methane is a colourless, odourless gas, which is the most common hydrocarbon in the earth's atmosphere. It is of significance as a greenhouse gas responsible for global warming. About 20% of the total greenhouse effect is attributable to methane.

NO_x - oxides of nitrogen are formed when nitrogen combines with oxygen during the combustion of fossil fuels. Other sources are the natural degradation of vegetation and the use of chemical fertilizers. Oxides of nitrogen affect visibility and lead to ozone formation. For monitoring purposes nitrogen oxides are considered the sum of nitric oxide and nitrogen dioxide.

NO - nitric oxide is the major oxide of nitrogen produced by combustion. It is rapidly oxidized to nitrogen dioxide in the atmosphere.

NO_2 - nitrogen dioxide is the most abundant of the oxides of nitrogen in the atmosphere. It is a reddish-brown gas. The Alberta guidelines of a 1-hour average concentration of 212 ppb, a 24-hour average concentration of 106 ppb, and an annual average concentration of 32 ppb, are based on the prevention of human effects.

O_3 - ozone at ground level is generated from emissions of NOx and hydrocarbons. At high concentrations, it may contribute to crop damage and cause respiratory problems. The Alberta guideline for ozone is 82 ppb for a 1-hour average. In the stratosphere, it protects the earth from excessive ultraviolet radiation.

pH - the measurement of the degree of acidity on a scale of 1 to 14. One is very acidic, 7 is neutral and 14 is very alkaline. The natural pH of precipitation in the absence of pollution is thought to be 5.6.

PM_{10} - particles less than 10 micrometer in diameter, small enough to be inhaled but do not reach the lungs.

$PM_{2.5}$ - particles less than 2.5 micrometer in diameter, small enough to be inhaled and may reach the lungs. Concentrations greater than 20 ug/m^3 are thought to adversely affect pulmonary function.

SO_2 - Sulphur dioxide is formed during the processing and combustion of fossil fuels containing sulphur. It is a colourless gas with a pungent odour, and can be detected by taste and odour at concentrations as low as 300 ppb. Historically SO_2 is the main component of acid deposition.

TRS – Total reduced sulphur compounds are mainly of hydrogen sulphide with small amounts of mercaptans.

VOCs - volatile organic compounds can be emitted naturally or as by-products of industrial processes. Examples are terpenes produced by forests, ethylene from industrial and natural sources, and chloroform from industry.