SUNCOR ENERGY

Project Millennium Application 2C

Submitted to **Alberta Energy and Utilities Board** and **Alberta Environmental Protection**

Volume 2C
Environmental Impact Assessment
Social Aspects, Impact Summary

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Project Millennium
Taking Suncor into the 21st Century

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LIST OF ABBREVIATIONS

"	Inch
$k	Thousand dollars
%	Percent
$<$	Less than
$>$	More than
°C	Temperature in degrees Celsius
°F	Temperature in degrees Fahrenheit
7Q10	Lowest 7-day consecutive flow that occurs, on average, once every 10 years
AAC	Annual Allowable Cut
AEOSRD	Alberta Energy Oil Sands and Research Division
AEP	Alberta Environmental Protection
AEP-LFS	Alberta Environmental Protection - Lands and Forest Service
AEPEA	Alberta Environmental Protection and Enhancement Act
AEUB	Alberta Energy and Utilities Board (also EUB)
Al-Pac	Alberta Pacific Forest Industries Inc.
AMD	Air Monitoring Directive
ANC	Acid Neutralizing Capacity
AOSERP	Alberta Oil Sands Environmental Research Program
API	American Petroleum Institute
ARC	Alberta Research Council
asl or ASL	Above sea level
ATP	AOSTRA Taciuk Process
avg.	Average
AVI	Alberta Vegetation Inventory
bbl	Barrel, petroleum (42 U.S. gallons)
bbl/cd	Barrels per calendar day
BCM	Bank cubic metres
BCY	Bank cubic yards
BOD	Biological oxygen demand
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
C	Carbon
C&R	Conservation and Reclamation
Ca^{2+}	Calcium base cation (particle)
$CaCO_3$	Calcium carbonate
CANMET	Canada Centre for Mineral and Energy Technology
CASA	Clean Air Strategic Alliance
$CaSO_4$	Calcium sulphate
CCME	Canadian Council of Ministers of the Environment
cd	Calendar day
CEA	Cumulative Effects Assessment
CEAA	Canadian Environmental Assessment Association
CEC	Cation exchange capacity
CEPA	Canadian Environmental Protection Act
ch	Calendar hour
CHWE	Clark Hot Water Extraction
CLI	Canadian Land Inventory

cm	Centimetre
cm/s	Centimetres per second
cm^2	Square centimetre
CO	Carbon monoxide
CO_2	Carbon dioxide
COD	Chemical oxygen demand
COH	Co-efficient of haze
CONRAD	Canadian Oil Sands Network for Research and Development
Consortium	Fine Tailings Fundamentals Consortium
CPUE	Cateh per unit of effort
CSEM	Continuous Stack Emissions Monitor
CT	Consolidated Tailings
CWQG	Canadian Water Quality Guidelines
d	Day
DBH	Diameter at breast height
DCU	Delayed Coking Unit
DEA	Diethanolamine
DEM	Digital Elevation Model
DIAND	Department of Indian Affairs and Northern Development
DL	Detection Limit
DO	Dissolved oxygen
DRU	Diluent Recovery Unit
e.g.	For example
EA	Effective Acidity
EC	Effective Concentration
EIA	Environmental Impact Assessment
ELC	Ecological Land Classification
elev	Elevation
EPL	End Pit Lake
ER	Exposure Ratio
ESPs	Electrostatic Precipitators
FEM	Finite Element Modelling
FGD	Flue Gas Desulphurization
FMA	Forest Management Agreement
ft	Feet
ft^3	Cubic feet
FTPH	Final Tailings Pump House
g	Grams
g/cc	Grams per cubic centimetre
g/s	Grams per second
GC/FID	Gas Chromatography/Flare Ionization Detection
GC/MS	Gas Chromatography/Mass Spectrometry
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIS	Geographic Information System
GJ	Giga-joules (10^9 joules)
GLC	Ground Level Concentration
Golder	Golder Associates Ltd.
GTG	Gas Turbine Generator
h	Hour

H_2S	Hydrogen sulphide
ha	Hectares
HNO_3	Nitric Acid (gas)
HQ	Hazard Quotient
HRSG	Heat Recovery Steam Generator
HSI	Habitat Suitability Indicies
HU	Habitat Unit
i.e.	That is
ibid.	In the same place
IC	Inhibiting Concentration
ICP	Inductively Coupled Argon Plasma Atomic Emission Spectrometric Analysis
IR	Infrared Spectrophotometric Analysis
IRIS	Integrated Risk Information System
IRP	Integrated Resource Plan
k	Thousand
K^+	Potassium Base Cation (particle)
kg	Kilogram
kg/d	Kilograms per day
kg/ha	Kilograms per hectare
kg/hr	Kilograms per hour
KIRs	Key Indicator Resources
km	Kilometre
km^2	Square kilometre
kmol.	kilo mole
kV	Kilovolt
kW	Kilowatt
L or l	Litre
lb/hr	Pounds per hour
LC	Lethal Concentration
LC/MS	Liquid Chromatography/Mass Spectrometry
LGHR	Low-Grade Heat Recovery
LHV	Lower Heating Value
LOAEL	Lowest Observed Adverse Effect Level
LOEC	Lowest Observed Effect Concentration
LOEL	Lowest Observed Effect Level
m	Metre
M	Mega (SI prefix)
m/s	Metres per second
m^2	Square metres
m^3	Cubic metres
m^3/cd	Cubic metres per calendar day
m^3/d	Cubic metres per day
m^3/ha	Cubic metres per hectare
m^3/hr	Cubic metres per hour
m^3/s	Cubic metres per second
masl	metres above sea level
MDEA	Methyl-diethanolamine
meq	Milli-equivalents
MFT	Mature Fine Tails

mg	Milligrams
MOU	Memorandum of Understanding
MSL	Mineral Surface Lease
μg	Microgram
μg/g	Micrograms per gram
μg/kg/d	Micrograms per kilogram body weight per day
mg/kg/d	Milligrams per kilograms body weight per day
μg/L	Micrograms per litre
mg/L	Milligrams per litre
$\mu g/m^3$	Micrograms per cubic metre
Mg^{2+}	Magnesium base cation (particle)
MJ	Megajoule (10^6 joules)
MM	Million
mm	Millimetre
MM.BTU	Million British Thermal Units
Mm^3	Mega metres (Million cubic metres)
Mobil	Mobil Oil Canada
mS/cm	milli-siemens per centimetre
MVA	Mega volt-amperes
MW	Megawatt
N	Nitrogen
ND	Not detected
N.D.	No data
N/A and n/a	Not applicable
NAP	Net Acidifying Potential
NAQUADAT	Alberta Environmental Historical Water Database
NH_4	Ammonia (particle)
NO	Nitric Oxide (gas)
No.	Number
NO_2	Nitrogen Dioxide (gas)
NO_3	Nitrate (particle)
NOAEL	No Observed Adverse Effect Level
NOEC	No Observed Effect Concentration
NOEL	No Observed Effect Level
NO_x	Oxides of nitrogen (NO, NO_2) (gas)
NO_y	All nitrogen species, $NO_x + N_2O + N_3O + ...$(gas)
NPRI	National Pollutant Release Inventory
NRBS	Northern River Basin Study
NRU	Naphtha Recovery Unit
O & G	Oil and Grease
OB	Overburden
OSEC	Oil Sands Environmental Coalition
OSLO	Other Six Lease Owners
OSRPAP	Oil Sands Reclamation Performance Assessment Protocol
OSWRTWG	Oil Sands Water Release Technical Working Group
P	Phosphorus
PAH	Polycyclic aromatic hydrocarbons
PAI	Potential Acid Input
PANH	Polycyclic aromatic nitrogen heterocycles

PASH	Polycyclic aromatic sulphur heterocycles
PM_{10}	Particulate matter with mean aerodynamic diameter $\leq$ 10 microns
$PM_{2.5}$	Particulate matter with mean aerodynamic diameter $\leq$ 2.5 microns
PMF	Probable maximum flood
ppb	Parts per billion
ppm	Parts per million
psi	Pounds per square inch
Q	Quarter (i.e., three months of a year)
QA/QC	Quality Assurance/Quality Control
RA	Reclamation Area
RAMP	Regional Aquatic Monitoring Program
RAQCC	Regional Air Quality Coordinating Committee
RfD	Reference Dose
RIWG	Regional Infrastructure Working Group
RMWB	Regional Municipality of Wood Buffalo
RRTAC	Reclamation Research Technical Advisory Committee
RSA	Regional Study Area
RsD	Risk Specific Dose
s	Second
S	Sulphur
SAR	Sodium absorption ratio
scf/d	Standard cubic feet per day
SCO	Synthetic crude oil
sd	Stream day
sep cell	Separation cell
SFR	Sand to fines ratio
Shell	Shell Canada Limited
SLC	Screening Level Criteria
SO_2	Sulphur dioxide
SO_4^{2-}	Sulphate (particle)
SO_x	Sulphur oxides
spp	Species
Suncor	Suncor Energy Inc., Oil Sands
Syncrude	Syncrude Canada Ltd.
t	Tonne
t/cd	Tonnes per calendar day
t/d	Tonnes per day
t/h	Tonnes per hour
t/hr	Tonnes per hour
t/sd	tonnes per stream day
TDS	Total dissolved solids
TEH	Total extractable hydrocarbons
THC	Total hydrocarbons
TID	Tar Island Dyke
TIE	Toxicity Identification Evaluation
TKN	Total Kjeldahl Nitrogen
TOC	Total organic carbon
Ton	2 000 pounds
Tonne	2 205 pounds (1000 kg)
TRV	Toxicity Reference Value

TSS	Total suspended solids
TV/BIP	Ratio of total volume removed to total volume of bitumen in place
TV/NRB	Ratio of total volume removed to net recovered bitumen (in barrels)
Twp.	Township
U.S. EPA	United States Environmental Protection Agency
USgpm	U.S. gallons per minutes
VOC	Volatile organic compound
Vol.	Volume
VRU	Vapour Recovery Unit
vs.	Versus
WA	Waste Area

F1 HUMAN HEALTH

F1.1 SCOPE OF ASSESSMENT

F1.1.1 Introduction

The human health impact assessment was conducted to evaluate the potential for impacts to human health as a result of Project Millennium (the Project). This section of the Project EIA provides information as required by the Project Terms of Reference issued on March 4, 1998 (AEP 1998). Specifically, the following are addressed:

- discussions on the potential implications of expected air quality for environmental protection and public health;
- consideration of interactive effects that may occur as a result of co-exposure of a receptor to various emissions and discussion of the limitations associated with the present understanding of this subject;
- description of the aspects of the Project that may have implications for public health, discussing the measures to be taken to prevent or minimize the potential for adverse health effects;
- discussion of the potential for changes to water quality, air quality and the bioaccumulation of contaminants in natural food sources in the Study Area to increase human exposure to contaminants ;
- chemical analysis of vegetation known to be consumed by humans;
- incorporation of data from the Alberta Oil Sands Community Exposure and Health Effects Assessment Program; and
- identification of anticipated follow-up work, including regional cooperative studies.

Section F1.2 provides details on the human health baseline for the Project. The assessment of the Project is presented in Section F1.3, while cumulative effects are discussed in Section F1.4.

This human health impact analysis considers the following major items:

- chemical release sources:
  - water releases from the Project during operation and following closure,
  - air releases from the Project during operation, including: (i) stack and fugitive plant sources; (ii) vehicle emissions; (iii) emissions from tailings ponds; and (iv) volatile emissions from mine surfaces,
  - observed chemical concentrations in fish from the Athabasca River,

- observed chemical concentrations in plants growing off-site in potentially impacted areas,
- observed chemical concentrations in animals collected at varying distances from oil sands operations;
- predicted chemical concentrations in plants that will grow on the reclaimed landscape, and
- observed chemical concentrations in bison pastured on reclaimed landscape;

- pathway-specific and multimedia exposures for local residents;
- traditional land use, including hunting/trapping/gathering activities;
- reasonable maximum exposures likely to be incurred by local residents under various scenarios; and
- evaluation of carcinogenic and non-carcinogenic endpoints for health effects.

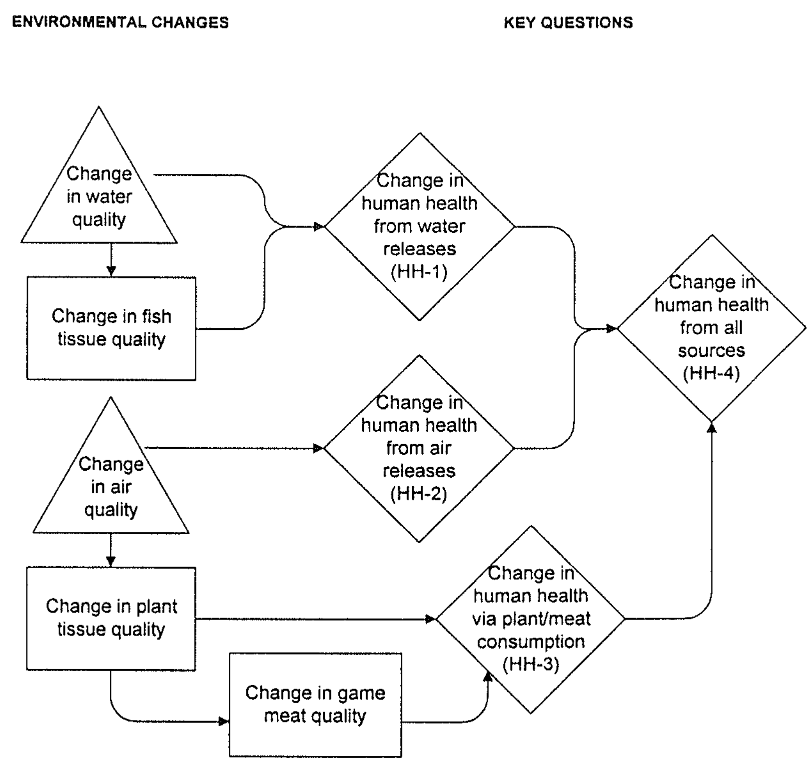
F1.1.2 Potential Linkages and Key Questions

Linkages between Project activities and human health impacts are presented in Figures F1.1-1 and F1.1-2. Triangles indicate links to other components. Further clarification of these environmental changes can be found in the appropriate sections of this document. Key questions were defined to reflect the issues previously raised by various regulatory agencies and stakeholders and to guide the subsequent analyses for the human health component. The five key questions for the human health impact assessment are listed below. The information which follows in parentheses refers to whether the postulated effect is: (a) incremental (i.e., Project-based) or cumulative (i.e., all regional sources); (b) caused by exposure from a single medium or multimedia exposure; and (c) due to the operational or closure phase of the Project.

HH-1: What impact will chemicals in operational water releases from Project Millennium have on human health? ***(incremental/single medium for operational phase)***

Water releases from the Project may result in exposure of people who use off-site waterbodies for recreational activities, such as swimming, boating, fishing and hiking, during the operational phase of the Project. The waterbodies affected by the Project are not currently used as a regular source of drinking water for local residents, but recreational users may occasionally drink water from these sources in off-site areas. This question evaluates the potential for human health impacts as a result of recreational water exposures and fish consumption during the operational phase.

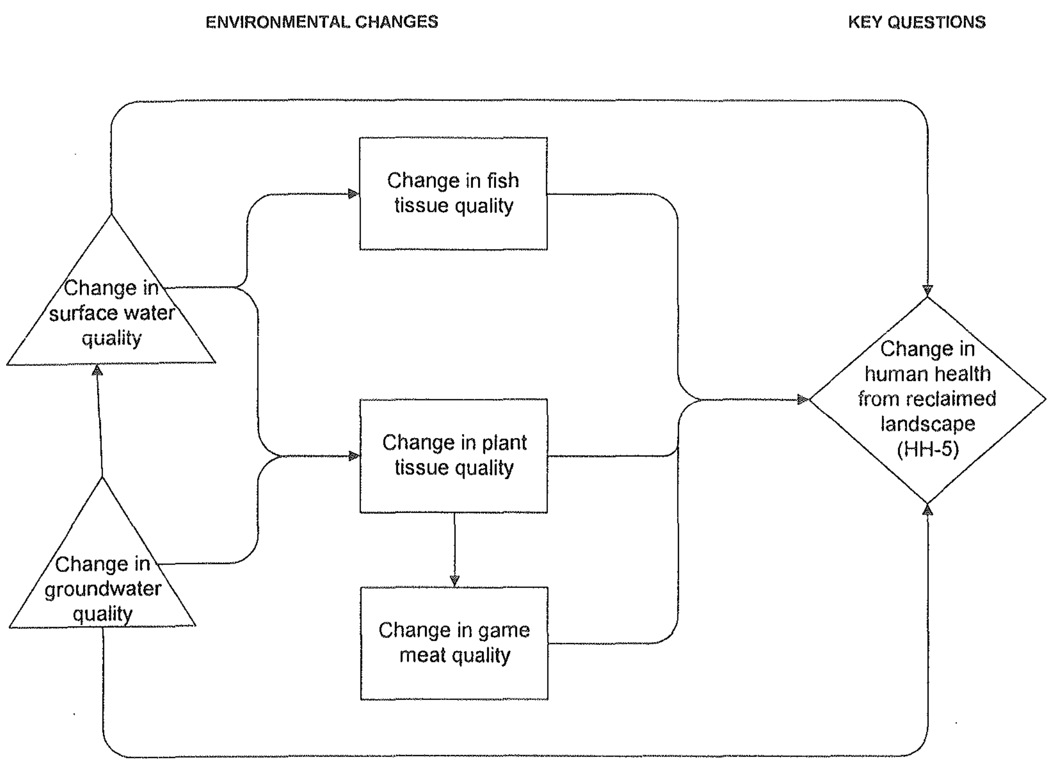
Figure F1.1-1 Linkage Diagram for Human Health for Construction and Operation Phases of Project Millennium



HH-2: What impact will chemicals in operational air emissions from Project Millennium have on human health? ***(incremental/single medium for operational phase)***

This question evaluates the potential for adverse effects to human health as a result of all Project air emissions that may be dispersed by winds to nearby residential communities, such as Fort McKay, Fort McMurray and Fort Chipewyan.

Figure F1.1-2 Linkage Diagram for Human Health for Closure Phase of Project Millennium



HH-3: What impact will consumption of local plants and game animals exposed to operational water releases and air emissions from Project Millennium have on human health? *(incremental/single medium for operational phase)*

Area residents are concerned about the quality of the country foods that are harvested in close proximity to oil sands activities. This question evaluates the potential for adverse effects due to the consumption of local plants (i.e., berries, leaves and roots) and game animals (e.g., moose, snowshoe hare, ruffed grouse).

HH-4: What impact will the combined exposure to water, air, plants and game animals have on human health during the operational phase of Project Millennium? ***(incremental/multimedia for operational phase)***

Area residents may be exposed to chemicals through a variety of different media. This question evaluates the combined exposure that might be incurred by area residents exposed to water, air, plants and game animals after Project start up.

HH-5: What impact will the release of chemicals in soils, plants and waters of the Project Millennium reclaimed landscapes have on human health? ***(incremental/multimedia for closure phase)***

Following closure of the Project, the land will have been reclaimed and revegetated, allowing wildlife to re-inhabit the area. Hunters and trappers may live on these reclaimed landscapes for extended periods of time, and possibly incur exposures to local soils, water, plants and game animals. Local plants and game meat may also be dietary components for residents of nearby communities. This question evaluates the potential for human health impacts from use of the reclaimed landscape.

F1.1.3 Study Area

The study area for human health is defined by the water and air components and is discussed in detail in Section A2.

F1.1.4 Methods

F1.1.4.1 Sources of Data

A large database of historical data, recent data and technical reports were reviewed and incorporated, where appropriate, into this assessment. The primary sources of pertinent information include:

- water quality data summarized in Section C3;
- fish quality data summarized in Section C4;
- air quality data summarized in Section B;
- plant tissue quality data summarized in Sections F1.2.4 and Appendix VI.7;
- game meat tissue quality data summarized in Section F1.2.5;
- the Alberta Oil Sands Community Exposure and Health Effects Assessment Program Pilot Study Report (AOSCEHEAP 1997) summarized in Section F1.2.2; and

- public health information from the Northern River Basins Study (NRBS) program summarized in Section F1.2.1.

F1.1.4.2 Impact Analysis

The first step of the human health impact analysis was to determine whether a certain Project-related activity has the potential to cause a change in environmental chemical exposure that might affect human health. Figures F1.1-1 and F1.1-2 show the linkages between Project activities, environmental changes and key questions.

Each potential link between environmental changes (e.g., water releases, air releases) and human health was initially evaluated qualitatively using principles of a screening level risk assessment to determine the validity of each linkage based on specific activities of the Project (i.e., whether a certain Project-related activity could result in an environmental change that might adversely affect human health). Subsequently, quantitative risk assessments were conducted, and the results were evaluated against criteria which define the environmental consequence that should be ascribed to the findings. These criteria are defined in Section F1.1.4.4.

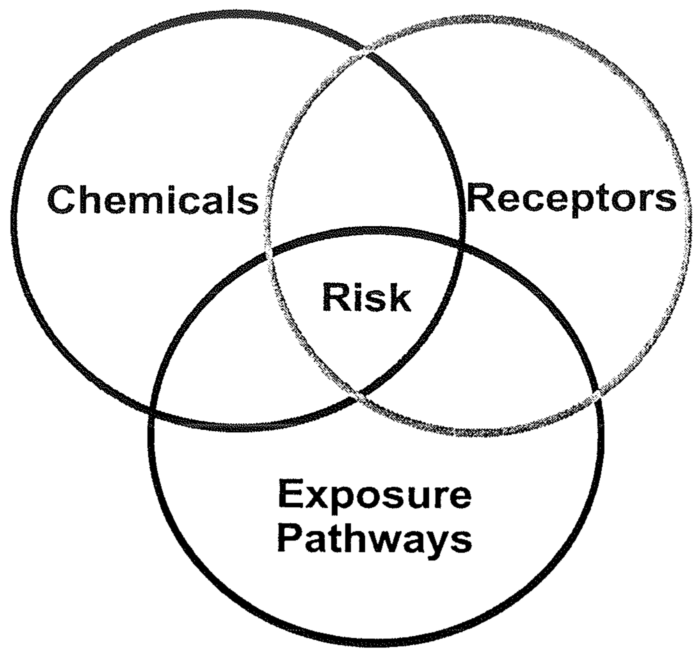
The overall risk assessment approach used to evaluate the linkages is summarized in the following section. Supporting documentation for the risk assessment is provided in Appendix VI.

F1.1.4.3 Risk Assessment

General Concepts

A risk assessment was conducted to evaluate whether activities associated with the Project might adversely affect people. This risk assessment was conducted according to established human health risk assessment protocols endorsed by Health Canada (Health Canada 1994) and risk assessment principles as outlined in a report to Health Canada (Health Canada 1995). The potential for a health risk to arise from environmental substances is predicated on the co-existence of three elements (Figure F1.1-3) including: i) chemicals must be present; ii) receptors (i.e., people) must be present; and iii) exposure pathways must exist between the source of the chemicals and people. In the absence of any one of the three elements outlined in Figure F1.1-3, health risks cannot occur. The presence of all three elements, however, does not necessarily indicate an unacceptable risk. In such situations, risk analysis involves addressing both the magnitude and uncertainty of these health risks.

Figure F1.1-3 Risk Components

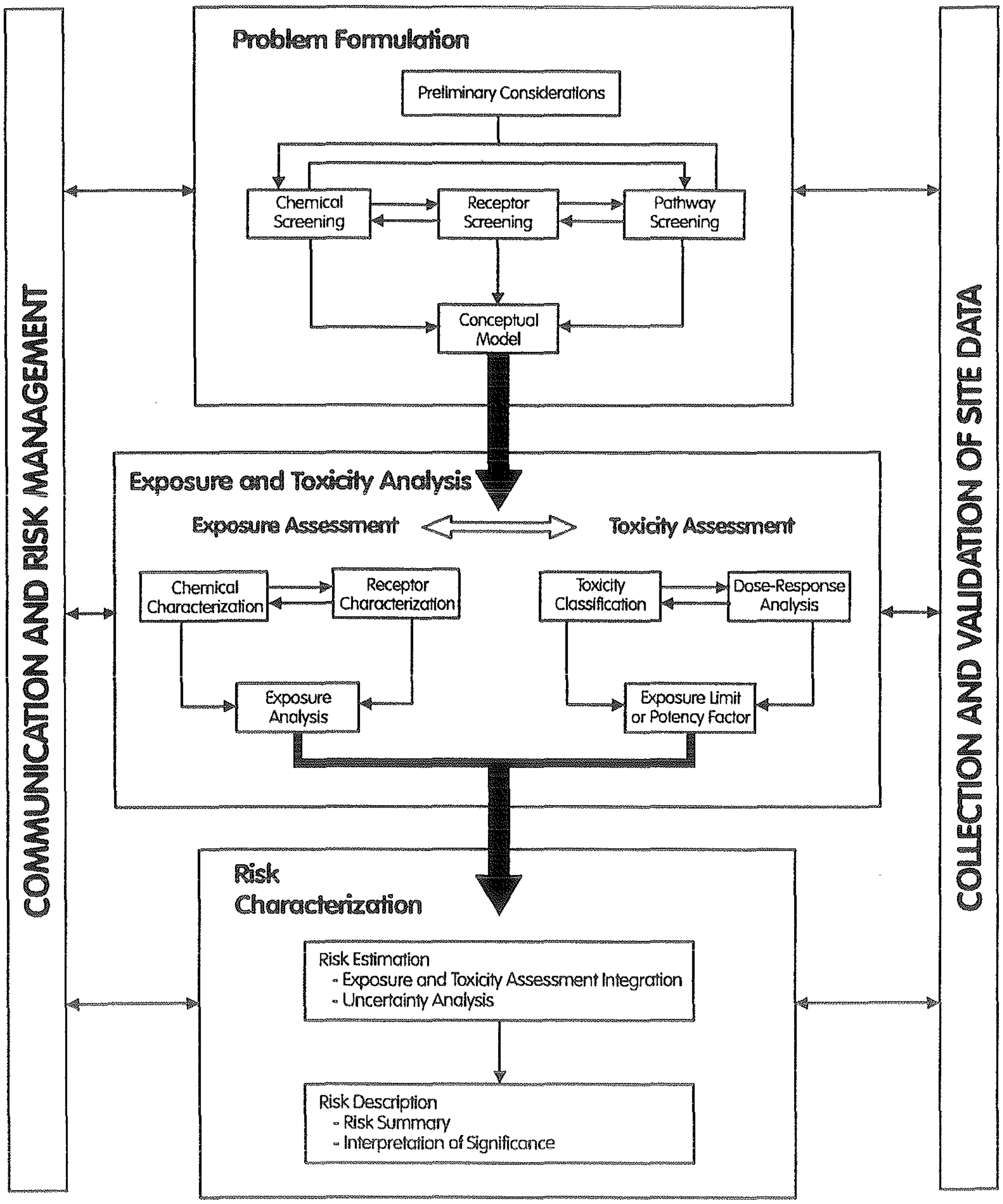


The process followed a widely recognized framework for environmental health risk assessment, as illustrated in Figure F1.1-4 (Health Canada 1995). The framework progresses from a qualitative initial phase (Problem Formulation), through Exposure and Toxicity Analysis and culminates in quantitative Risk Characterization. The following sections provide further insight to these specific phases.

Problem Formulation

The Problem Formulation phase of a risk assessment is a conservative screening-level assessment of possible impacts on health. The objective of the Problem Formulation for this assessment was to develop a focused understanding of how chemical releases from the Project might affect the health of people who currently use adjacent areas for recreation, live in nearby residential communities, and/or may in the future use the reclaimed landscape. This was achieved by considering the attributes of the site, identifying the human activity that is expected to occur on-site and in nearby off-site areas, focusing on the chemicals that may be hazardous through low level chronic exposure, and identifying the plausible exposure pathways between chemicals and receptors.

Figure F1.1-4 Risk Assessment Framework



Problem Formulation is the critical initial phase of the risk assessment and involves consideration of three major elements, as illustrated in Figure F1.1-4:

- Preliminary Considerations: characterization of the site and scope of the problem.
- Screening Process: identification of the chemicals, exposure pathways and human receptors of greatest concern.

- Development of the Conceptual Model: a visual representation of the environmental fate and exposure pathways by which receptors of concern may come in contract with chemicals.

The Problem Formulation process (or screening level assessment) was conducted for each key question. Where the Problem Formulation indicated a potential linkage between Project activities and human health (i.e., presence of chemicals of concern, receptors and exposure pathways), a detailed risk assessment was carried out to further investigate the potential impact. Where the results of the Problem Formulation indicated no potential linkage between Project activities and human health, no further evaluation was done.

Preliminary Considerations

Details of activities during construction, operation and closure of the Project have been fully described in Volume 1 of the Application.

Land Use

Human use of the site will change over the life of the Project. During the construction and operational phases, the site will be restricted to industrial uses. Nearby waterbodies, such as the Athabasca River and Shipyard Lake, and forested areas may be used for recreation (e.g., swimming, boating, fishing, hiking) and harvesting of local plants and game animals by aboriginal people during the construction and operational phases. The human health component focused on the operational phase because of its substantially longer time frame, additional emission sources and larger potential area of effect compared to the construction phase. Following closure of the Project, use will likely shift from occasional recreational use to intermittent residential use for hunters and trappers, who may live in cabins directly on the reclaimed landscape for extended periods. Thus, the exposure scenarios for the operational and closure phases are different, and therefore are evaluated separately.

Regulatory Considerations

With respect to relevant regulatory policies/criteria, the approach utilized various provincial and federal environmental quality standards.

Site-Specific Aboriginal Community Considerations

Unique concerns of aboriginal residents were incorporated into the risk assessment. Specifically, the risk assessment evaluated chemical concentrations in plants used by aboriginal people as sources of food and/or medicine, using community-specific exposure parameters, (e.g., food consumption rates and frequencies), determined from historical documentation for the communities of Fort McKay and Fort Chipewyan (Fort McKay 1996d, 1997a, Wein 1989), and personal communication (Fort McKay Environment Services Ltd.). Similarly, aboriginal consumption of game meat was addressed with consideration of the types of animals used as food by local communities and the typical frequencies and rates of game meat consumption. Finally, a hunter/trapper land use scenario was evaluated to address the potential for temporary residential use of the reclaimed landscape by aboriginal hunters/trappers, with associated exposures to plants and game animals harvested from the site.

Screening Process

In a risk assessment, it is not possible or practical to evaluate every potential chemical, receptor and exposure pathway. For this assessment, a comprehensive screening process was completed in the problem formulation phase to focus the assessment on chemicals, receptors and exposure pathways of greatest concern (i.e., chemicals with the greatest toxic potential; receptors with the greatest likelihood of being exposed and the greatest sensitivities; exposure pathways that account for the majority of exposure to the chemical releases). If no unacceptable health risks are predicted for these, it is highly likely that no unacceptable health risks would exist for other chemicals, receptors or exposure pathways.

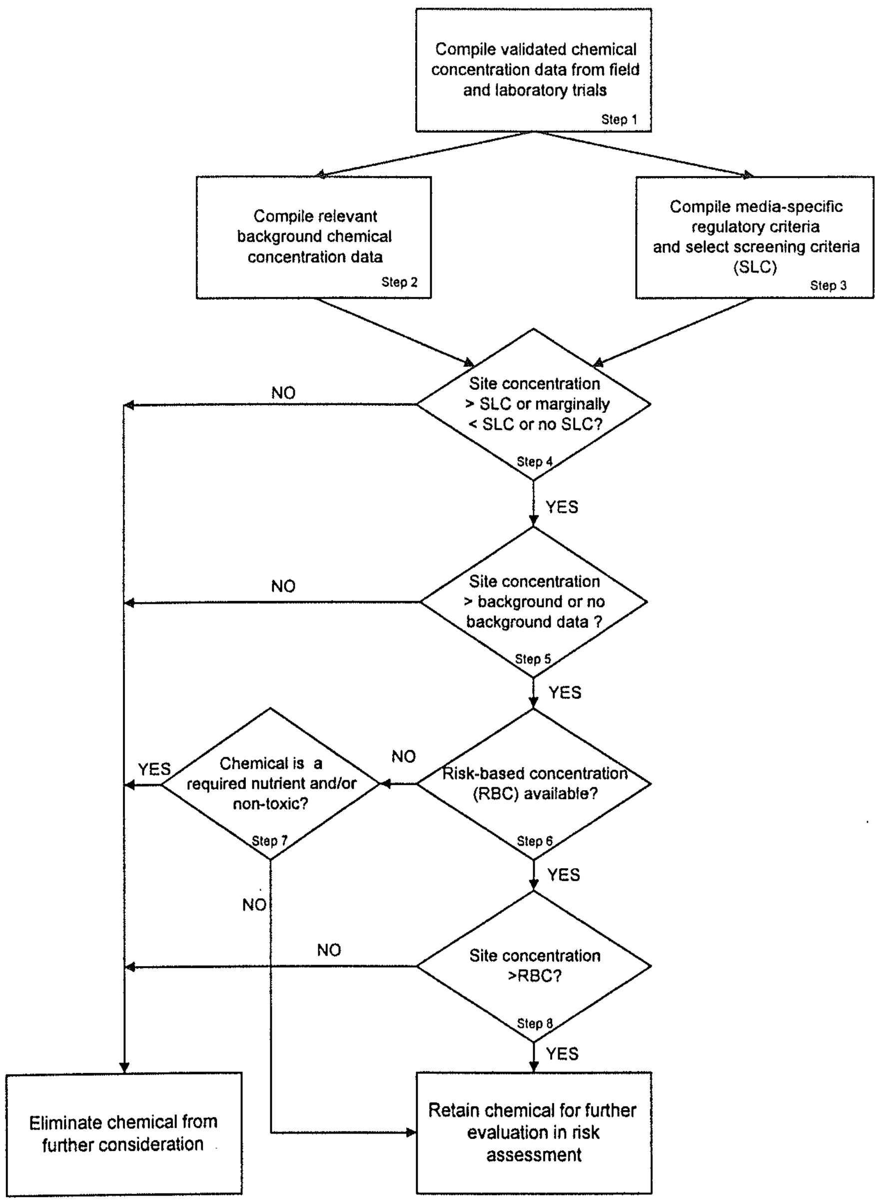
Three screening procedures were conducted in the problem formulation phase:

- chemical screening;
- receptor screening; and
- exposure pathway screening.

Chemical Screening

The objective of the chemical screening process was to focus the list of chemicals measured in various media (e.g., water, air, fish, plants and meat) on those chemicals that may be a concern because of their concentrations and their potential to adversely affect human health. This list of chemicals of potential concern was used to assist in receptor and exposure pathway screening. Chemicals identified in this screening process were carried forward for quantitative analysis. The chemical screening process used for the human health risk assessment followed a methodical, step-wise process, as shown schematically in Figure F1.1-5 and briefly described below. Further details are provided in Appendix VI.1.3.

Figure F1.1-5 Process for Chemical Screening



Note: See text below for explanation of the steps involved in chemical screening

Steps 1 and 2: Validated site and background chemical concentration data were compiled and maximum observed, or conservatively predicted, concentrations were selected.

Step 3: Media-specific regulatory criteria (e.g., water quality guidelines) were compiled (where available) and the lowest of these criteria was selected as the Screening Level Criterion (SLC).

Step 4: Site concentrations were compared to SLC. If chemical concentrations were greater than or equal to the SLC, the chemicals were carried forward to Step 5. If chemical concentrations were much less than the SLC, they were eliminated from further consideration in the risk assessment. However, if chemical concentrations were marginally less than the SLC, these chemicals were conservatively carried forward to Step 5. If no SLC were available, chemicals were carried forward to Step 5.

Step 5: Site concentrations were compared to background chemical concentrations. If chemical concentrations were less than or equal to background concentrations, they were eliminated from further consideration in the risk assessment, since these chemical concentrations were assumed to be natural in origin and not Project-related. If chemical concentrations exceeded background concentrations or if no background data were available, they were carried forward to Step 6. In some cases, chemicals which are naturally elevated in background were carried through the risk assessment (e.g., arsenic, beryllium) due to their contribution to total carcinogenic risk when combined with other Project-related chemical emissions.

Step 6: Risk-based concentrations (RBCs) were identified for the remaining chemicals. RBCs were based on conservative exposure scenarios, assuming child exposure and a target exposure ratio of 0.1, rather than 1.0, for non-carcinogenic chemicals (i.e., one-tenth of the exposure considered to be without adverse effects to sensitive individuals). For carcinogenic chemicals, RBCs were calculated at a risk level of one-in-one-million (i.e., the lower end of the range of cancer risk usually considered acceptable by provincial and federal agencies). If RBCs were not available and could not be derived, chemicals were retained and evaluated for nutrient and/or non-toxic status in Step 7. If RBCs were available, chemicals were retained and evaluated for exceedance of RBCs in Step 8.

Step 7: Certain substances were eliminated from further consideration based on their importance as a dietary component, status as an essential nutrient, or general lack of toxic effects. Calcium, magnesium, potassium, iron and sodium can generally be eliminated from an evaluation at the screening stage based on dietary and nutritional status (U.S. EPA 1989a). Other chemicals (e.g., ammonia, chloride, manganese, silicon, sulphate, zinc) may be considered non-toxic under certain conditions of exposure. The specific rationale for exclusion of chemicals in Step 7 is presented in Appendix VI.1.3.

Step 8: In the final step of the chemical screening process, site concentrations were compared to the RBCs. If the chemical concentration was greater than or equal to the RBC, the chemical was retained for further evaluation in the risk assessment. If the chemical concentration was less than the RBC, the chemical was eliminated from further consideration.

The chemicals of potential concern retained for further evaluation in the risk assessment for each key question are listed in Sections F1.2, F1.3 and F1.4.

This screening focused not only on chemicals related to the operations of the Project, but additionally on background concentrations of other substances (e.g., naturally occurring or anthropogenic) in the Athabasca River and Shipyard Lake. Some chemicals, such as chlorinated organics derived from pulp mills, were not investigated here because the Project is not a source for those chemicals and they are closely monitored and managed by the pulp industry. In addition, there may be natural pathogenic hazards, such as bacteria and viruses, associated with river water that could pose a health hazard to people who drink untreated river water. These were not considered in the risk assessment, since they are not related to the Project.

Receptor Screening

The objective of the receptor screening process was to identify people who are currently using the area or may use the reclaimed landscape in the future. The receptors identified here were carried forward for quantitative analysis. For non-carcinogenic chemicals, a hypothetical child and adult were chosen for evaluation of end land use scenarios. Although a child is unlikely to live on the reclaimed landscape like an adult hunter/trapper, a hypothetical child was evaluated for HH-5, since children may still be exposed through ingestion of plants and game meat harvested from the reclaimed landscape. For carcinogenic chemicals, a so-called "composite receptor" was evaluated from birth until 70 years of age to address the residual risk from carcinogenic substances after cessation of exposure. Since development of cancer is a long-term process, it is best to evaluate a receptor over their entire lifespan, rather than evaluating only a certain phase of life (e.g., childhood). The concept of a "composite receptor" embraces behavioural and physiological changes that occur through various lifestages from birth to old age (e.g., breathing rates, body weights, drinking water intake). This is used in place of lifetime averaged values.

Senior citizens were considered as potential receptors for the risk assessment due to concerns expressed by stakeholders. A comparison between Canadian exposure parameters for seniors (age 60+) and adults (age 20+) revealed no significant difference in terms of body weight, skin surface area, water intake rate and dietary composition (Richardson 1997). Inhalation and food intake rates are slightly lower for seniors than for adults, and seniors are also more likely to spend more time indoors (Richardson 1997), thereby lowering their exposure. Seniors may be more sensitive to chemical exposure due to compromised health. However, toxicity reference values for the current assessment were conservatively derived to ensure that sensitive members of the human population, such as seniors, would be protected (refer to the Toxicity Assessment for further explanation). For this reason, it was concluded that results for the adult receptor (age 20+) would also apply to seniors (age 60+) and therefore a separate senior receptor was not evaluated.

Receptor parameters used in this assessment were obtained from Health Canada (1994) and are representative of average Canadians, regardless of gender. Following a review of a recent compilation of Canadian exposure parameters for male and female receptors (Richardson 1997), it was determined that Health Canada (1994) receptor parameters were more conservative. Therefore these were used in this assessment. Details of the receptor screening process and selection of receptor parameters are provided in Appendix VI.2.2. Table F1.1-1 lists the potential receptors and land use scenarios for each key question.

Table F1.1-1 Potential Receptors and Land Use Scenarios

HH-1	HH-2	HH-3	HH-4	HH-5
Receptors				
Adult[a]	Adult[a]	Adult[a]	Adult[a]	Adult[a]
Child[b]	Child[b]	Child[b]	Child[b]	Child[b] (food ingestion only)
Composite[c]	Composite[c]	Composite[c]	Composite[c]	Composite[c]
Land Use Scenarios				
Recreational[d]	Residential[f]	Traditional Food Harvesting[g]	Recreational[d]	Hunting or Trapping[h]
Swimming[e]			Swimming[e]	Recreational[d]
			Residential[f]	
			Traditional Food Harvesting[g]	

[a] Adults are defined as 20 years of age up to a lifespan of 70 years (Health Canada 1994).
[b] Children are defined as between the ages of 7 months and 4 years for HH-1, HH-3 and HH-5, (maximum ingestion rate to body weight ratio); children between the ages of 5 to 11 years were evaluated for HH-2 (maximum inhalation rate to body weight ratio) (Health Canada 1994).
[c] Composite receptors are lifetime receptors evaluated from birth to 70 years of age (Health Canada 1994) with appropriate weighting of life phases.
[d] Recreational scenario includes occasional use of local rivers in off-site areas for recreational activities (i.e., hiking, boating, fishing).
[e] Swimming scenario includes occasional use of the local rivers and lakes in off-site areas for swimming.
[f] Residential scenario includes year-round residence within the communities of Fort McKay, Fort McMurray and Fort Chipewyan.
[g] Traditional Food Harvesting Scenario includes year-round harvesting of local plants and game animals (e.g., blueberries, Labrador tea, cattail/ratroot, moose, snowshoe hare, grouse) by members of nearby communities.
[h] Hunter/trapper scenario includes year-round occupation of the reclaimed landscape for hunting and trapping activities.

Exposure Pathway Screening

The objective of the exposure pathway screening process was to identify the major pathways by which people may be exposed to chemicals from the site. Details of the exposure pathway screening process are provided in Appendix VI.3.2. Table F1.1-2 lists the potential exposure pathways considered for each key question.

Table F1.1-2 Potential Exposure Pathways for Consideration

Exposure Pathway	HH-1	HH-2	HH-3	HH-4	HH-5
dermal contact with water	✓			✓	✓
ingestion of water	✓			✓	✓
ingestion of fish	✓			✓	✓
inhalation of volatile chemicals		✓		✓	✓
inhalation of airborne particulate matter		✓		✓	✓
ingestion of plants			✓	✓	✓
ingestion of game meat			✓	✓	✓

Conceptual Models

The results of chemical, receptor and exposure pathway screening were used to develop conceptual models for the risk assessment. Separate conceptual models were developed for evaluation of each key question and are presented in Section F1.3. The exposure pathways and receptors indicated in the conceptual models were assessed for chemicals of concern identified by the chemical screening process.

Exposure Assessment

Exposure assessment is the process of estimating the daily intake rate (dose) of a chemical received by a person under a given exposure scenario. An exposure assessment was conducted for each key question where chemicals of concern, receptors and exposure pathways were identified. Exposure equations, receptor parameters and chemical-specific parameters used in the exposure assessment are provided in Appendix VI.4. Further details of the exposure assessments conducted for each key question are provided in Sections F1.2, F1.3 and F1.4.

Bioavailability

Bioavailability refers to the amount of chemical that is capable of entering the bloodstream following contact with that chemical. This is an important concept because most chemicals only exert their toxic effects following absorption into the bloodstream. Bioavailability is a concept that can be applied to both environmental exposures and exposures to test species in toxicity tests. For the exposure component of human health risk assessment, the bioavailability of each chemical via ingestion or inhalation was assumed to be 100%. This is a conservative assumption which may increase risk estimates, because it implies that 100% of a chemical ingested or inhaled is also absorbed into the blood. A more accurate assessment of exposure may indicate that absorption is significantly less than 100%, with a resultant reduction in absorbed dose and consequent health risk.

For dermal exposures, it is necessary to determine the amount of chemical that would be absorbed by the body following exposure to chemicals in the water (i.e., while swimming). The parameter that describes the extent of absorption is the dermal permeability constant (Kp). Chemical-specific dermal permeability constants, identified by the U.S. EPA (1992b), are listed in Appendix VI.4.3.

Toxicity Assessment

Toxicity assessment is the identification and quantification of the chemical concentration or dose (i.e., daily intake), above which exposure to a receptor might cause an adverse effect (U.S. EPA 1988a).

Derivation of Toxicity Reference Values

In the toxicity assessment, toxicity information for each chemical was used to provide qualitative and quantitative estimates of health effects associated with exposure to site chemicals. The toxicity assessment considered both the cancer or non-cancer (threshold) effects that a chemical may cause. The quantitative toxicity reference values (i.e., exposure limits) used to evaluate carcinogens are called Risk Specific Doses (RsDs) and for this assessment describe daily intake rates that correspond to a lifetime cancer risk of one-in-one-hundred-thousand (i.e., 1×10^{-5}), a level of societal risk generally considered acceptable by provincial and federal agencies. This is distinctly different from the risk level used during the chemical screening process where the RBC was set to one-in-one-million (i.e., 1×10^{-6}) as a conservative measure to ensure that substances of marginal concern were not excluded. Toxicity reference values used to evaluate non-carcinogens are called Reference Doses (RfDs) and describe a daily intake rate considered to be without adverse effect to sensitive members of the population over a lifetime. In cases where a chemical has the potential to elicit both carcinogenic and non-carcinogenic effects, the most conservative endpoint was evaluated.

Toxicity reference values used in this assessment are based on dose-response toxicity evaluations available through agencies and toxicological databases such as Health Canada, IRIS (Integrated Risk Information System, U.S. EPA on-line database), CCME (Canadian Council of Ministers of the Environment), and the Total Petroleum Hydrocarbon Criteria Working Group (TPHCWG). Toxicity reference values were selected, without adjustments for bioavailability, for use in this risk assessment.

It should be recognized that toxicity reference values are typically derived through extrapolation of toxicity data from animal studies for application to humans. In such cases, to account for uncertainties and limitations in the toxicity data, uncertainty factors are applied to the No-Observed-Adverse-Effect-Level (NOAEL) or the Lowest-Observed-Adverse-Effect-Level (LOAEL) determined in the animal study. Uncertainty factors typically range from 100 to 1000, and routinely address protective measures for potentially sensitive members of the human population. For some of the chemicals addressed in this assessment, uncertainty factors as high as 3,000 were applied in developing toxicity reference values. Therefore, in addition to the conservatism derived from the exposure assessment, toxicity reference values provide an additional and substantive element of conservatism that is intrinsic to the numerical risk estimates.

Table F1.1-3 provides a summary of the toxicity reference values used in this assessment. Further details on the toxicology of these chemicals and selection of the toxicity reference values for this assessment are provided in Appendix VI.5.2.

Toxicity of Naphthenic Acids

Previous oil sands EIAs recognized that naphthenic acids, a component of CT water, are important to consider from a human health perspective. However, to date, there are insufficient mammalian toxicological data to calculate a defensible reference dose (RfD) for naphthenic acids. Reference doses are normally calculated based on chronic or subchronic studies in laboratory animals. Currently, there are only acute lethal toxicity mammalian data available for naphthenic acids. The acute toxicity data suggest that naphthenic acids have relatively low potencies for lethality under acute exposure conditions.

Further characterization of chronic toxicity posed to mammals by naphthenic acids or CT solids/water is needed to resolve this data gap. In association with the Steepbank Mine Approval, a provision was made and agreed upon between AEP and Suncor that Suncor would pursue characterization of the toxicity of naphthenic acids, to reduce the uncertainty surrounding toxicity from low level long-term environmental exposure. To this end, Suncor proposed an action plan for toxicological evaluation of naphthenic acids/CT water. As a first step in this action plan, Suncor, in collaboration with a contract laboratory, recently completed a mutagenicity study of CT water. The study evaluated the mutagenic potential of CT water, which contains naphthenic acids and other components, and currently discharges into Pond 5. The study employed two bacterial assays (the reverse mutation or Ames assay and the SOS ChromoTest). The overall results are equivocal: the Ames assay indicated mutagenic activity in both the fresh and aged CT water samples, and the SOS ChromoTest indicated a lack of mutagenic potential in both fresh and aged samples. Equivocal results regarding mutagenicity are, in fact, not uncommon, as some tests are more or less effective than others and the concept of false positive and false negative responses is commonly encountered. To further resolve these equivocal results, Suncor has initiated an additional mutagenicity study

Table F1.1-3 Toxicity Reference Values Used in the Risk Assessment

CHEMICAL	Toxicity Reference Value Type[a]	Value[b]	Slope Factor[c] $(mg/kg*d)^{-1}$	Type of Health Effect	Reference
Metals					
antimony	RfD	0.0004	not applicable	no toxicity observed; tolerable daily dose	U.S. EPA 1997
arsenic	RsD	0.000006	1.5 [d]	skin and lung tumors	CCME 1997
barium	RfD	0.0175	not applicable	cardiovascular disease	U.S. EPA 1997
beryllium	RsD	0.0000023	4.3[d]	lung tumors	U.S. EPA 1997
boron	RfD	0.0175	not applicable	testicular atrophy amd spermatogenic arrest	Health Canada 1990
cadmium (water)	RfD	0.0005	not applicable	nephrotoxicity, carcinogenicity	U.S. EPA 1997
cadmium (food)	RfD	0.001	not applicable	nephrotoxicity, carcinogenicity	U.S. EPA 1997
chromium (III)	RfD	1.0	not applicable	no observed adverse effects on body weight and food consumption	U.S. EPA 1997
chromium (VI)	RfD	0.005	not applicable	no observed adverse effects on body weight and food consumption	U.S. EPA 1997
copper	RfD	0.05-0.1	not applicable	no toxicity observed; tolerable daily dose	CCME 1997
lead	RfD	0.00357	not applicable	neurological effects in children	Health Canada 1996
molybdenum	RfD	0.005	not applicable	serum uric acid levels	U.S. EPA 1997
nickel	RfD	0.02	not applicable	nasal and lung carcinogenicity, body weight	U.S. EPA 1997
selenium	RfD	0.005	not applicable	clinical selenosis	U.S. EPA 1997
vanadium	RfD	0.007	not applicable	chronic toxicity	HEAST 1995
Organics					
acetaldehyde	RsD	0.0013	0.0000077[d]	nasal metaplasia	U.S. EPA 1997
acetone	RfD	0.1	not applicable	increased liver weight and renal toxicity	U.S. EPA 1997
acrolein	RfC	0.00002	not applicable	squamous metaplasia	U.S. EPA 1997
anthracene	RfD	0.3	not applicable	no treatment effects	TPHCWG 1997
benz(a)anthracene	RsD	0.000014	0.73[f]	tumors	TPHCWG 1997/U.S. EPA 1997
benzene	RsD	0.00034	0.029[e]	leukemia in humans	U.S. EPA 1997
benzo(a)pyrene	RsD	0.0000014	7.3	stomach/respiratory tract tumors	TPHCWG 1997/U.S. EPA 1997
benzo(b)fluoranthene	RsD	0.000014	0.73[f]	tumors	TPHCWG 1997/U.S. EPA 1997
benzo(k)fluoranthene	RsD	0.000014	0.073[f]	tumors	TPHCWG 1997/U.S. EPA 1997
chrysene	RsD	0.000014	0.73[f]	tumors	TPHCWG 1997/U.S. EPA 1997
dibenz(a,h)anthracene	RsD	0.0000014	7.3	tumors	TPHCWG 1997/U.S. EPA 1997
fluoranthene	RfD	0.04	not applicable	nephropathy, hepatotoxicity	TPHCWG 1997
fluorene	RfD	0.04	not applicable	hematological effects	TPHCWG 1997
formaldehyde	RsC	0.0008	0.045[e]	squamous cell carcinoma	U.S. EPA 1997
formaldehyde	RfD	0.2	not applicable for oral	reduced weight gain, histopathalogy	U.S. EPA 1997
indeno(1,2,3-cd)pyrene	RsD	0.00014	0.073[f]	tumors	TPHCWG 1997/U.S. EPA 1997
naphthalene	RfD	0.04	not applicable	decreased body weight	TPHCWG 1997
pyrene	RfD	0.03	not applicable	nephropathy	TPHCWG 1997
TPH:C2-C8 aliphatics[b]	RfC	18.4	not applicable	neurotoxicity	TPHCWG 1997
TPH:C9-C12 aliphatics[b]	RfC	1.0	not applicable	decreased body weight	TPHCWG 1997
TPH:C6-C8 aromatics[b] (excludes benzene)	RfC	0.4	not applicable	hepatoxicity, nephrotoxicity	TPHCWG 1997
TPH:C9-C12 aromatiicx[b]	RfC	0.2	not applicable	hepatic, hematological effects	TPHCWG 1997

(a) RfD: oral reference dose, unless stated otherwise

RfC: reference concentration for non-carcinogens

RsD: risk-specific dose equating to 1:100,000; RsC: risk-specific air concentration equating to 1:100,000.

(b) Units are (mg/kg*d) for RfD & RsD; & (mg/m^3) for RfC & RsC.
(c) Slope factor: the rate of change in frequency of cancer per unit change in exposure, used to derive RsD/RsC.
(d) Based on oral exposure.
(e) Based on inhalation exposure.
(f) Based on U.S. EPA potency factors relative to benzo(a)pyrene.
(g) TPH: total petroleum hydrocarbons; Cx- Cy: fraction of TPH constituents consisting of the range of carbon atoms indicated.

that employ mammalian systems, and therefore will add to a weight-of-evidence approach when interpreting the relevance of these results to mammalian health risks.

The "mouse micronucleus test" has been selected for use. It involves dosing a group of mice with various doses of CT water that best reflects CT water seepage into the environment. This water is known to contain naphthenic acids and other substances. The test mice, together with control animals, are subsequently sampled and examined for a cellular feature, known as a micronucleus, which is a chromosomal anomaly indicative of DNA damage. A higher frequency of micronuclei in test animals compared to control animals would suggest a component of the CT water is mutagenic. No statistical difference would suggest the constituents within CT water are not mutagenic. Finally, Suncor is also providing financial support for academic research concerning the toxicity of naphthenic acids at the University of Saskatchewan. This program is still in the design stage, but as results become available they will be implemented for validation of the risk assessment conducted for Project Millennium.

Toxicity of Chemical Mixtures

People are exposed simultaneously to many different substances each day, through our air, food, water and other materials with which they come into contact. Some of these substances are usually thought of as beneficial (e.g., proteins in food, antibiotics), while others are usually considered potentially harmful.

Most experiments in which the potential toxicity of chemicals is evaluated study only one chemical at a time. This approach may allow us to understand how that single substance behaves in a living system, but it does not allow us to evaluate the potential for two or more substances to interact. Due to the very large number of chemicals to which people are exposed, the number of possible chemical mixtures is virtually infinite. Our understanding of the complex interactions of mixtures of materials is therefore extremely limited. The study of chemical mixtures is a high priority research area in toxicology. However, even the most recent investigations focus on the prediction of toxicity in relatively simple mixtures involving only a few compounds at a time.

Given the current limitations of scientific understanding of chemical interactions, it is not possible to accurately assess the potential interactions which could result from simultaneous exposure of an organism to a mixture of substances. It is worth noting that most Canadian environmental criteria based on protecting human health take account of chemical interactions to the extent that information is available. In practice, however, such information is extremely limited.

There are at least five ways in which two substances may interact. These are:

- ***Independence***: There is no interaction between the substances. This can occur when two substances affect different organs, and are dealt with in different ways in the body.
- ***Additivity***: Each substance contributes to the same toxic effect in the same organ by the same mechanism, with the observed toxicity equal to that expected by adding the toxicities of the individual agents.
- ***Synergism***: two or more toxic substances interact such that the toxicity of the mixture is greater than would be expected if the substances were acting additively or independently. For example, people who use both tobacco and alcohol have a much higher risk of some cancers than would be expected if these two products were acting additively.
- ***Antagonism***: two substances interact such that the effect of one substance is counteracted by the other. For example, antidotes are antagonistic to the poisons they are used to treat.
- ***Potentiation***: potentiation refers to an interaction which may be considered a special type of synergism. Potentiation is said to occur when a substance which is not toxic by itself increases the toxic potency of another substance.

Since chemicals are usually assessed only on an individual basis, there may be concerns about how mixtures can impact on health. There are two points worth considering in this regard:

- Interactions are probably just as likely to make mixtures less toxic than the sum of their constituents as to make them more toxic than the sum of their constituents. While some interactions are known to be non-additive and non-independent (i.e., they are synergistic, potentiative or antagonistic), it is reasonable to expect, in general, an approximately equal number of more- and less-than-additive interactions. This idea is based on the many ways in which the body breaks down and eliminates chemicals, making some more toxic ("activation") and some less toxic ("deactivation").
- Most health-based regulatory standards are based on approaches, data and assumptions which usually lead to standards that are highly protective of health and the environment. The Canadian approach to setting health-based environmental quality objectives is inherently conservative (protective). For example, drinking water criteria are often set to limit exposure to a small fraction (i.e., commonly 1/1,000 to 1/100) of a level which does not cause any adverse effects in the most sensitive non-human species studied. For cancer-causing chemicals, environmental criteria are often developed to limit lifetime excess cancer risks to levels which are very low (i.e., considered negligible or not measurable by regulators) compared to other risks commonly faced by people. For these chemicals, regulations are usually based on an estimate of the maximum possible level of risk, not the most likely level of risk indicated by experimental data and human evidence.

With regard to the environmental impact assessment of Project Millennium and the issue of mixture toxicity, it is important to note that mixture toxicity has been addressed, to the extent possible, using the following principles:

- Where different substances have the potential to present a carcinogenic risk, the cancer risk has been added to yield a total lifetime cancer risk. This addresses the issue of potential concurrent exposure to different carcinogens, irrespective of the form of the potential carcinogenic effect.
- Where different substances have the potential to yield the same non-carcinogenic risks (e.g., reproductive effects in wildlife), such risks have been defined in the form of an exposure ratio and then summed to yield a "total exposure ratio" reflective of the particular effect. This approach, conservatively ignores the potential that antagonism may occur, and assumes the combined effects are at least additive.
- Where potential exposure to petroleum hydrocarbons is being considered, the toxicity is based, in part, on results from laboratory studies that have employed petroleum hydrocarbon products. Such studies and resultant toxicity data inherently address the potential interaction that may occur when the product mixture is taken in by the test animal, and provide additional insight towards extrapolation of safe exposure levels for humans.

Thus, while the toxicology and health risk assessment cannot fully define the issue of mixture toxicity and synergism in its entirety because of limitations in these sciences, additional steps and conservative measures which err on the side of safety have been employed in the Project EIA.

Risk Characterization

In the risk characterization step, Exposure Ratios (ERs) were calculated as the ratio of the predicted chemical intake (dose) to the toxicity reference value, according to the following equation:

$$ER = \text{estimated daily intake} \div \text{toxicity reference value}$$

An ER is calculated for each chemical of concern and for each exposure pathway, based on the estimated intake rates (dose) and the toxicity reference values.

For non-carcinogenic chemicals, an ER value of less than 1 represents exposure scenarios that do not pose a significant health risk to exposed receptors (Health Canada 1995). For carcinogenic chemicals, an ER value that is less than 1 indicates that the rate of intake for a chemical or group of chemicals is less than that attributed to an incremental lifetime risk of cancer of 1 per 100,000 individuals ($1x10^{-5}$), which does not pose a significant health risk to exposed individuals (Health Canada 1995).

When the ER is greater than 1, the scenarios pose a potential concern and require further scrutiny. It is important to note that ER values greater than 1 do not necesarily indicate that adverse health effects will occur due to the conservatism employed in their estimation.

When interpreting the results of the risk assessment, it is necessary to consider the uncertainty associated with ER estimates. An examination of each of the input parameter values indicates that they are biased in a way that tends to overestimate the predictions (also known as a conservative or protective bias). For example, exposure point concentrations represent a 95% confidence limit on the mean annual concentration. Exposure parameter values represent reasonable maximum exposure values; that is, they are reasonable upper bounds and not average values. Bioavailability is set to a maximum value (100%). In addition to these conservative biases of the individual input parameters, the use of multiple conservative assumptions itself mathematically compounds the conservative bias in the ER values. Consequently, risk estimates are likely to be lower than those reported here, and ER values greater than 1 do not necessarily represent a human health concern. In general, the degree of protectiveness inherent to the conservative assumptions employed inflate risk estimates by at least an order magnitude and typically more. This excludes the uncertainty factors inherent in the toxicity reference values employed in the calculations (previously noted to be 100 - 3,000 fold). Therefore, it is the opinion of the risk assessment practitioners that calculated ER values of 1 to 10 be regarded as marginal exceedances, and in all likelihood, indicative of negligible impacts.

F1.1.4.4 Residual Impact Classification and Environmental Consequences

For the human health component, the environmental consequence was primarily determined by the magnitude of impact, although duration and geographic extent, reversibility, frequency and scientific uncertainity were also factors (See Section A2, Table A2-8). For the human health assessment, magnitude of impact is based exclusively on whether or not the Project activity might adversely affect human health. The magnitude of impact was based on the quantitative risk estimates for all key questions. ER values greater than 1 represent scenarios that pose a potential concern. However, since many conservative factors are typically used to derive both the intake rates and the toxicity reference values, the ER estimates will tend to overestimate the potential for risk. This is consistent with a protective approach to risk evaluation. Thus, an ER value of greater than 1 indicates a potential health concern that needs further scrutiny to identify the reason for the elevated ER; this may lead to additional data collection to more accurately quantify risks. Hence, magnitude of impact has been defined as follows:

Negligible	ER < 1 and no data gaps, or ER marginally greater than 1 (i.e., 1<ER<10) due to naturally elevated background exposures and/or conservative exposure assumptions.
Low	No ER because of lack of data, although enough evidence to suggest that exposure is unlikely to adversely affect health; additonal information is necessary to support this conclusion.
Moderate	10<ER<20 and no immediately apparent mitigation options are available.
High	ER > 20, and no immeditely apparent mitigation options are available; hence exposure has potential to adversely affect people's health.
Unresolved	Insufficient information to draw any conclusions.

Duration, geographic extent and frequency were defined in Section A2, Table A2-8. Scientific uncertainty is described in detail for each key question.

The concept of reversibility requires further clarification with respect to the human health assessment. Human health impacts were classified as reversible if the exposure pathways were considered to be controllable. For example, exposure to end pit lake water is considered to be a reversible impact, since access to this waterbody can be controlled by erecting barriers, or by implementing future mitigation measures to reduce or prevent human exposure. Similarly, if future air quality monitoring identifies concentrations that could lead to an impact on human health, the facility could be scaled back or temporarily shut down, or further mitigation measures could be implemented to reverse the impact.

For a full description of the criteria for defining impacts and environmental consequence, the reader is referred to Section A2.

F1.2 HUMAN HEALTH BASELINE/ENVIRONMENTAL SETTING

F1.2.1 Current Status of Human Health

Results of a baseline human health study completed as part of the Northern River Basins Study (Alberta Health 1997) are summarized here to provide an indication of the general health of populations residing within the region.

The Northern River Basins Study (NRBS) Human Health Monitoring Program (Alberta Health 1997) summarized the overall population health status of communities within the NRBS area. The NRBS area includes the Alberta and Northwest Territories portions of the Peace, Athabasca and Slave river basins. The Northern Lights Health Region of the NRBS area is similar to the RSA for this EIA.

The NRBS Human Health Monitoring Program also considered cause-effect relationships between the reported human health conditions and chemicals from industrial and agricultural development in the north. However, it was not possible to correlate or assess the influence of environmental factors, such as levels of airborne chemicals, with disease incidences. This is because a variety of genetic, socio-economic and lifestyle factors (e.g., smoking, exercise, diet) may contribute to incidence, prevalence and severity of a particular disease. Therefore, the following summary focuses only on the apparent trends in health status of human populations within the NRBS area and not on the potential linkages between health conditions and environmental factors.

F1.2.1.1 Population Health Indicators

The following indicators of population health were evaluated: self-reported health status, life expectancy, fertility rate, infant mortality, low birth weight, teen birth rate, mortality rate and potential years of life lost. These indicators provide an overall indication of the general health status of an area and can be used to compare populations from different regions. Health measures for the NRBS area were compared with corresponding values for other rural and urban areas of Alberta (Alberta Health 1997).

Self-Reported Health Status

In 1996, a population health survey was conducted throughout Alberta in which respondents were asked to rate their overall health status as excellent, very good, good, fair or poor. Most Albertans rated their health as very good or excellent. The self-reported health status within the NRBS area was consistent with the ratings in other areas of Alberta.

Life Expectancy

Life expectancy at birth was not significantly lower within the NRBS area than in other areas of Alberta.

Fertility Rate

The fertility rate (i.e., the average number of children born to women aged 15 to 49 in the study area) for the NRBS area was compared with other regions of the province. In general, rural populations, such as the NRBS area had higher fertility rates than urban areas. In addition, the analysis indicated that women in the NRBS area tend to give birth and complete childbearing at a younger age than women in other areas of Alberta.

Infant Mortality

Infant mortality is defined as the number of deaths to children less than 1 year of age per 1,000 live births. The rate of infant mortality within the NRBS area was consistent with other areas of Alberta. Infant mortality may be affected by prenatal care, the health of the mother, the social environment, the natural environment and the nature of the health care system. The infant mortality rate in Alberta is marginally, but not significantly greater than the Canadian average.

Low Birth Weight

Low birth weight (i.e., less than 2.5 kg; 5.5 lbs.) may result in a higher incidence of complications related to birth, developmental delays, long-term health problems and premature death. Alberta has a high percentage of low birth weight babies, compared with the Canadian average. However, the NRBS area has fewer reported low birth weights than other areas of Alberta and the Northern Lights Health Region has one of the lowest rates of low birth weight within the NRBS area.

Teen Birth Rate

The teen birth rate is defined as the number of births to women under 20 years of age per 1,000 females between the ages of 13 and 19 years. Babies of young mothers are typically smaller and might have health problems associated with low birth weight. In addition, social and economic disadvantages might also result in adverse health effects in babies of young mothers. The teen birth rate reported for the Northern Lights Health Region is not significantly different than the Alberta teen birth rate.

Mortality Rate

The mortality rate (i.e., number of deaths per 1,000 people) is higher in the NRBS area than other areas of the province. However, the mortality rate for the Northern Lights Health Region is consistent with the rest of Alberta.

Potential Years of Life Lost

Potential years of life lost is a measure of the rate of premature death, defined as death that occurs before 70 years of age (excluding infant mortality). This value is slightly, but not significantly, higher for women in Alberta compared with the Canadian average. The value for Albertan men is consistent with the Canadian average. In general, this value is higher for males than for females in both Alberta and Canada as a whole. The value of this parameter for the Northern Lights Region is consistent with the Alberta statistics.

Summary of Health Indicators

Overall, health indicators for the NRBS area are similar to other rural areas of Alberta. However, the fertility and teen birth rates within the NRBS area are greater than other areas of Alberta; although for the Northern Lights Region the teen birth rate is not specifically different from other areas of Alberta. For this reason, irrespective of the potential for environmental exposure, it is possible that higher than average rates of infant mortality, low birth weight, childbirth complications and congenital anomalies (i.e., medical conditions arising from birth, but diagnosed later in life) may occur for this region of Alberta (Alberta Health 1997).

F1.2.1.2 Health Outcomes

Health outcomes refer to reported incidences of disease within a population. In the NRBS study, health outcomes were measured in terms of the number of hospitalizations, physician visits and mortalities related to a specific disease. The five major causes of death in Alberta, in descending order of occurrence, are heart disease, cancer, injury and suicide, stroke and respiratory disease (Alberta Health 1997). The incidence of major diseases are described briefly below, emphasizing the health status of populations within the NRBS area in relation to other areas of Alberta and Canada.

Circulatory Diseases

Circulatory diseases refer to diseases of the heart or blood vessels (e.g., hypertension, stroke, coronary heart disease). Scientific research has indicated relationships between circulatory diseases and factors such as age, stress, oral contraceptives, genetics, diabetes, hyperlipidaemia, lifestyle (e.g., smoking, diet, exercise) and socio-economic status (Alberta Health 1997). Overall, the NRBS study concluded that there was no difference in frequency of contact with the health care system for circulatory diseases within the NRBS area compared with other regions of Alberta.

Respiratory Diseases

Respiratory diseases include asthma, bronchitis, emphysema and other lung ailments. Several factors, such as gender, genetic inheritance and lifestyle (e.g., smoking, income, education) have been associated with the incidence of respiratory diseases (Alberta Health 1997). There is also some evidence to suggest that air pollution may lead to an increased incidence of respiratory diseases. The NRBS study concluded that residents of the NRBS area are diagnosed more frequently with pneumonia and chronic bronchitis, but less frequently with asthma or acute upper respiratory infection than other areas of Alberta. For the reasons previously mentioned, it is not possible to correlate airborne chemical concentrations with a higher incidence of some respiratory diseases in the NRBS area.

Cancer

All types of cancer are included in this category. The probability of Albertans developing cancer during their lifetime is 1 in 3 (Alberta Health 1997). This statistic embraces all sources, such as family history, genetics, lifestyle (e.g., smoking, exercise, diet) and exposure to environmental carcinogens. This probability contrasts sharply with risks considered to be acceptable by chemical exposures, which are much lower (i.e., 1 in 100,000). Although the rate of hospitalization for cancer is higher in the NRBS area than in other regions of Alberta, the incidence of invasive cancers and cancer mortalities within the NRBS area is consistent with other areas of Alberta.

Gastrointestinal Diseases

Gastrointestinal diseases include all disorders of the digestive system (e.g., gastroenteritis, hepatitis, food and waterborne diseases, ulcers, renal failure). Several factors, such as family history, genetics, stress, microbial infection, alcohol and caffeine ingestion, and oral exposure to environmental contaminants may contribute to the development of gastrointestinal diseases (Alberta Health 1997). Due to the small sample sizes, comparisons between NRBS and other areas were unavailable.

Endocrine, Metabolic and Nutritional Disorders

Endocrine, metabolic and nutritional disorders include diseases that: affect the endocrine system; show evidence of nutritional deficiencies; or affect metabolism (e.g., diabetes, anemia). Although the rate of hospitalization for these disorders is higher within the NRBS area than the rest of Alberta, the number of physician visits is lower, and the mortality rate is consistent with the rest of Alberta.

Neurological Diseases

Neurological diseases include diseases affecting the brain and nervous system (e.g., Alzheimer's, Parkinson's, multiple sclerosis, epilepsy). The majority of hospitalizations related to neurological diseases are for people greater than 60 years of age. The NRBS study concluded that there is no indication that NRBS residents are any more likely to be diagnosed with neurological disorders than in other areas of the province.

Reproductive System Diseases

Reproductive system diseases include menstrual cycle disorders, infertility (male or female), spontaneous abortion and endometriosis. Several factors, such as nutrition, alcohol intake during pregnancy, lifestyle and exposure to environmental contaminants may contribute to the development of these types of conditions (Alberta Health 1997). Generally, the rate of hospitalization is higher, but the number of physician visits is lower within the NRBS area. Only endometriosis shows consistently higher hospitalization and physician visit rates within the NRBS region. Potential causes for the increased incidence of endometriosis are unknown.

Stillbirth and Infant Death

The rate of post-neonatal deaths in the NRBS area is slightly higher than the rest of Alberta. Several factors, such as smoking and/or alcohol consumption during pregnancy, socio-economic disadvantages, complications of umbilical cord/placenta, low birth weight, birth defects and maternal health conditions (e.g., hypertension), may contribute to increased incidence of post-neonatal deaths (Alberta Health 1997).

Congenital Anomalies

Congenital anomalies are medical conditions arising from birth, although they may not be diagnosed until later in life (e.g., structural defects, chromosomal and monogenic syndromes). In general, the incidence rate and number of physician visits in the NRBS area are lower than or comparable to the Alberta average. The Northern Lights Health Region has the lowest incidence of reported congenital anomalies in the NRBS region.

Summary of Health Outcomes

In general, the health status of the NRBS area is not significantly different from that of other areas of Alberta or Canada. Certain types of health outcomes, including pneumonia, chronic bronchitis, endometriosis and post neonatal death have a higher incidence in the NRBS area. This may be due to several factors, including age, family history, lifestyle, socio-economics and environmental exposure (Alberta Health 1997).

F1.2.2 Effects of Baseline Air Quality on Human Health

F1.2.2.1 Alberta Oil Sands Community Exposure and Health Effects Assessment Program

The Alberta Oil Sands Community and Health Effects Assessment Program (AOSCEHEAP) is a joint industry, government and community initiative to collect high quality exposure data over the time frame of the oil sands industry which will enable a defensible assessment of environmental influences to human health. Presently, this initiative is specifically focused on air quality data for exposure assessment of regional residents. The program is in the early stages and so far the efforts have addressed the data quality objectives, sampling methods and equipment needed to facilitate the ultimate goal of exposure assessment.

To this end, AOSCEHEAP has reported on a review of the state-of-the-practice personal air monitoring devices, and has conducted a brief pilot study to demonstrate the feasibility of the preferred sampling devices (AOSCEHEAP 1997). The study suggests the devices are, for the most part, practical for implementation in a larger scale study. However, some data suggest that the personal air monitoring devices may not reflect the ambient air quality, but rather they may reflect influences from brief encounters with micro-environments, such as the exhaust plume from a car (e.g., nitrogen dioxide). Results of the chemical analysis indicate that levels of exposure can vary considerably amongst and within individuals, and chemical levels will vary within a given day. This suggests that multiple measures should be taken to accurately determine the level of exposure to individuals and populations. The pilot study indicated no evidence of detectable personal exposure to ozone. The indoor and personal measures of nitrogen dioxide were greater than outdoor ambient conditions. The highest level of sulfur dioxide exposure was encountered outside and these levels appear to be influencing the indoor exposure as well. Some of the volatile organic carbon compounds were almost non-detectable, while others were not only detectable, but highly associated with other chemicals of their class. Therefore, when devising a sampling program for the main study, careful consideration should be given to the selection of volatile organic carbons to analyze.

The limited data generated from the pilot study is not suitable for conducting exposure assessment for health risk assessment, although the full scale study is anticipated to provide this capability. The main study, which constitutes the second phase of the program, is intended to produce baseline population exposure and health outcome data. This phase is currently in progress and involves a population exposure assessment survey and a population health assessment. This is accomplished through use of a questionnaire to characterize various parameters/activities needed to explore potential associations with field measurements of personal and ambient exposure conditions. As part of the health assessment, several measures of biomarkers are included in the study design, to provide physiologically-based information respecting both exposure and health effects. Biomarkers of exposure include blood and urine analyses of organic and inorganic chemicals. Biomarkers of health effects include assays using blood, urine and lung tissue for endpoints of mutagenicity, activation of detoxification pathways, macromolecules adduct formation, chromosomal abberrations, oncogene expression, immune function and respiratory function. In addition, assessment of neurobehavioural status is included as an effect endpoint. Further details of this study design are available from the AOSCEHEAP technical approach document (AOSCEHEAP 1995). Results of the main study were not available during preparation of this EIA; however, the report is anticipated in the early summer of 1998.

F1.2.2.2 Baseline Air Quality Risk Assessment

A baseline human health risk assessment was conducted to evaluate air quality as a result of airborne chemical emissions from existing and approved facilities in the oil sands region. In response to interests articulated by various stakeholders respecting current and future air quality, Suncor undertook a stack survey of air emissions. The results from the survey were not available in time for the assessment here although information respecting volatile organic chemicals (VOCs) was available and integrated. Information respecting particulate emissions and associated polycyclic aromatic hydrocarbons and metals will be available when their analysis is complete.

Baseline air concentrations of volatile organic chemicals (VOCs) were predicted at Suncor air stations and at the communities of Fort McMurray, Fort McKay and Fort Chipewyan according to methodologies presented in Section B2. The baseline risk assessment calculated risk estimates for children and adults based on these air quality predictions. The baseline risk assessment for air quality provides a basis of comparison for additional contributions from the Project and from other planned developments in the CEA.

Concentrations of chemicals of concern in air were predicted using dispersion modelling, as described in Section B2. The major sources of airborne chemicals included: off-gassing from the tailings pond and mine surfaces, emissions from the vehicle fleet, and emissions from stack and fugitive plant sources. Maximum ground level air concentrations for the chemicals of concern were estimated (Section B2) for Fort McKay, the closest residential community to the Project, as well as Fort McMurray and Fort Chipewyan (refer to Section B2 for details). These ambient air concentrations were then used in exposure modelling to determine the estimated daily intake of these chemicals by local residents. In addition, since people may be exposed to airborne chemicals while carrying out activities in areas near the Project site (e.g., hunting/trapping, gathering plants), maximum predicted concentrations at Suncor air stations were also evaluated in the risk assessment. For this assessment, a hunter/trapper was assumed to live temporarily at the location of maximum air concentrations outside the Project Millennium boundaries for 6 months per year. No differentiation was made between indoor and outdoor air concentrations.

For non-carcinogenic chemicals, potential residential exposure was estimated for children and adults. For potentially carcinogenic chemicals (i.e., benzene), exposure was estimated based on the assumption that an individual lives their entire life in the aforementioned communities (i.e., a composite receptor was evaluated from birth to 70 years of age).

Daily intake rates were estimated for benzene and for various groups of petroleum hydrocarbons as defined by a range of carbon chain lengths and structural similarities. The latter strategy was employed because toxicity data are not available for all components of the hydrocarbon spectrum. Therefore, such chemical exposure and risks were conservatively estimated using the recent methods of the Total Petroleum Hydrocarbon Criteria Working Group (TPHCWG 1997) involving hydrocarbon fractions (i.e., groups of related chemicals) and surrogate or fraction-specific toxicity reference values (see Appendices VI.4 and VI.5.2 for detailed descriptions of chemical groupings and toxicology of the various TPH fractions).

Results of the analyses and the corresponding exposure ratios are presented in Table F1.2-1.

Table F1.2-1 Baseline Exposure Ratios for Inhalation of VOCs

Chemical/Group	Fort McKay	Fort McMurray	Fort Chipewyan	Lower Camp
Residential Child and Adult - Non-carcinogens[a]				Adult Hunter[c]
C2-C8 Aliphatics[d]	0.0028	0.0013	0.00018	0.019
C9-C12 Aliphatics[e]	0.04	0.0019	0.0026	0.27
C6-C8 Aromatics[f]	0.014	0.0065	0.00091	0.093
C9-C12 Aromatics[g]	0.011	0.0049	0.0007	0.071
Composite - Carcinogens[b]				Adult Hunter[c]
benzene	0.027	0.012	0.0018	1.2

(a) Denotes a child and adult residing in one of the three communities.
(b) Denotes a person exposed to benzene from birth to 70 years of age while residing in one of the three communities
(c) Denotes an adult hunter/trapper temporarily living for 6 months of the year at the location of maximum air concentrations outside of the Project boundaries (Lower Camp).
(d) Includes all straight chain and cyclic alkanes/alkenes with carbon numbers ranging from 2 to 8.
(e) Includes all straight chain and cyclic alkanes/alkenes with carbon numbers ranging from 9 to 12.
(f) Includes all aromatic compounds except benzene with carbon numbers ranging from 6 to 8.
(g) Includes all aromatic compounds with carbon numbers ranging from 9 to 12.

ER values for all chemicals/chemical groups and all receptors in the communities of Fort McKay, Fort McMurray and Fort Chipewyan are less than 1, indicating that current air quality as a result of VOC emissions from existing and approved facilities is within acceptable limits for the protection of human health. For the adult hunter/trapper who lives 6 months per year for 50 years at the location with the highest chemical concentrations, ER values are also less than 1, with the exception of benzene, which marginally exceeds 1. Due to the conservative assumptions used in the assessment, the marginal exceedance does not indicate an adverse health impact.

F1.2.3 Effects of Baseline Water Quality on Human Health

A baseline human health risk assessment was conducted to evaluate existing chemical concentrations in the Athabasca River and Shipyard Lake. Chemicals were conservatively screened against one-tenth of the risk-based concentrations (RBC) for human health. Screening tables are presented in Appendix VI.1.3. Results of chemical screening identified seven chemicals:

- arsenic (Athabasca River and Shipyard Lake);
- benzo[a]anthracene (Athabasca River);
- benzo[a]pyrene (Athabasca River);
- beryllium (Athabasca River);
- boron (Shipyard Lake);
- cadmium (Athabasca River); and
- vanadium (Athabasca River).

Arsenic and beryllium have been identified previously as substances which are naturally elevated in the Athabasca River, both upstream and downstream of existing oil sands facilities. The remaining chemicals (i.e., benzo(a)anthracene, benzo(a)pyrene, boron, cadmium and vanadium) appear to be elevated downstream of existing oil sands facilities and, along with molybdenum, have been identified as chemicals of concern for the impact assessment of Project Millennium.

A baseline human health risk assessment was conducted for these chemicals and molybdenum to establish baseline risk estimates. Child and adult receptors were chosen for the following two exposure scenarios:

- Swiming exposure: dermal exposure and incidental ingestion of water during swimming; and
- Recreational exposure: ingestion of river/lake water during recreational activities (e.g., fishing, boating, hiking) plus occasional ingestion and dermal exposure while swimming.

Baseline exposure ratios (ERs) for the Athabasca River swimming and recreational scenarios are presented in Tables F1.2-2 and F1.2-3. All ER values for child and adult receptors were less than 1, indicating that exposures from recreational activities are within acceptable limits.

Table F1.2-2 Baseline Exposure Ratio Values for Baseline Swimming Exposure

Receptor/Chemical	Athabasca River 1997	Athabasca River 2000-2025	Athabasca River 2030	Athabasca River Far Future	Shipyard Lake 1997
Child - Non-carcinogens					
barium	0.014	0.014	0.014	0.014	0.01
boron	0.001	0.001	0.002	0.002	0.005
cadmium	0.0008	0.0008	0.0008	0.0008	0.000002
molybdenum	0.0002	0.0004	0.0004	0.0001	0.0000004
vanadium	0.0007	0.0005	0.0005	0.0003	0.0000009
Adult - Non-carcinogens					
barium	0.00003	0.00003	0.00003	0.00003	0.00002
boron	0.0001	0.0001	0.0001	0.0001	0.0005
cadmium	0.00004	0.00004	0.00004	0.00004	0.00000008
molybdenum	0.00002	0.00003	0.00003	0.00001	0.00000003
vanadium	0.00008	0.00005	0.00005	0.00003	0.00000005
Composite - Carcinogens					
arsenic	0.02	0.03	0.02	0.02	0.007
beryllium	0.04	0.04	0.04	0.04	no data
benzo[a]pyrene	0.001	0.08	0.08	0.08	no data
benzo[a]anthracene	0.00004	0.001	0.001	0.0007	no data
Total Carcinogens	***0.061***	***0.15***	***0.14***	***0.14***	***0.007***

Table F1.2-3 Baseline Exposure Ratio Values for Baseline Recreational Exposure

Receptor/Chemical	Athabasca River 1997	Athabasca River 2000-2025	Athabasca River 2030	Athabasca River Far Future	Shipyard Lake 1997
Child - Non-carcinogens					
barium	0.03	0.03	0.03	0.03	0.02
boron	0.05	0.05	0.06	0.06	0.19
cadmium	0.04	0.04	0.04	0.04	0.00007
molybdenum	0.01	0.02	0.02	0.005	0.00002
vanadium	0.03	0.02	0.02	0.01	0.00002
Adult - Non-carcinogens					
barium	0.006	0.006	0.006	0.006	0.004
boron	0.02	0.02	0.02	0.02	0.07
cadmium	0.008	0.008	0.008	0.008	0.00002
molybdenum	0.003	0.006	0.006	0.002	0.000006
vanadium	0.009	0.006	0.006	0.004	0.000005
Composite - Carcinogens					
arsenic	1.4	2.1	1.7	1.6	0.47
beryllium	3.2	3.2	3.2	3.2	0.08
benzo[a]pyrene	0.02	0.03	0.03	0.01	no data
benzo[a]anthracene	0.003	0.007	0.008	0.008	no data
Total Carcinogens	***4.6***	***5.3***	***4.9***	***4.9***	***0.55***

ER values for arsenic and beryllium were greater than 1 for the composite receptor, based on recreational exposure to Athabasca River water. Baseline concentrations of arsenic and beryllium are naturally elevated in the Athabasca River. Maximum concentrations were used in exposure modelling. For risk estimation, it was conservatively assumed that arsenic and beryllium behave as non-threshold carcinogens, and therefore the toxicity reference values selected for these substances are extremely low.

The resultant ER values for the baseline recreational scenario marginally exceeded 1, while ER values for the swimming scenario were less than 1. Project Millennium is not expected to contribute to increased concentrations of these chemicals in the Athabasca River or Shipyard Lake.

Arsenic and beryllium are natural constituents of the earth's crust and therefore may be found naturally in surface water. Typical background concentrations of arsenic in Canadian rivers range from 1 to 8 μg/L, and some rivers have reported concentrations as high as 50 μg/L (CCREM 1987). Predicted baseline arsenic concentrations in the Athabasca River range from 1.0 to 1.7 μg/L, which is within the range for Canadian rivers. The average concentration of beryllium in Canadian surface fresh waters has been estimated to be less than 1 μg/L, but concentrations in Western Canada were reported to range up to 5 μg/L (CCREM 1987). The baseline beryllium concentration in the Athabasca River is predicted to be 1 μg/L, which is within the range reported for surface waters in Western Canada. Finally, it should be noted that arsenic concentrations in the Athabasca River are much lower than the Canadian Drinking Water Guideline of 25 μg/L. There is no Canadian drinking water guideline for beryllium; however, U.S. EPA has specified a guideline of 4 μg/L. Beryllium concentrations in the Athabasca River are lower than this drinking water guideline. For these reasons, the naturally elevated concentrations of arsenic and beryllium in the Athabasca River are considered acceptable for drinking water purposes.

In summary, baseline water concentrations in the Athabasca River and Shipyard Lake do not currently pose an adverse impact to human health.

F1.2.4 Effects of Baseline Vegetation Quality on Human Health

Certain local plants (e.g., blueberries, Labarador tea leaves and cattail/ratroot) are harvested and consumed on a regular basis by members of nearby communities. Air emissions from oil sands developments may deposit directly onto plant surfaces and they may deposit onto soils and be taken up by plant roots. Stakeholders have expressed concern over the potential for chemical uptake by people who consume these plants. For this

reason, the potential for impacts to human health from ingestion of local plants was evaluated. This assessment focuses on three plant species which are consumed by local aboriginal people: blueberries, Labrador tea leaves and cattail root. Although many more species of plants are consumed by local aboriginal people, these species are used as surrogates to evaluate the potential for human health impacts from consumption of traditional plants.

F1.2.4.1 Vegetation Sampling Program

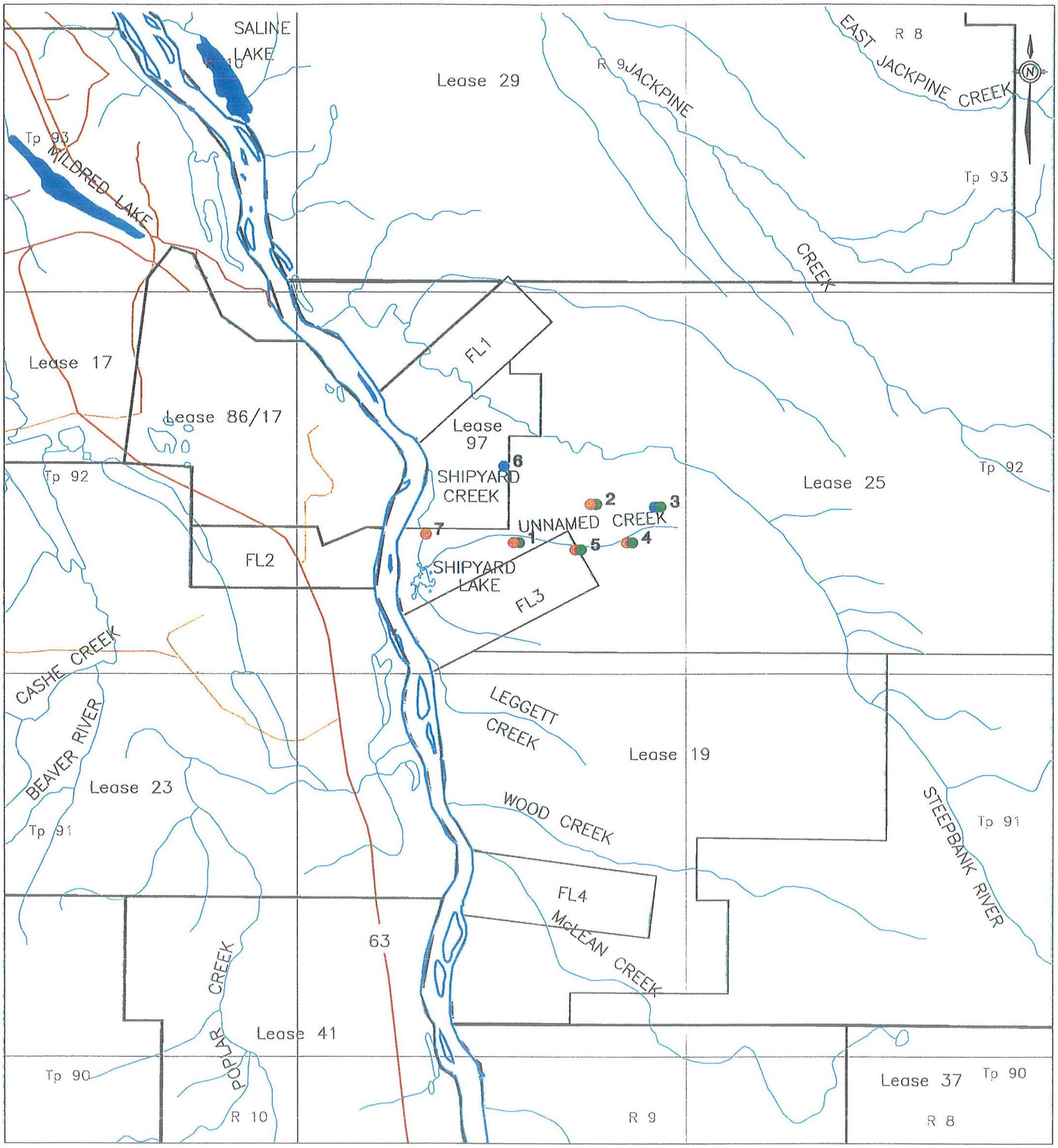
A vegetation sampling program was conducted specifically for the purpose of addressing public health concerns. The design of this study involved a combination of traditional knowledge and western science. Sampling was completed for both Suncor's Project Millennium and Shell's Muskeg River Mine Project (Shell 1997). Samples of blueberries, Labrador tea leaves and cattail roots, along with separate but corresponding soil and/or sphagnum samples at the base of the plants, were collected during August, 1997 from the following areas:

- Suncor Lease 25 (area within the deposition zone of air emissions from existing Suncor operations; Figure F1.2-1);
- Muskeg River Mine Project area (pre-development);
- Mariana Lakes area, approximately 65 km south of Fort McMurray (out of oil sands region control location); and
- West of Syncrude, outside the zone of influence of air emissions (oil sands region control location).

Although an attempt was made to collect ratroot, no ratroot plants were observed during field investigations, and therefore, no samples were harvested. In the current assessment, it was assumed that the chemical concentrations in ratroot would be similar to chemical concentrations in the cattail root samples collected in this field study, since cattail and ratroot have been observed growing in the same types of habitat.

Five composite samples of each species (composed of berries, leaves or roots from three different plants) were collected from each test area and from control areas. Similarly, composite soil samples were obtained from the base of the plants which had been sampled in each test and control area. Plant and soil samples were analyzed for metals and PAHs. The results of chemical analysis are tabulated in Appendix VI.7 (Table VI.7-1).

PAHs were not detected in blueberries or cattail roots. Small quantities (i.e., levels at or slightly exceeding the limit of detection) of naphthalenes and phenanthrene/anthracene were detected in some samples of Labrador tea leaves collected within Suncor Lease 25 and the Muskeg River Mine Project site. However, these PAHs were also detected in control samples of Labrador tea leaves, and concentrations in the test areas do not differ significantly from concentrations found in control areas. It is possible that these observations reflect the natural prevalence of petroleum hydrocarbons in this region. There is historical evidence of a forest fire in the Mariana Lakes region, which may have contributed to the observed concentrations of PAHs in Labrador tea leaves from this region, since PAHs may be released naturally from burning wood. It should also be noted that naphthalenes, phenanthrene and anthracene are non-carcinogenic PAHs, J:\1997\2205\8836\PLANTS.dwg



LEGEND

- LABRADOR TEA LEAVES
- BLUEBERRIES
- CATTAIL ROOTS

REFERENCE

DIGITAL DATA SETS 74D AND 74E
RESOURCE DATA DIVISION, ALBERTA
ENVIRONMENTAL PROTECTION, 1997.

0 1 2 3 4 5km

SCALE 1:150,000

DATUM IS IN NAD83 UTM

SUNCOR ENERGY

Project Millennium
Taking Suncor into the 21st Century

LOCATION FOR COLLECTION OF VEGETATION SAMPLES

17 Apr. 1998	Figure F1.2-1	DRAWN BY: RFM/CG

which have relatively low toxic potency compared with carcinogenic PAHs, such as benzo[a]pyrene, and they are not bioaccumulative. Observed levels in Labrador tea leaves are much less than those that would be associated with adverse human health effects.

Inorganic chemical concentrations in blueberries collected from Suncor Lease 25 were generally within the range of measured concentrations in control locations and the Muskeg River Mine Project area, with the exception of copper, sodium and zinc, which were slightly elevated in samples collected from Suncor Lease 25 in comparison to controls. All of these compounds are essential elements for human nutrition and the measured concentrations in blueberries from test areas would not be associated with any adverse effects to human health.

Several inorganic chemical concentrations in Labrador tea leaves and cattail roots were elevated in samples collected from Suncor Lease 25 and the Muskeg River Mine Project site in comparison to control samples (i.e., aluminum, barium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, nickel, selenium, sodium, strontium, vanadium and zinc). As discussed previously for blueberries, some of these compounds are essential elements for human nutrition and are ubiquitous in the environment. Others (i.e., barium, cadmium, lead, nickel and vanadium) are not essential elements and elevated levels in test areas warrant further investigation in the risk assessment.

Overall, plant tissue residues were not consistently elevated in areas where oil sands air emissions are a factor. In addition, among the three plant species tested, there was no consistent subset of metals that were elevated compared with control plant concentrations. Therefore, the observed plant concentrations cannot be solely attributed to oil sands operations. This, however, may also be a consequence, in part, of the relatively small number of replicates (5 per site).

F1.2.4.2 Comparison to Blueberry Concentrations Measured in 1989

Table F1.2-4 shows a comparison of chemical concentrations in blueberries collected in 1997 to concentrations reported for blueberries collected in 1989 from similar locations (Aquatic Resource Management Ltd. 1989). Metal concentrations in blueberries do not appear to have increased since 1989. However, sulphur concentrations in 1997 are significantly greater than concentrations measured in 1989 in both control and potentially impacted areas. Since this apparent trend is evident in all samples, it may be a function of differences in analytical techniques between the two studies. Alternatively, this difference may reflect the added contribution of sulphur from dust deposited onto the berries.

Table F1.2-4 Comparison of Chemical Concentrations in Blueberries Collected in 1989 and 1997

Chemical/Location	Blueberry Concentrations (mg/kg)	
	1989	1997
Control Area (Mariana Lake)		
sulphur	90-156	630-708
arsenic	<0.01-0.04	<0.2
lead	<0.1-9.3	<0.1
mercury	0.0062-0.0096	0.01-0.02
nickel	<1.0-4.9	<0.08-0.56
vanadium	<0.1-1.4	<0.08
Fort McKay Area		
sulphur	121-150	452-654
arsenic	0.01-0.02	<0.2
lead	<0.1-1.5	<0.4
mercury	0.006-0.017	<0.01-0.02
nickel	<1.0-2.7	0.27-0.99
vanadium	<0.1-0.3	<0.08
Suncor/Syncrude area		
sulphur	101-250	452-707
arsenic	<0.01-0.04	<0.2
lead	<0.1-5.7	<0.1-0.3
mercury	0.0077-0.033	0.01-0.02
nickel	<1.0-5.7	<0.08-0.66
vanadium	<0.1-1.8	<0.08

The protocol for the 1989 study involved pre-washing of berries before analysis in order to measure true chemical accumulation into the fruit. However, in the 1997 vegetation study, berries were not washed prior to digestion to account for the total amount of chemical that could be potentially ingested by humans and wildlife who eat unwashed fruit. The latter is a more conservative estimate for humans and a more realistic scenario for wildlife. From a human health perspective, sulphur is an essential component of proteins and therefore is found throughout the human body. Elemental sulphur is considered to be one of the least toxic elements, and concentrations similar to those measured in blueberries can be found in other edible plant and animal products that are consumed on a regular basis. Excessive sulphur ingestion has been shown to cause no direct toxic effects in animal studies, but may cause temporary ionic imbalances resulting in diarrhea or weight loss (NAS 1980). Thus, although sulphur concentrations in blueberries may have increased since 1989, these concentrations would not be associated with adverse human health effects.

F1.2.4.3 Traditional Plant Consumption Patterns

A detailed discussion of traditional plant use by aboriginal communities within the RSA has been previously provided in Sections D3.2 and F3.2. The following paragraphs pertain to the specific consumptive use of blueberries, Labrador tea and cattail/ratroot. Traditional plant consumption patterns for communities within the RSA were reviewed based on historical documentation (Fort McKay 1996d, 1997a, Aquatic Resources Management

Ltd. 1989, Wein 1989) and personal communication with Fort McKay Environment Services Ltd.

Berries may be eaten year-round, either fresh, frozen or in preserves (Fort McKay 1997a). The reported mean frequency of berry consumption in the communities of Fort Smith and Fort Chipewyan was 63 times per person per year (Wein 1989). The average daily consumption rate of berries was reported to be five grams per person per day, assuming consumption every day throughout the year (i.e., 1825 grams per year, Wein 1989). Berry consumption within Fort McKay was suggested to be approximately one cup per day when berries are available and smaller quantities throughout the winter months in jams, pies and baked goods (Fort McKay Environmental Services (Ltd.), pers. comm.).

The mean consumption frequency of Labrador and mint tea was reported as seven times per year, with an upper maximum of 31 times per year (Wein 1989). Fort McKay (1997a) also reported rare use of Labrador tea in the area. Ratroot and cattail root are picked, dried and used year-round as medicines (ratroot) and as a source of starches and sugars (cattail). These roots may be boiled and consumed as a liquid or chewed (Fort McKay 1996d and 1997a). Although ratroot is commonly consumed by members of the aboriginal communities within the RSA, it is used very sparingly, and

yearly consumption would not likely exceed 1 cup (Fort McKay Environmental Services (Ltd.), pers. comm.).

F1.2.4.4 Baseline Human Health Risk Assessment for Vegetation Consumption

The data from the vegetation sampling program were further evaluated in the form of a baseline human health risk assessment. A chemical screening process was conducted to evaluate whether the observed concentrations in plant samples may have any adverse effect on human health. This was pursued to address concerns expressed by the Fort McKay Band (Fort McKay First Nations 1997) and other stakeholders. The chemical screening was based on the above data and the typical consumption patterns of nearby residential communities, as described in the previous section.

Chemical concentrations in plant tissues from Suncor Lease 25 and the Muskeg River Mine Project area were screened against risk-based concentrations (RBCs), based on the following conservative assumptions:

- children were assumed to ingest 20 g of berries every day and 5 g of Labrador tea and cattail/ratroot once per week throughout the year;
- adults were assumed to ingest 15 g of berries every day and 5 g of Labrador tea and cattail/ratroot once per week throughout the year; and

- chemical concentrations in plant tissue were conservatively compared against RBCs for child exposure, based on a target exposure ratio (ER) of 0.1 (i.e., ten-fold lower than levels associated with acceptable risk).

Screening tables are presented in Appendix VI.1.3. The chemical screening process identified the following nine chemicals for further evaluation in the baseline risk assessment for the vegetation types identified in parentheses:

- antimony (Labrador tea leaves);
- barium (Labrador tea leaves and cattail root);
- boron (blueberries and cattail root);
- cadmium (blueberries);
- copper (blueberries, Labrador tea leaves and cattail root);
- lead (blueberries, Labrador tea leaves and cattail root);
- molybdenum (cattail root);
- nickel (Labrador tea leaves); and
- vanadium (cattail root).

Children and adults were identified as receptors for the baseline risk assessment and were assumed to consume 20 and 15 g of blueberries, respectively, every day throughout the year and 5 g each of Labrador tea leaves and cattail root, once a week throughout the year. Maximum measured concentrations in plants from Suncor Lease 25 or the Muskeg River Mine Project area were used in calculating the risk estimates to ensure a conservative assessment. In addition, although a chemical may have only been retained because of concentrations in one plant type, it was conservatively evaluated in all plant types where concentrations were measurable, to address concerns associated with combined exposure to all plant types.

Exposure ratios are presented for each plant separately and for the combined exposure to all three plant types in Table F1.2-5. For both child and adult receptors, ER values were less than 1 for exposure to each plant separately and for combined exposure to all plants, indicating that predicted conservative exposures likely to be incurred by residents who consume local plants are well within acceptable limits. Therefore, baseline plant tissue concentrations do not currently pose an adverse impact to human health.

Table F1.2-5 Exposure Ratio Values for Blueberry, Labrador tea and Cattail Root Consumption by Children and Adults

Receptor/Chemical	Blueberries	Labrador Tea Leaves	Cattail Root	All Plants Combined
Child				
antimony	nd	0.02	nd	0.02
barium	0.07	0.02	0.007	0.097
boron	0.12	0.02	0.02	0.16
cadmium	0.03	0.001	0.002	0.033
copper	0.01	0.008	0.002	0.02
lead	0.03	0.009	0.008	0.047
molybdenum	0.007	0.0003	0.004	0.011
nickel	0.015	0.004	0.006	0.025
vanadium	nd	0.0002	0.01	0.01
Adult				
antimony	nd	0.003	nd	0.003
barium	0.09	0.003	0.001	0.094
boron	0.17	0.002	0.003	0.175
cadmium	0.04	0.0002	0.0003	0.04
copper	0.02	0.002	0.0003	0.022
lead	0.02	0.0008	0.0007	0.022
molybdenum	0.009	0.00005	0.0007	0.0098
nickel	0.02	0.0007	0.001	0.022
vanadium	nd	0.00004	0.002	0.002

nd = not detected

F1.2.5 Effects of Baseline Game Meat Quality on Human Health

Stakeholders have expressed concern over the potential intake of trace metals from the consumption of game meat. A number of wildlife species (e.g., moose, snowshoe hare, ruffed grouse and ducks) are hunted, trapped and consumed on a regular basis throughout the year by members of local communities in areas around the oil sands developments. Wildlife exposure to air and water emissions from oil sands developments may affect tissue quality. Wildlife may also be exposed to substances through consumption

of plants and prey that may be affected by oil sands emissions. This section describes the results of animal tissue sampling programs and the consumption patterns of aboriginal communities within the RSA. Finally, it provides a preliminary assessment of the potential for adverse health effects from consumption of game meat based on the available data.

F1.2.5.1 Animal Tissue Sampling Programs

Between 1987 and 1997, the following sampling programs have been conducted to determine the concentrations of trace metals within the tissues of selected species:

- deer mice and red-backed voles were collected in the Athabasca/Fort McMurray area at varying distances from the oil sands developments in 1987 (Pauls and Arner 1989) and 1994 (Conor Pacific 1998a Draft);

- bison meat and liver were collected from Syncrude's Toe Berm Pasture in 1995 (Pauls et al. 1995); and
- shrews, red-backed voles, red squirrels, snowshoe hares and ruffed grouse were collected from sites near Suncor, Syncrude and Fort McMurray in 1997 (Conor Pacific Environmental Technologies Inc. 1998b).

The 1987 sampling program determined elevated concentrations of aluminum, copper and titanium in deer mice and elevated concentrations of copper in red-backed voles near the plant sites. All other metals (barium, cadmium, chromium, manganese, nickel, lead, vanadium and zinc) were not elevated near the plant sites. Data collected from the Fort McMurray area were compared with concentrations in small mammals from wooded areas in the city of Edmonton. Results indicated that the highest tissue concentrations of aluminum, titanium and copper occurring at Fort McMurray were equal to, or less than, tissue concentrations in animals from the Edmonton area. The study concluded that it appeared unlikely that current levels of metals in small mammals near the plant sites would adversely affect small mammals or their predators. However, future study was recommended to determine trends in trace metal concentrations over time (Pauls and Arner 1989).

Therefore, in 1994, a similar program was conducted. The 1994 program determined that trace metals did not accumulate in whole body tissues of deer mice at rates similar to those observed in 1987. Trace metal concentrations of aluminum, barium, chromium, nickel, titanium and zinc in whole body tissues for 1994 were lower than those found in 1987, and there was no trend of decreasing metal concentrations with distance from the oil sands developments. Lead, manganese and vanadium concentrations did not show any differences between 1987 and 1994, while copper concentrations in 1994 were greater than those in 1987. The 1987 relationship between aluminum, copper and titanium concentrations and distance from oil sands plants was not present in the 1994 study. In addition, there was no relationship between cadmium, chromium, manganese or vanadium concentrations and distance from the oil sands plants. In the 1994 study, barium, lead and nickel concentrations increased in whole body homogenates with distance from the oil sands plants. This trend was also observed in 1987 for barium (Conor Pacific 1998a Draft).

In the 1994 study, samples were also analyzed separately as: (i) whole body minus digestive tissues; and (ii) digestive tissues alone. All metals, with the exception of barium, chromium and zinc, were higher in the digestive tract than in the body tissues. Barium was found to be higher in the body than the digestive tract, and there was no difference observed for chromium and zinc. Separate assessment of body burdens and digestive tract burdens suggests that the main route of exposure for metals is the oral route (Conor Pacific 1998a Draft).

Pauls et al. (1995) reported residue concentrations for adipose, skeletal muscle and liver tissue from a female bison, which had been held on the toe berm pasture (an area consisting of tailings sand with a 50 cm cap) along the west and north side of the Syncrude tailings settling pond dyke. The bison died of injuries during handling. Muscle tissue samples were analyzed for metals, while liver tissues were analyzed for PAHs and metals. PAHs, with the exception of naphthalene, were not detected in the liver sample. Metal concentrations were generally higher in liver tissues than in muscle tissues. The tissue concentrations were determined to be low and would not result in any adverse effects to human health if consumed (Pauls et al. 1995).

In 1997, several shrews, red-backed voles, red squirrels, snowshoe hares and ruffed grouse were collected near the Suncor and Syncrude plant sites and Fort McMurray. These samples are currently being analyzed for trace metals and results were not available in time for inclusion in this report (Conor Pacific 1998b).

F1.2.5.2 Game Meat Consumption Patterns

Several studies have been conducted to determine game meat consumption patterns within the communities of Fort McKay and Fort Chipewyan (Wein 1989, Fort McKay 1996d, 1997a). The results of these studies are summarized in this section.

Consumption of moose meat and fat is greater than consumption of any other species of bird, animal or fish, and is eaten by virtually every member of the community of Fort McKay, nearly every day. Moose fat is consumed a maximum of 252 times a year, while moose meat is consumed a maximum of 270 times per year (Fort McKay 1997a). Consumption of all other moose tissues is less than 30 times per year. Fort Smith and Fort Chipewyan communities reported a total annual mean consumption of moose of 58 times per year (Wein 1989). All parts of the moose are consumed.

Snowshoe hare may be eaten year round with an upper bound frequency of 150 times per year (Fort McKay 1997a). This species is generally taken on an opportunistic basis and is also a species which younger people in the community use to develop their hunting skills. Fort Smith and Fort Chipewyan communities reported a total annual mean consumption of 27 times per year for small mammals and 18 times per year for snowshoe hare. The highest recorded mean consumption estimate was 71 times per year (Wein 1989).

Less than half of the members consume the flesh and tail of beaver . Other mammals, in order of preference, include the white-tailed deer, mule deer and muskrat (Fort McKay 1997a). Bison may be eaten year round (Wein 1989), and any surplus of bison in the future could be sold for consumption (Fort McKay 1997a). However, bison are not a regular staple in the diet of the Fort McKay community. Mean consumption rates of 15 occasions per year have been reported (Wein 1989).

A number of resident and migratory game birds are consumed. Approximately, three quarters of the Fort McKay community seasonally eat the flesh, gizzard and liver of ducks (which include mallards, pintails, scaup, buffleheads, redheads and divers, such as the canvasbacks and occasional goldeneye). Sharp-tailed grouse, ruffed grouse and spruce grouse are also consumed at a maximum frequency of 75 times per year by approximately two thirds of the Fort McKay community (Fort McKay 1997a). All species of grouse are taken by members of the community in an opportunistic fashion and the activity continues through out the year. Fort Smith and Fort Chipewyan communities reported a total annual mean consumption rate of 13 times per year for upland birds. The highest recorded mean was 50 times per year (Wein 1989).

Rodent species, such as mice, shrew, squirrels and voles, are not eaten; however, their diet, foraging behavior, small home range and year round residence provide an ideal test organism for determination of trace metal concentrations in mammals around the oil sands developments (Pauls and Arner 1989, Conor Pacific 1998a Draft). These species may accumulate higher concentrations of trace metals than large game animals, such as moose, due to their higher exposure potential.

The daily ingestion rates of game meat in the communities of Fort McKay and Fort Chipewyan were not recorded for each individual animal; however, Wein (1989) reported an average consumption rate of 55 grams per day of country meat and birds for the communities of Fort Smith and Fort Chipewyan. Adult males between the ages of 25 to 49 consumed the highest amount at 89 grams per day, young female adults consumed the lowest amount at 29 grams per day and young male adults/adolescents between the ages of 13 and 24 consumed a maximum of 67 grams per day. Consumption rates for children less than 13 years of age were not reported.

F1.2.5.3 Baseline Human Health Risk Assessment for Game Meat Consumption

The data collected from the animal tissue sampling programs were further evaluated in the form of a baseline human health risk assessment. This analysis was pursued in light of explicit interests expressed by the Fort McKay Band (Fort McKay First Nation 1997). The process involved screening chemical concentrations found in animal tissues to determine whether the observed levels may have any adverse effect on human health. The chemical screening was based on data from the animal tissue sampling programs and the typical consumption patterns of the communities of Fort McKay and Fort Chipewyan, as described in the preceding sections.

Chemical concentrations in animal tissues were screened against risk-based concentrations (RBCs), based on the following conservative assumptions:

- RBCs were based on child exposure, with a target exposure ratio (ER) of 0.1 (i.e., ten-fold lower than levels associated with acceptable risk); and
- children were assumed to ingest 67 grams per day of game meat every day throughout the year (ingestion rate based on values reported in Wein 1989 for adolescents/young adults, the youngest age group evaluated).

Screening tables are presented in Appendix VI.1.3. The chemical screening process identified eight metals that require further evaluation in the baseline risk assessment for the animals listed in parentheses:

- Barium (vole, mouse and bison);
- Cadmium (vole, mouse and bison);
- Chromium (mouse);
- Copper (vole, mouse and bison);
- Lead (vole and mouse);
- Nickel (mouse, bison liver);
- Selenium (bison); and
- Vanadium (vole and mouse).

Maximum measured concentrations in rodents and/or bison tissues were used in calculating the risk estimates to ensure a conservative assessment. Consumption rates used for children and adults were 67 and 100 grams per day, respectively, based on the values reported by Wein (1989) for the communities of Fort Smith and Fort Chipewyan. No similar quantitative estimates of game meat consumption were reported for Fort McKay, but consumption patterns were assumed to be similar. Two assessments were conducted as follows:

- 100% of the daily intake of game meat was assumed to consist of rodents as a conservative surrogate for game meat and tissue quality (the worst case of 1987 and 1994 data); and
- 90% of the daily intake of game meat was assumed to consist of bison meat, with the remaining 10% consisting of bison liver.

Exposure ratios are presented for each of these scenarios in Table F1.2-6. For both child and adult receptors, ER values based on exposure to rodents were higher than those based on exposure to bison meat and liver, and some

Table F1.2-6 Exposure Ratio Values for Game Meat Consumption by Children and Adults

Receptor/Chemical	Rodent Diet	Bison Diet
Child		
barium	0.55	0.014
cadmium	1.86	0.083
chromium	0.048	[a]
copper	0.23	0.16
lead	2.34	[a]
nickel	0.16	0.036
selenium	[b]	0.087
vanadium	1.33	[a]
Adult		
barium	0.15	0.0039
cadmium	0.51	0.023
chromium	0.013	[a]
copper	0.065	0.04
lead	0.65	[a]
nickel	0.045	0.01
selenium	[b]	0.024
vanadium	0.37	[a]

[a] not detected
[b] data not available

values exceeded 1. Although rodents are not eaten by the communities of Fort McKay or Fort Chipewyan, risk estimation was conducted using rodent tissue metal concentrations since this was the most comprehensive animal tissue data set available. As stated previously, rodents are likely to accumulate higher concentrations of metals in their tissues than larger mammals, due to their close contact with soils, small home range and small body size.

The ERs for game meat consumption based on the more realistic bison diet (including meat and liver) were less than 1. Therefore, if concentrations in moose and other game animals are similar to that observed in bison, baseline game meat tissue concentrations of trace metals are not expected to pose an adverse impact to human health. Since the bison data are based on analysis of a single animal, further analysis of game meat tissue samples would be beneficial to increasing the certainty associated with these predictions. The 1997 animal tissue sampling program included some game animal species, including snowshoe hare and ruffed grouse; however, results were not available for inclusion in this analysis.

F1.3 HUMAN HEALTH IMPACT ASSESSMENT

F1.3.1 Key Question HH-1: What Impact will Chemicals in Operational Water Releases from Project Millennium have on Human Health?

F1.3.1.1 Analysis of Potential Linkages

The linkage between the Project activity and potential changes to water quality has previously been established under Section C3.2. The present section therefore focuses on whether a valid linkage exists between potential water quality changes and human health.

Linkage Between Changes in Water Quality and Human Health

Since Project Millennium is not yet in operation, measured data specific to the Project could not be evaluated. However, surrogate data from existing operations (i.e., Suncor and Syncrude) were used to provide an estimate of the chemistry of release waters during operation, at closure and in the far future under equilibrium conditions and, in turn, predicted water quality in receiving waters.

To determine whether changes in water quality may affect human health, a problem formulation was conducted including chemical, receptor and exposure pathway screenings as described in Appendix VI. The chemical screening was conducted using predicted future water concentrations in the Athabasca River and Shipyard Lake. Where predicted future chemical concentrations in the Athabasca River as a result of Project Millennium were equal to predicted baseline concentrations for the Athabasca River and no unacceptable human health risks were predicted for these chemicals in the baseline risk assessment (Section F1.2.3), these chemicals were excluded from further evaluation in the impact assessment (e.g., arsenic, beryllium, molybdenum). However, chemicals were not excluded from the impact assessment of Shipyard Lake for this reason, due to the uncertainties associated with comparisons to the limited baseline data. Screening tables are presented in Appendix VI.1.3. Results of chemical screening identified the following chemicals for further evaluation in the risk assessment:

- benzo(a)pyrene (Shipyard Lake)
- benzo(a)anthracene (Shipyard Lake)
- naphthenic acids (Shipyard, Athabasca River)
- arsenic (Shipyard Lake)
- beryllium (Shipyard Lake)
- boron (Shipyard Lake)

- vanadium (Shipyard Lake)

Potentially exposed people and land uses were identified. Both adults and children may use local waterbodies (such as the Athabasca River and Shipyard Lake) for recreational activities, such as swimming, boating or hiking. During these activities, people may become exposed through ingestion of river water and dermal contact with water while swimming.

Since elevated chemical concentrations, receptors and exposure pathways may apparently co-exist, a potential linkage exists between water quality changes and human health.

Linkage Between Changes in Fish Tissue Quality and Human Health

A combined field and laboratory study was completed to address the potential for accumulation of chemicals in fish tissue. These data are summarized in Section C4 and briefly described below.

Walleye, goldeye and longnose sucker were collected in 1995 as part of a baseline aquatics study in the oil sands region (Golder 1996c). Walleye and goldeye were captured in the Athabasca River near Suncor and longnose sucker were captured as they moved up the Muskeg River to spawn. All three species spend part of the open-water season in the vicinity of existing oil sands operations. Composite samples of fish fillets were analyzed for organic chemicals and metals (data presented in Section C4). Samples from longnose sucker contained trace concentrations of naphthalene (0.02 to 0.04 μg/g) and methylnaphthalene (<0.02 to 0.03 μg/g); however, other PAHs were not detectable (detection limits range from 0.02 to 0.04 μg/g). No PAHs were detected in walleye and goldeye samples. In general, levels of trace metals in fish tissue were low or less than detection.

Uptake of oil sands related chemicals into fish tissue was also investigated during two laboratory fish health studies where juvenile walleye and rainbow trout were exposed to a variety of waters, including a dilution series of water collected from Suncor's Tar Island Dyke (TID) drainage system (0.1 to 10% strength), Suncor wastewater treatment system effluent (0.01 to 10% strength), laboratory control water and Athabasca River water collected upstream of existing oil sands operations (i.e., background controls). The fish were exposed to these waters in a flow-through system for 28 days, sacrificed and their tissues analyzed for PAHs and trace metals (HydroQual 1996a,b). PAH concentrations in juvenile walleye and rainbow trout were generally below detection following exposure to TID water; naphthalene and methyl naphthalene levels in rainbow trout were at or just above the detection level in both control and treatment samples (0.02 to 0.03 μg/g; Section C4). PAHs were not detected in fish exposed to the wastewater treatment system effluent water. Concentrations of most metals were generally low or below detection limits in both treatment and control samples. The only notable exceptions were for arsenic and mercury where concentrations of <0.1-2.3 μg/g and 0.02-0.45 μg/g, respectively, were measured. However, the highest concentrations were associated with the background control fish exposed to the Athabasca River water. Thus, no significant accumulation of PAHs or metals (relative to detection limits or levels in background control fish) is indicated by either laboratory exposure of fish to Tar Island Dyke water and wastewater treatment system effluent or from fish captured in the Athabasca River.

It should be noted that there may be changes in fish tissue quality with respect to chemicals that create off-flavours in fish tissue, and these chemicals might be present at concentrations below analytical detection limits. Although tainting is an important issue from the perspective of use of the fish resource, it is not strictly speaking a health issue. Therefore, the potential for tainting of fish tissue is discussed in Section C4.

Notwithstanding the lack of evidence of accumulation of chemicals in fish tissue, a chemical screening was conducted to determine whether ingestion of fish from the Athabasca River might potentially pose a hazard to people's health. The chemical screening process followed the same screening protocol as for drinking water and employed data from field samples and the two studies noted above. Nickel was the only chemical identified in the conservative chemical screening process. Further examination of the fish tissue data indicated that nickel was only detected in the Athabasca River Goldeye sample at low concentrations and was not measurable in fish exposed to TID water in the laboratory accumulation study. For this reason, nickel was not carried forward for further evaluation in the risk assessment.

It should also be noted that levels of mercury in fish tissues are elevated upstream of the oil sands region and may be a source of mercury exposure for people eating fish from this region of the river. Elevated levels of mercury in fish tissues have also been noted by NRBS, and have been attributed to natural sources (NRBS 1996). Water quality modelling suggests that the Project will not change the waterborne mercury levels. Therefore, over the long-term operation, mercury levels in fish tissue are not anticipated to be increased by the Project activities. For these reasons, mercury was not evaluated further in the risk assessment.

In summary, based on the data and results of the screening level assessment discussed above, release waters do not appear to contribute to increases in chemical concentrations in fish within the LSA or RSA to levels that would be associated with adverse health effects. Hence, it is concluded that a linkage between changes in fish tissue quality associated with the Project and human health does not exist.

F1.3.1.2 Analysis of Key Question

To further investigate the linkage between off-site water quality and human health, a quantitative human health risk assessment was conducted for conceptual exposure model HH-1 (Figure F1.3-1) using methods described in Section F1.1.4.3. Key aspects of the risk assessment are discussed here; additional details are provided in Appendix VI.

Concentrations of the chemicals of potential concern were predicted for the Athabasca River and Shipyard Lake according to the method described in Section C3. The maximum concentrations predicted to occur during operation (2000-2025), at closure (2030) and the far-future (under equilibrium conditions) are presented in Section C3.2 and in chemical screening tables in Appendix VI.1.3. These concentrations were used as exposure concentrations to estimate daily intake rates for off-site exposures during operation. Predicted water concentrations at closure and in the far future are evaluated in terms of both recreational exposure and temporary residential exposure to hunters/trappers in Key Question HH-5, Section F1.3.5.

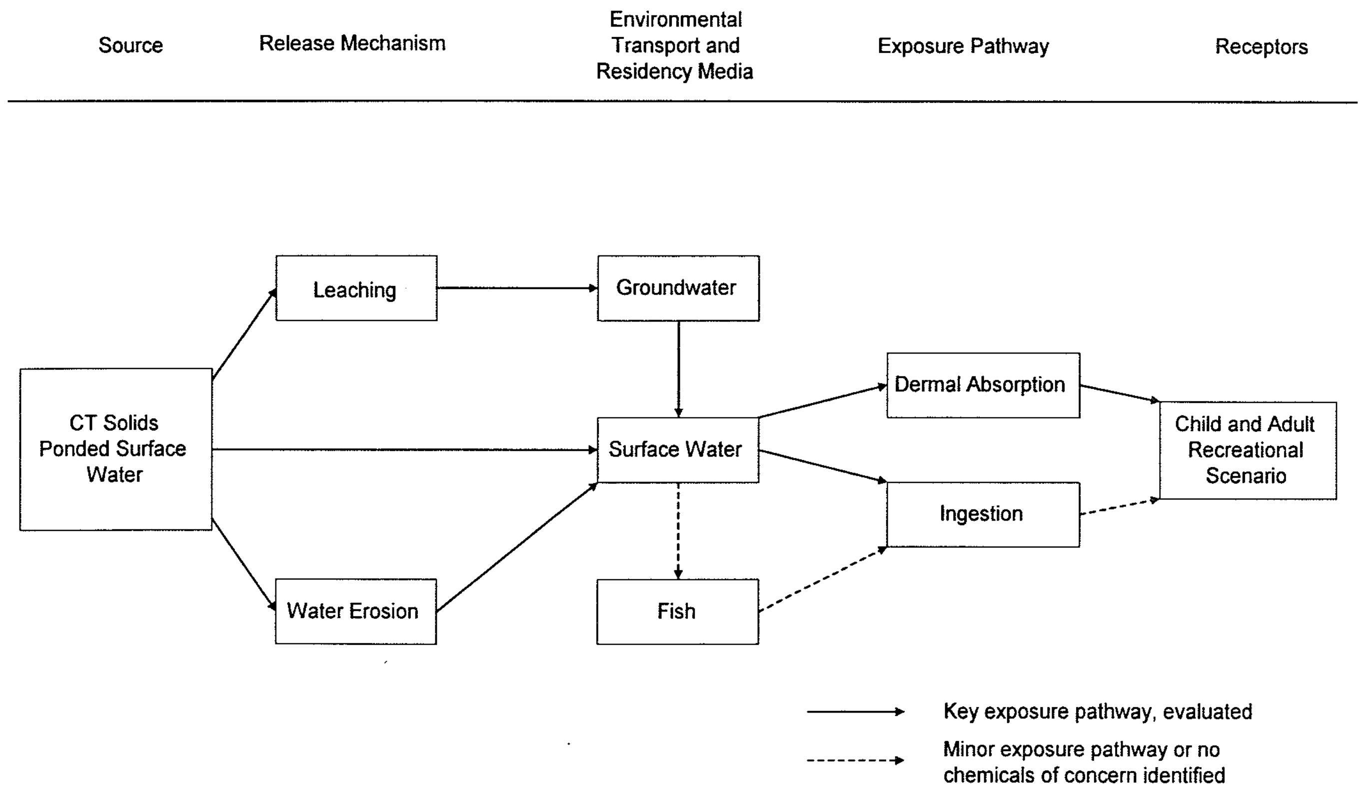
For the swimming scenario, it was assumed that people could absorb chemicals across the skin (i.e., dermal absorption) and could incidentally ingest small quantities of water. People were assumed to swim in the Athabasca River and/or Shipyard Lake two days per week for two months during the summer (i.e., 16 times per year). Children and adults were assumed to spend 2.5 h and 1 h, respectively, in the water per event.

The major route of exposure for recreational use (e.g., hiking, boating, fishing) was assumed to be occasional consumption of water during recreational activities. People were assumed to drink from the river/lake two days a week, year round. It was also assumed that recreational users would occasionally swim in these waterbodies. Therefore, exposures for recreational receptors include both drinking water and occasional swimming exposure.

These scenarios are the same as those used in the baseline risk assessment (Section F1.2.3) and in previous EIAs for the Steepbank Mine, Aurora Mine and the Muskeg River Mine Project (Golder 1996k; BOVAR 1996e; Shell 1998). A residential drinking water scenario was not included in the assessment because people in the area do not use untreated water from the Athabasca River or Shipyard Lake as a primary drinking water source.

For the scenario associated with HH-1, consumption of fish caught downstream of the Project was assumed to pose no incremental risk above background based on previous studies indicating no significant difference in fish quality from fish caught upstream (Golder 1996c). However, fish consumption has been evaluated for several chemicals in the multimedia exposure assessment for key question HH-4.

Figure F1.3-1 HH-1: Conceptual Model for the Water Releases Scenario



Exposure ratios for Shipyard Lake swimming and recreational scenarios are presented in Tables F1.3-1 and F1.3-2 below. Intermediate calculations such as intake rates appear in Appendix VI.6.2. All ERs for non-carcinogenic chemical exposure to child and adult receptors were less than 1, indicating that exposures from recreational activities during operation of the Project are within acceptable limits. ERs for carcinogenic chemicals were also less than 1, with the exception of arsenic and beryllium in Shipyard Lake for the recreational scenario. Using the rationale discussed previously in Section F1.2.3 for baseline arsenic and beryllium concentrations in the Athabasca River, concentrations of these chemicals predicted for Shipyard Lake are within the range reported for surface waters in Western Canada and are less than drinking water guidelines. Therefore, the marginal exceedance of 1 does not indicate an unacceptable human health risk. Refer to Section F1.2.3 for a more detailed discussion.

Table F1.3-1 Exposure Ratios for Swimming Exposure to Shipyard Lake Water during the Operational Phase

Receptor/Chemical	Shipyard Lake Operation (2000-2025)
Child - Non-carcinogens	
boron	0.008
vanadium	0.0003
Adult- Non -carcinogens	
boron	0.0007
vanadium	0.00002
Composite - Carcinogens	
arsenic	0.02
beryllium	0.04
Total Carcinogens	**0.06**

Table F1.3-2 Exposure Ratios for Recreational Exposure to Shipyard Lake Water During the Operation Phase

Receptor/Chemical	Shipyard Lake Operation (2000-2025)
Child - Non-carcinogens	
boron	0.28
vanadium	0.01
Adult- Non -carcinogens	
boron	0.09
vanadium	0.004
Composite - Carcinogens	
arsenic	1.3
beryllium	3.2
Total Carcinogens	**4.5**

Naphthenic Acids

To date, there are insufficient mammalian toxicological data to calculate a defensible reference dose (RfD) for naphthenic acids, and therefore to assess the potential for chronic adverse human health effects. RfDs are normally calculated based on chronic or subchronic studies in laboratory animals. Currently, there are only acute lethal toxicity mammalian data available for naphthenic acids. The acute toxicity data suggest that naphthenic acids have a relatively low potency for lethality under acute exposure conditions. Predicted concentrations in the Athabasca River and Shipyard Lake are much less than concentrations that would be associated with acute lethality.

Further study has been and will be initiated by Suncor to determine the potential for chronic mammalian toxicity of naphthenic acids and CT water. Recently, Suncor completed preliminary studies to determine the potential for mutagenicity of CT water (both fresh and aged). Preliminary results of this study were equivocal, and therefore further studies have been initiated by Suncor. In addition, industry-sponsored studies of the mammalian toxicity of naphthenic acids in laboratory animals is in the planning stages at the University of Saskatchewan. Refer to Section F1.1.4.3, Toxicity Assessment, for further details.

F1.3.1.3 Residual Impact Classification and Environmental Consequences

Based on the results of the risk assessment, impacts to human health are not predicted to occur due to water emissions during operation of Project Millennium. However, due to the uncertainty regarding the potential effects of chronic low level exposure to naphthenic acids present in water releases, the magnitude of impact and resultant environmental consequence are rated as follows:

Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence
Negative	Low	Local	Long-Term	Reversible	Moderate	Low

Impacts were classified according to the information presented in Section A2, Table A2-8. The direction of the impact is negative, because some chemical concentrations will increase in the Athabasca River and Shipyard Lake, thereby increasing exposures to people. The magnitude of impact for the chemicals evaluated is negligible, since ER values were less than 10 (refer to Section F1.1.4.4 for more details). However, due to the uncertainty associated with the chronic toxicity of naphthenic acids, the magnitude of impact was classified as low, rather than negligible. The geographic extent is local, since impacts are restricted to the LSA. The duration is long-term, since exposures may occur for greater than 30 years. The impact is reversible, since further studies are being conducted to determine the potential chronic toxicity of naphthenic acids, and mitigation options will be considered as necessary to reduce exposures. On the basis of these classifications, the environmental consequence is low.

Certainty

The assessment of potential impacts to users of the Athabasca River and Shipyard Lake was based on a number of highly protective assumptions, with the intent to overestimate rather than underestimate risk. The protective assumptions related to chemical screening have been discussed in Section F1.1.4.3. These assumptions provide assurances that no chemicals were excluded from the screening step, except those that clearly pose no incremental risk to human health. Risk estimates were calculated deterministically to provide single value estimates of ERs; however, a significant degree of uncertainty is associated with most ER values. In light of this uncertainty, to ensure that this assessment errs on the side of safety, protective input values were used throughout. Hence, the actual risks to human health will likely be even lower than those suggested by ER estimates because of the multiple protective assumptions as outlined below:

- reasonable worst case exposure point concentrations in the Athabasca River and Shipyard Lake were used, assuming no decay or degradation of chemicals;
- exposure locations were set within the mixing zone of the Athabasca River, downstream of all potential water emissions;
- exposure parameter values for human receptors represent reasonable maximum exposure values; and
- toxicity reference values adopted are protective of sensitive members of the population (e.g., seniors) under chronic exposure conditions.

Due to the conservatism involved in the risk assessment, it is unlikely that potential risks have been underestimated. However, some uncertainty exists with respect to the following:

- lack of a toxicity reference value for naphthenic acids;
- possible interactions of chemical mixtures; and
- uncertainties inherent to predictive water quality modelling (refer to Section C3).

As noted in Sections F1.1.4.3, Toxicity Assessment, it is unlikely that interactions of chemical mixtures will affect the conclusions presented herein.

F1.3.1.4 Monitoring

A suite of chemical substances, including the chemicals of concern discussed here, will continue to be monitored annually in surface water at predetermined locations in the Athabasca, Muskeg and Steepbank rivers and Shipyard Lake as part of the RAMP program. In addition to water quality monitoring, periodic sampling of fish tissues for chemical analysis should be included in the RAMP program to validate the exposure and risk assessments.

Further study has been initiated by Suncor to determine the potential for chronic mammalian toxicity of naphthenic acids and/or CT water. In addition, a 3-year University of Saskatchewan study has been proposed. Refer to Section F1.1.4.3, Toxicity Assessment, for further details.

F1.3.2 Key Question HH-2: What Impact Will Chemicals in Operational Air Emissions From Project Millennium Have on Human Health?

F1.3.2.1 Analysis of Potential Linkages

The effect of the Project activity on air quality has been examined and reported previously in Section B3. Air emissions and dispersion modelling have confirmed this linkage and characterized the change in air quality anticipated from Project activities.

Linkage Between Air Quality and Changes in Human Health

As previously noted, for the linkage to be valid three essential components of environmental health risk must co-exist; these are: i) chemicals at potentially hazardous concentrations; ii) human receptors; and iii) operable exposure pathways. The latter two are intuitively evident in the form of local residents and visitors who are exposed to the local/regional air quality. The remaining issue then, is to determine whether the predicted changes in air quality are potentially hazardous.

In response to interests articulated by various stakeholders respecting current and future air quality, Suncor undertook a stack survey of air emissions. The results from the survey were not available in time for the assessment here, although information respecting volatile organic chemicals (VOCs) was available and integrated. Information respecting particulate emissions and associated polycyclic aromatic hydrocarbons and metals will be available when their analysis is complete.

Where predicted ambient air concentrations of VOCs were available, they were not compared against screening level criteria (i.e., regulatory criteria) because in many cases such criteria are lacking. Therefore, although the linkage for these chemicals was neither validated nor invalidated, it was considered prudent to retain them for further analysis of key question HH-2.

In summary, the linkage between human health effects and concentrations of select air quality parameters is considered valid and warrants further quantitative analysis.

F1.3.2.2 Analysis of Key Question

To further investigate the potential linkage between air quality and human health, a quantitative human health risk assessment was conducted for conceptual model HH-2 (Figure F1.3-2) using methods described in Section F1.1. Key aspects of the risk assessment are discussed here; additional details are provided in Appendix VI.

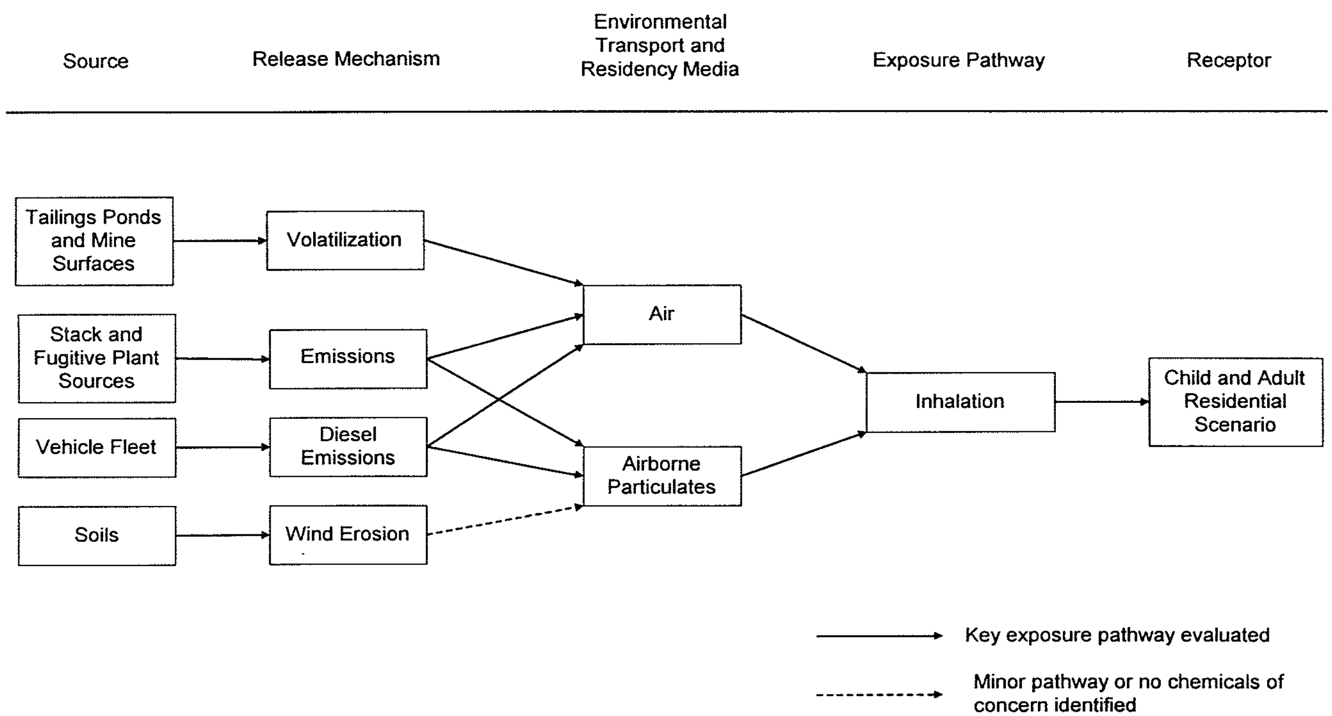
Analysis of this key question was approached from three perspectives. These perspectives involved: i) the predicted ambient concentrations of vapour phase chemicals; and ii) conservative assumptions of chemicals that may be adsorbed to airborne respirable particulates

Step 1: Vapour Phase Chemicals

Concentrations of chemicals of concern in air were predicted using dispersion modelling, as described in Section B3. The major sources of airborne chemicals included: off-gassing from the tailings pond and mine surfaces, emissions from the vehicle fleet, and emissions from stack and fugitive plant sources. Maximum long-term-averaged ground level air concentrations for the chemicals of concern were estimated (Section B3) for Fort McKay, the closest residential community to the Project, along with Fort McMurray and Fort Chipewyan (refer to Section B3 for details). Additionally, a location known as "Lower Camp" was also included for consideration of people such as hunters/trappers who may spend extended periods of time closer to the site and experience air quality different from the communities noted above. The ambient air concentrations (i.e., no differentiation between indoor and outdoor air concentrations) were then used in exposure modelling to determine the estimated daily intake of these chemicals by local residents.

For non-carcinogenic chemicals, potential residential exposure was estimated for children of age 5-11 years, a lifestage at which the greatest exposure via inhalation (per unit body mass) occurs (Health Canada 1994). Residential exposure was also estimated for adults. Finally, for potentially carcinogenic chemicals, exposure was estimated based on the assumption that an individual lives their entire life in the aforementioned communities (i.e., a composite receptor was evaluated from birth to 70 years of age).

Figure F1.3-2 HH-2: Conceptual Model for the Air Releases Scenario



Daily intake rates were estimated for individual chemicals where possible and also on a grouped basis. For some chemicals, particularly the Total Petroleum Hydrocarbons (TPH), toxicity data are not available for all components of the hydrocarbon spectrum. Therefore, such chemical exposure and risks were conservatively estimated through the recent methods of the Total Petroleum Hydrocarbon Criteria Working Group (TPHCWG 1997) involving hydrocarbon fractions (i.e., groups of related chemicals) and surrogate or fraction-specific toxicity reference values (see Appendices VI.4 and VI.5.2 for detailed descriptions of chemical groupings and toxicology of the various TPH fractions).

Results of the analyses and the corresponding exposure ratios are presented in Table F1.3-3.

Table F1.3-3 Exposure Ratios for Inhalation of VOCs

Chemical/Group	Fort McKay	Fort McMurray	Fort Chipewyan	Lower Camp
Residential Child and Adult - Non-carcinogens[a]				Adult Hunter[c]
C2-C8 Aliphatics[d]	0.0049	0.0023	0.00035	0.03
C9-C12 Aliphatics[e]	0.051	0.024	0.0037	0.32
C6-C8 Aromatics[f]	0.023	0.011	0.0016	0.14
C9-C12 Aromatics[g]	0.017	0.0079	0.0012	0.10
Composite - Carcinogens[b]				Adult Hunter[c]
benzene	0.036	0.017	0.0026	1.5

(a) Denotes a child and adult residing in one of the three communities.
(b) Denotes a person exposed to benzene from birth to 70 years of age while residing in one of the three communities
(c) Denotes an adult hunter/trapper temporarily living for 6 months of the year at the location of maximum air concentrations outside of the Project boundaries (Lower Camp).
(d) Includes all straight chain and cyclic alkanes/alkenes with carbon numbers ranging from 2 to 8.
(e) Includes all straight chain and cyclic alkanes/alkenes with carbon numbers ranging from 9 to 12.
(f) Includes all aromatic compounds except benzene with carbon numbers ranging from 6 to 8.
(g) Includes all aromatic compounds with carbon numbers ranging from 9 to 12.

Exposure ratios for non-carcinogenic VOCs (i.e., the grouped hydrocarbons), indicate that the health risks of predicted ambient air quality in the surrounding communities are negligible. This is so, in spite of conservative assumptions arising from air dispersion modelling and exposure modelling, and the assignment of conservative toxicity reference values to hydrocarbon groups (i.e., assumption that chemical constituents within the group are all as toxic as the most toxic member of the group).

The modelled results for benzene indicate that the ER value for lifetime cancer risks associated with ambient air quality in the surrounding communities are less than one, and acceptable. For the hunter, which was assessed on the basis of air quality and residence adjacent to the Suncor fenceline (i.e., Lower Camp), the ER was 1.5. However, in light of the degree of conservatism inherent in the computation and the provincially acceptable level of incremental risk being one in one-hundred thousand, the computed risk is considered to be negligible.

Step 2: Airborne Particulates and Adsorbed Chemicals

Particulate Matter (PM)

Health Canada (WGAQOG 1997) states that there is no evidence that supports the concept of a threshold effect level for PM_{10} and $PM_{2.5}$ substances. PM is viewed essentially as having no threshold with respect to the positive associations between particulate matter and morbidity and mortality. However, they recognize that at levels below 15 $\mu g/m^3$, the association cannot reliably be predicted (WGAQOG 1997). Available information suggests total particulates less than 30μm in diameter at Fort McMurray averaged 9-15 $\mu g/m^3$ over the period 1990 to 1994 (Golder 1996d). Results of particulates analysis from the stack survey, which Suncor undertook in response to interest articulated by stakeholders, were not received in time for inclusion in this EIA. The results and their ramifications to human health will be made available after the analysis is completed.

Presently, the true incremental contribution to health risk that can be attributed to PM_{10} and $PM_{2.5}$ is subject to wide debate and requires consideration of the patterns of long-term averaged (i.e., monthly and annual) site-specific measurements, since this cannot be extrapolated from data for other urban centres (WGAQOG 1997). In light of these considerations and information presented by Health Canada (WGAQOG 1997), Suncor will continue to participate in regional assessment programs of air quality.

Chemicals Potentially Adsorbed to Fugitive Particulates

The forgoing discussion of health effects of PM is concerned with the association between PM levels and observed levels of hospitalization and population mortality. The particulate matter in these studies inherently include typical urban chemicals associated with the respirable particulates. However, to provide added insight, this step in the analysis focuses on the potential chemical exposure that may arise from inhalation of fugitive particulates, but excludes any effect that might be associated with the physical particulate matter itself.

At the time of submission of this document, direct measurements of ambient concentrations of chemicals associated with airborne particulates in the oil sands area were not available. However, two sources of data are anticipated to be available in the near future, namely i) results of the Suncor stack survey and dispersion modelling, and ii) results of the Alberta oil sands ambient and personal air monitoring study. Thus, it is not possible to explicitly quantify off-site health risks associated with this exposure pathway, although the new information is forthcoming and will be available when their analysis is completed.

There is, however, indirect evidence that suggests that exposures to particulates from dust derived on-site pose no health hazard to people who may reside near the Project site. This is illustrated in the following screening-level assessment that was previously conducted by Golder in respect of the Steepbank Mine EIA (Golder 1996d) for chemicals that may be associated with fugitive particulates. The rationale is reproduced here:

Syncrude maintains two high volume samplers, one located near Fort McMurray and the other on Syncrude's existing site (Tailings North). (Suncor has no comparable samplers). These samplers collect air samples for a 24-h period, once every six days (~61 samples per year) and typically collect particles that are less than 30 μm in diameter. From 1990 to 1994, the annual, maximum recorded concentrations ranged from 34 to 79 $\mu g/m^3$ at Fort McMurray and 88 to 273 $\mu g/m^3$ at Tailings North; and geometric means ranged from 9.4 to 14.9 $\mu g/m^3$ at Fort McMurray and from 10.5 to 19.0 $\mu g/m^3$ at Tailings North. The particles sampled are presumably derived from natural sources (forest fires, off-site dust), dust generated on-site and from air emissions from Suncor's and Syncrude's plants.

It was assumed that all of the particulates measured at the Tailings North monitoring site are derived solely from dust derived from the active mines and tailings sand structures (e.g., wind-based erosion of tailings dykes, dust generated by vehicular traffic). It was further assumed that 100% of the particulates measured at the site are of respirable size (generally considered to be less than 10 μm in diameter). These are both highly protective assumptions for assessing potential off-site health hazards.

It was assumed that the relative amounts of PAHs and metals measured in tailings sand are representative of relative concentrations in particulates collected at Tailings North and at off-site locations. It was further assumed that the worst-case particulate level of 273 $\mu g/m^3$ (i.e., maximum concentrations recorded from 1990 to 1994 at Tailings North) was representative of typical off-site particulate levels that might occur adjacent to existing or future operations. Then, worst-case concentrations of PAHs and metals associated with respirable particulates can be estimated as shown in Table F1.3-4.

Predicted worst-case exposure concentrations were compared with RBCs for air, where the RBCs are set at levels to protect the health of sensitive individuals who are exposed for 24 hours per day, 350 days per year for 30 a (Table F1.3-4). As evident from Table F1.3-4, predicted concentrations are considerably lower than RBCs. Considering the multiple protective assumption built into this analysis, it is reasonable to conclude that dust generated from the Project operations does not pose an off-site health hazard.

Table F1.3-4 Predicted Concentration of Airborne Contaminant Adsorbed to Particulates and RBCs

Chemical	Concentration in Tailings sand (mg/kg)	Predicted Concentration in Air ($\mu g/m^3$)	EPA Risk-Based Concentration (air) (mg/m^3)
PAHs			
acenaphthene	0.01	0.0000027	220
anthracene	0.01	0.0000027	1100
benzo(a)anthracene	0.15	0.000041	0.01
benzo(a)pyrene	0.01	0.0000027	0.001
benzo(b&k)fluoranthene	0.03	0.0000082	0.01
biphenyl	0.01	0.0000027	180
dibenzo(a,h)anthracene	0.01	0.0000027	0.001
fluoranthene	0.01	0.0000027	150
fluorene	0.01	0.0000027	150
naphthalene	0.01	0.0000027	150
pyrene	0.04	0.0000109	110
INORGANICS			
aluminum	172	0.047	3700
antimony	0.05	0.000014	1.5
arsenic	0.63	0.00017	1.1
barium	4.9	0.0013	0.52
beryllium	0.1	0.000027	0.0075
boron	0.1	0.000027	21
cadmium	0.3	0.000082	0.00099
chromium	0.5	0.00014	0.00015
cobalt	2	0.00055	220
copper	0.5	0.00014	140
lead	2	0.00055	0.00037
manganese	56.5	0.015	0.052
mercury	0.03	0.0000082	0.31
molybdenum	2	0.00055	18
nickel	2	0.00055	73
phosphorus	22	0.0060	0.0073
selenium	0.02	0.0000055	18
vanadium	2.8	0.00076	26
zinc	5.8	0.0016	1100

Note: Reproduced from Golder 1996f.

F1.3.2.3 Residual Impact Classification and Environmental Consequence

Based on the results of the risk assessment concerning volatile organic chemicals (VOCs) and the analysis of surrogate data respecting airborne particulates with PAHs and metals, impacts to human health are not predicted to occur as a result of the Project. Particulate, metal and PAH emissions are being examined further by the stack survey analyses currently in progress to provide further resolution of the contribution of these substances to overall health risks. Therefore, the magnitude of impact and resultant environmental consequence are rated as follows:

Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence
Negative	Low	Regional	Long-Term	Reversible	Moderate	Low

Impacts were classified according to the information presented in Section A2, Table A2-8. The direction of the impact is negative, because airborne chemical concentrations will increase as a result of the Project. The magnitude of impact is low, since the ER values were below or only marginally greater than one. The geographic extent is regional, since exposures may occur outside the LSA. The duration is long-term, since exposures may occur for greater than 30 years. The impact is reversible, since further information will be available in the near future, and mitigation options together with continually improving emission technology will be considered if necessary to reduce exposures. On the basis of these classifications, the environmental consequence is low.

Certainty

This assessment was based on a variety of conservative assumptions including the following:

- maximum predicted ambient air exposure concentrations which derive from conservative air dispersion modelling methods;
- exposure assumes people reside in the communities for their entire lives; and
- where exposure assessment involves summation of concentrations across a group of chemicals, the most conservative toxicity reference value was employed (i.e., assumes greater potency for most substances in the group).

Collectively, these assumptions weigh heavily towards exposure ratios that over-estimate the true risk that is likely to be manifested by the Project.

The main areas of uncertainty associated with this analysis include:

- the uncertainty inherent with estimated fugitive emissions and air dispersion modelling (Section B3) that manifest as uncertainty in the predicted exposure concentrations;
- the uncertainty associated with the health risk of low levels of particulate matter in the form of PM_{10} and $PM_{2.5}$; and
- the uncertainty associated with forecasted metal and PAH air concentrations.

In summary, while there is moderate uncertainty in certain information used to estimate health risks of air quality, there is reasonable certainty that the risks have not been underestimated because of the offsetting effect of the conservative assumptions employed.

F1.3.2.4 Monitoring

Although the impact level and environmental consequence is low for the linkage between air quality and human health, air quality remains a paramount issue that requires regular monitoring to ensure that: i) health risks remain low, and ii) comprehensive data exists to facilitate validation of the present findings. Therefore, ambient air monitoring and periodical personal air monitoring will be conducted to provide comprehensive baseline measurements of air quality at the communities examined in this assessment. The monitoring will address conventional air parameters and also characterize additional parameters including $PM_{2.5}$, and a suite of organic chemicals considered to be markers of the various emission sources. To achieve this, Suncor is currently an active member and provides leadership in the following programs:

- Wood Buffalo Environmental Association (WBEA): A multiparty group representing communities, industry and government established to address concerns about air quality in the Fort McMurray/Fort McKay region; and
- Alberta Oil Sands Community Exposure and Health Effects Assessment Program: A multiparty initiative involving community, industry and government participation in characterizing environmental exposure and effects associated with the oil sands industry.

F1.3.3 Key Question HH-3: What Impact will Consumption of Local Plants and Game Animals Exposed to Operational Water Releases and Air Emissions from Project Millennium have on Human Health?

F1.3.3.1 Analysis of Potential Linkages

Parts of certain local plants (e.g., berries, leaves and cattail/ratroot) are harvested and consumed on a regular basis by members of regional communities. Air emissions from the Project may deposit directly onto plant surfaces, or they may deposit onto soils and be taken up by plant roots. Stakeholders have expressed concern over the potential for uptake of the deposited air emissions by people who consume these local plants. For this reason, the potential for adverse effects to human health from ingestion of local plants was evaluated.

Linkage Between Project Activities, Changes in Plant Tissue Quality and Human Health

The linkage between oil sands activities and plant tissue quality was evaluated previously in the baseline assessment, Section F1.2.4. This linkage was neither validated nor invalidated, since there was no consistent subset of chemicals that were elevated within areas subject to oil sands air emissions. Nevertheless, the baseline risk assessment results indicated no unacceptable health risks to people who consume these plants. Although the data from the vegetation program did not show a definitive linkage between oil sands activities and plant tissue concentrations, there is some uncertainty associated with the small sample size and in choosing test areas on the basis of modelled air deposition zones. Additionally, it is plausible that under future conditions when Millennium is anticipated to be operational, air deposition onto plants may change.

In response to the above uncertainties and concerns articulated by stakeholders respecting air deposition of airborne chemicals onto vegetation, Suncor undertook a stack survey to collect information respecting particulate matter, organic chemicals and metals. Information from this study will be used to model the deposition of air contaminants onto vegetation and then interpret this in the context of potential exposure for humans consuming plants from this area. However, the results of the stack survey were not received in time to be incorporated into this section at the time of submission. The results are anticipated to be available in the near future.

In summary, due to this uncertainty, potential linkages between activities of Project Millennium, changes in plant tissue quality and human health were considered valid for further evaluation. The results of the stack survey and ramifications to human health will be available after the analysis is complete.

Linkage Between Project Activities, Changes in Game Meat Quality and Human Health

Since game animals (i.e., moose, snowshoe hare, ruffed grouse and ducks) form a significant portion of the diet of regional residents, the potential for adverse effects to human health from ingestion of game meat was raised as a concern by local residents. Game animals may be exposed to chemical emissions from the Project primarily through ingestion of water and plants, and air inhalation. As stated in the wildlife health assessment (Section D5.2), direct air inhalation is considered to be a minor exposure pathway for wildlife. However, air emissions from the Project may deposit directly onto plant surfaces, or they may deposit onto soils and be taken up by plant roots. Subsequent ingestion of these plants by herbivorous animals may lead to accumulation of chemicals in animal tissues.

Tissue concentrations in animals harvested near operating oil sands facilities were evaluated in the baseline section, F1.2.5. In general, tissue concentrations of metals in rodents in 1994 were less than those measured in 1987, suggesting that exposures have decreased despite the increase in production. This may be due to improvements in pollution control technology. Thus, the current data do not suggest that tissue concentrations in game animals will increase from present levels as a result of operation of Project Millennium. Results of the 1997 animal tissue sampling program conducted by Syncrude will provide insight as to whether this decreasing trend is continuing. However, results of the study were not available for inclusion in this assessment.

In summary, oil sands operations do not currently appear to contribute to increases in chemical concentrations in plants or animal tissues and therefore would not be likely to reach concentrations in game meat that would be associated with adverse human health effects. Limited field data of rodents and bison tissue residues supports this position. Hence, a linkage between changes in the tissue quality of game meat associated with the Project and human health was considered invalid.

F1.3.3.2 Analysis of Key Question

To investigate the linkage between air emissions, vegetation quality and human health, an analysis of baseline conditions was conducted, as reported in Sections F1.2.4 and F1.2.5. Also of further analysis is in progress, as described above, according to conceptual model HH-3 (Figure F1.3-3) and will integrate the results of the recently conducted Suncor stack survey. The results of this analysis will be available in the near future.

In the interim, the available information regarding plant consumption and relevance to human health is discussed in the context of baseline conditions (Section F1.2.4). That analysis indicated no unacceptable health risks to people who consume these plants.

F1.3.3.3 Residual Impact Classification and Environmental Consequence

Based on the results of the baseline risk assessment concerning vegetation and game meat quality and relevance to consumption of these food items, impacts to human health are not predicted to occur due air deposition of chemicals onto plants and soils as a result of the project. This is being examined further by the analyses currently in progress and described above. Therefore, notwithstanding the lack of demonstrated health risk, and in light of the analysis currently in progress, the magnitude of impact and resultant environmental consequence are rated as follows:

Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence
Negative	low	Local	Long-Term	Reversible	Moderate	Low

Impacts were classified using the information associated with baseline conditions of plant and game meat quality. However, conservative modifications were made to allow for uncertainties as an interim measure until the results of the stack survey allow predictive modelling of future air deposition during operation of Millennium. The direction of the impact is negative because of the plausibility that increased production could conceivably increase deposition onto plants thereby potentially increasing exposure (note: no consideration for improved air emission technology has been considered here). Although baseline ER values are less than one, the magnitude of impact has been classified as low (rather than negligible) in light of uncertainties pending completion of the stack survey analysis. The geographic extent is regional, pending results of the analysis of air deposition. The duration is considered long-term because the air emissions and potential changes in tissue residue may occur for greater than 30 years. The impact is reversible because i) air emission technology is continuously improving, ii) over time the deposited residues will attenuate in the environment following cessation of air emissions and iii) in the unlikely event that exposure via this pathway becomes a concern, it can be controlled through modification of food resource selection. On the basis of these classifications, the environmental consequence is low.

Certainty

The results of this analysis contain a moderate degree of uncertainty because the input information derives largely from baseline conditions, rather than predictive modelling of future conditions during operation. However, in light of this uncertainty, the classification of the impact has been conservatively modified to reflect this uncertainty; hence the magnitude of impact and environmental consequence has been elevated as an interim measure until results of the air deposition modelling are available.

F1.3.3.4 Monitoring

Suncor is a member of the Wood Buffalo Environmental Association (WBEA). The Environmental Effect Monitoring (EEM) Committee is planning to implement a 1998 study, which will involve sampling of plant tissue for analysis and interpretation respecting human health.

Additionally, on-going air monitoring under the operational phase will allow further validation of the rate of air deposition of chemicals onto plants.

Finally, continuation of monitoring of game meat quality will provide an additional data which can act as a sentinel of potential exposure chemicals to humans mediated by chemical uptake into plants due to air deposition.

F1.3.4 Key Question HH-4: What Impact will the Combined Exposure to Water, Air, Plants and Game Animals Have on Human Health During the Operational Phase of Project Millennium?

F1.3.4.1 Analysis of Potential Linkages

Stakeholders have expressed concerns over the combined exposure of local residents to chemicals from various media potentially affected by Project emissions. People living in the area may be exposed to chemicals from a number of sources, including water, fish, air, plants and game animals. The potential for adverse human health effects from each of these sources have been evaluated separately in key questions HH-1 to HH-3. No human health impacts were identified in these assessments. However, in light of the validity of individual linkages, a potential linkage exists between the combined exposure to these media and human health. For this reason, combined exposure was evaluated in the risk assessment.

F1.3.4.2 Analysis of Key Question

To calculate risk estimates for the combined exposure to all media, incremental risk estimates (ER values) for each media were summed, resulting in a total ER value for each chemical. Chemical screening for each media identified different chemicals. However, for the purposes of this linkage analysis and to ensure a conservative assessment of combined exposure, any chemical that was retained for one media was evaluated in all media where data were available. Although fish tissue quality was not identified as a concern for human consumption on its own, chemical contributions from ingestion of fish were integrated here to provide a more comprehensive estimate of exposure and health risk. ER values for the recreational water scenario were used, since these are more conservative than ER values for the swimming scenario. The same exposure parameters and pathways used in the previous linkage analyses also apply in the present case (Figures F1.3-1 to F1.3-3).

ER values are presented for each media and for all media combined in Table F1.3-6. It is important to that the contribution to the ER values by exposure through plant and game meat consumption is predicated on esitmates derived for the baseline condition becasue results of the air stack survey and associated deposition modelling were not completed in time for incorporation here (as discussed in under HH3). While there is some uncertainty associated with these muti-media risk estimates due to the lack of the predictive component vis-à-vis conditions during operations, the baseline data nevertheless provide good insight.

Table F1.3-6 indicates the magnitude of the non-carcninogenic risks are substantially less than one, and that an inordinate amount of air deposition onto plants would be required to increase the baseline exposure from plants and game to a level where the multi-media exposure becomes a concern.

Figure F1.3-3 HH-3: Conceptual Model for Local Plant and Game Animal Scenarios

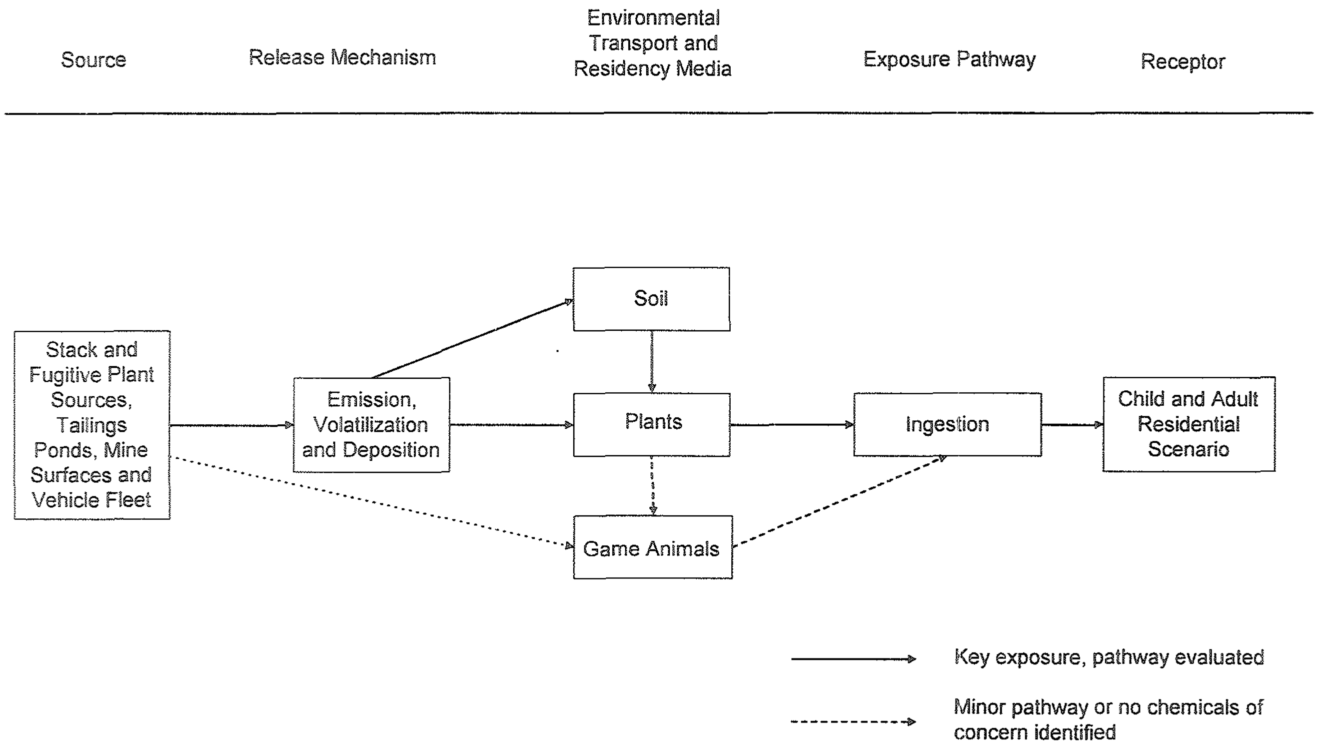


Table F1.3-6 Exposure Ratio Values for Children and Adults during Operation

Receptor/Chemical	Water [a]	Fish	Air[b]	Plants[c]	Meat[d]	All Sources
Child- Non-carcinogens [e]						
antimony	0.0005	nd	n/a	0.02	nd	0.02
barium	0.02	0.004	n/a	0.097	0.014	0.14
boron	0.28	nd	n/a	0.16	n/a	0.44
cadmium	0.036	nd	n/a	0.033	0.083	0.15
copper	0.0007	0.002	n/a	0.02	0.39	0.41
lead	0.0004	nd	n/a	0.047	nd	0.047
molybdenum	0.01	nd	n/a	0.011	nd	0.021
nickel	0.002	0.06	n/a	0.025	0.036	0.12
selenium	0.001	0.05	n/a	0.01	0.087	0.15
vanadium	0.015	nd	n/a	0.01	nd	0.025
C2-C8 Aliphatics[g]	n/a	n/a	0.0049	n/a	n/a	0.0049
C9-C12 Aliphatics[h]	n/a	n/a	0.051	n/a	n/a	0.051
C6-C8 Aromatics[i]	n/a	n/a	0.023	n/a	n/a	0.023
C9-C12 Aromatics[j]	n/a	n/a	0.017	n/a	n/a	0.017
Adult - Non-carcinogens[e]						
antimony	0.0002	nd	n/a	0.003	nd	0.0032
barium	0.007	0.002	n/a	0.094	0.0039	0.10
boron	0.09	nd	n/a	0.175	n/a	0.27
cadmium	0.01	nd	n/a	0.04	0.023	0.073
copper	0.0002	0.001	n/a	0.022	0.11	0.13
lead	0.00008	nd	n/a	0.022	nd	0.022
molybdenum	0.003	nd	n/a	0.01	nd	0.013
nickel	0.0006	0.03	n/a	0.022	0.01	0.063
selenium	0.0005	0.02	n/a	0.002	0.024	0.047
vanadium	0.005	nd	n/a	0.002	nd	0.007
C2-C8 Aliphatics[g]	n/a	n/a	0.0049	n/a	n/a	0.0049
C9-C12 Aliphatics[h]	n/a	n/a	0.051	n/a	n/a	0.051
C6-C8 Aromatics[i]	n/a	n/a	0.023	n/a	n/a	0.023
C9-C12 Aromatics[j]	n/a	n/a	0.017	n/a	n/a	0.017
Composite - Carcinogens[f]						
arsenic	2.0	nd	n/a	0.54[k]	nd	2.54
beryllium	3.2	nd	n/a	nd	nd	3.2
benzene	n/a	nd	0.036	n/a	n/a	0.036
PAH carcinogenic	0.01	nd	n/a	nd	nd	0.01
Total Carcinogens	**5.21**	**0**	**0.036**	**0.54**	**nd**	**5.79**

nd = not detected.
n/a = no data available or not applicable.
(a) ERs for water are the maximum predicted for the Athabasca River ot Shipyard Lake during the operation phase.
(b) ERs for air are the maximum predicted for residential air exposure in Fort McKay, the nearest community, during the operational phase
(c) ERs for plants are the predicted values for the sum of blueberry, Labrador tea and cattail root consumption estimates, as presented in the baseline assessment (Section F1.2.4)
(d) ERs for meat are the predicted values for bison meat and liver consumption, as presented in the baseline assessment (Section F1.2.5)
(e) ERs for child and adult residential receptors for non-carcinogenic chemicals.
(f) ERs for a composite receptor for carcinogenic chemicals.
(g) Includes all straight chain and cyclic alkanes/alkenes with carbon numbers ranging from 2 to 8.
(h) Includes all straight chain and cyclic alkanes/alkenes with carbon numbers ranging from 9 to 12.
(i) Includes all aromatic compounds except benzene with carbon numbers ranging from 6 to 8.
(j) Includes all aromatic compounds with carbon numbers ranging from 9 to 12.
(k) Based on the maximum concentration of arsenic measured in cattail root; not detected in other plant types.

For carcinogenic compounds, the lifetime cancer risk is essentially detemined by waterborne arsenic and beryllium which collectively account for an ER of 5.21, and this is considered to be a marginal in light of the conservativatism employed and consistent with background concentrations.

Finally, with respect to the potential for chemical interactions, the following points are offered:

- It is not scientifically defensible to simply sum all the individual metal-related ERs because they do not all have the same effect or act in the same way. Nevertheless, if the exercise is carried out for either the child or adult, the sum of the ERs for metals remains less than 1, suggesting that even if they were additive in nature the exposure would not be adverse.

- Potential synergistic, or antagonistic, chemical interactions cannot be entirely ruled out. However, with the exception of barium, the metal ERs are typically one to two orders of magnitude less than 1, in spite of the conservative factors employed. Further, each toxicity reference value has a substantive conservative uncertainty factor associated with it (e.g., 100 to 1000 fold) making it highly unlikely that a synergistic effect would be significant. If antagonistic interaction occurred, this would simply reduce the risks of health effects further. The same concept applies for organic substances in light of their low ER values. Refer to Section F1.1.4.3, Toxicity Assessment, for a more detailed discussion of the toxicity of mixtures.

  For non-carcinogenic chemicals all ER values are less than one. Therefore, based on the results of the multimedia assessment presented here, non-carcinogenic substances do not present unacceptable health risks to people who live in the area and may experience all the exposure pathways described.

  For carcinogenic substances, the estimated ER value is 5.79. This value marginally exceeds the reference value of one and is considered negligible in light of the conservative assumptions employed. In addition, it is noted that virtually all of the estimated risk is due to background concentrations or arsenic and beryllium.

  Finally, consideration of PAHs and metals has been incorporated in this analysis in the context of water, plants, fish and game meat. However, their contribution from the particulate fraction of future air quality requires further resolution following completion of the Suncor stack survey analysis, previously discussed. This will be available following completion of the stack survey and dispersion modeling analysis.

F1.3.4.3 Residual Impact Classification and Environmental Consequence

In light of the results foregoing discussion, recognition of toxicity data lacking for assessment of naphthenic acids, and the preference for predictive air modelling based on the recent stack survey (currently in progress), the magnitude of impact and environmental consequence are summarized as follows:

Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence
Negative	Low	Regional	Long-Term	Reversible	Moderate	Low

Impacts were classified according to the information presented in Section A2, Table A2-8. The direction of the impact is negative, because some chemical concentrations will increase as a result of the Project. The magnitude of impact is low, because the ER values for all sources combined are less than or marginally greater than one and surrogate data previously discussed for air, together with limited data for naphthenic acids, do not suggest otherwise. The geographic extent is regional, since exposures may occur outside the LSA. The duration is long-term, since exposures may occur for greater than 30 years. The impact is reversible, since further information will be available in the near future, and mitigation options will be considered if necessary to reduce exposures. On the basis of these classifications, the environmental consequence is low.

Certainty

In addition to the conservative assumptions described under each of the preceding key questions, the assessment of combined exposures was also exceptionally conservative in that it assumed people would be exposed to maximum measured or estimated chemical concentrations in all media at the same time, an unlikely scenario. In predicting the magnitude of the impact, there is a reasonable degree of confidence that the high degree of conservatism offsets the undertainty arising from the limited information available for naphthenic acids and airborne PAHs and metals, pending the analyses that are in progress (previously noted). The reader is also referred to discussions of certainty associated with the analyses of previous key questions, as they are applicable here.

F1.3.4.4 Monitoring

Monitoring as previously noted for the individual linkages will provide appropriate data for integration in the context of this multimedia assessment. Similarly, further characterization of the chronic toxicity of naphthenic acids, as previously noted, applies here.

F1.3.5 Key Question HH-5: What Impact Will the Release of Chemicals in Soils, Plants and Waters of the Project Millennium Reclaimed Landscapes Have on Human Health?

Key question HH-5 is evaluated in two parts. Part A evaluates the potential for adverse effects to human health as a result of recreational exposure (e.g., swimming, boating, fishing) to chemical concentrations predicted for surface waters of Shipyard Lake, Athabasca River and the end pit lake (EPL) at closure and in the far future. The approach used for Part A mirrors that used for key question HH-1, which focused on surface waters during the operational phase. Part B involves evaluation of the potential for adverse human health effects as a result of residential exposures to chemicals on the reclaimed landscape by hunters/trappers, including exposure to the aforementioned water bodies, as well as exposure to soils, plants and game meat. As such, Part B is a multi-media assessment of exposures on the reclaimed landscape in the far future.

F1.3.5.1 Part A: Impacts of Water Quality at Closure and in the Far Future on Human Health

Analysis of Linkages

Predicted water concentrations in Shipyard Lake, Athabasca River and the end pit lake at closure and in the far future were evaluated with respect to human health. Where predicted future chemical concentrations in the Athabasca River as a result of Project Millennium were equal to predicted baseline concentrations and no unacceptable human health risks were predicted for these chemicals in the baseline risk assessment (Section F1.2.3), they were excluded from further evaluation in this section.

The results of chemical screening identified the following chemicals for further evaluation in the risk assessment:

- benzo(a)anthracene (end pit lake);
- benzo(a)pyrene (end pit lake);
- antimony (end pit lake);
- arsenic (Shipyard Lake, end pit lake);
- barium (end pit lake);
- beryllium (Shipyard Lake, end pit lake);
- boron (Shipyard Lake, end pit lake);
- lead (end pit lake);
- molybdenum (end pit lake);
- strontium (end pit lake); and

- vanadium (end pit lake).

In addition, no screening criteria were available for naphthenic acids and therefore this group of chemicals was retained for further evaluation. Screening tables are presented in Appendix VI.1.3 (data for operation, closure and far future are presented on the same screening tables). No chemicals were identified as being of potential concern in the Athabasca River, with the exception of naphthenic acids due to the aforementioned uncertainty.

Since chemicals, receptors and exposure pathways have been identified, a potential linkage exists between water quality changes and human health.

Analysis of Key Question (Part A)

The approach for Part A mirrors that used for assessment of water quality during operation in key question HH-1, Section F1.3.1 (refer to conceptual model in Figure F1.3-1). In the exposure assessment, it was conservatively assumed that humans would be exposed through ingestion of drinking water and through dermal contact and incidental ingestion of water while swimming. People were assumed to swim in Shipyard Lake and/or the EPL two days per week for two months during the summer (i.e., 16 times per year). Children and adults were assumed to spend 2.5 h and 1 h, respectively, in the water per event. For the recreational exposure scenario, people were assumed to drink from these water bodies two days per week, year round. It was also assumed that recreational users would occasionally swim in these water bodies. Therefore, exposures for recreational receptors include both drinking water and occasional swimming exposure. ER values for recreational and swimming exposures at closure and in the far future are presented in Tables F1.3-7 and F1.3-8.

ER values are less than 1 for swimming and recreational exposures to Shipyard Lake water. Therefore, no impacts to human health are predicted for exposures to Shipyard Lake water at closure and in the far future.

With respect to the EPL, ER values are less than 1 for swimming exposure, suggesting that swimming exposures do not pose an unacceptable health risk. However, ERs for boron, molybdenum, arsenic and beryllium for recreational exposure exceed the critical ER of 1 for the child or composite receptor at closure. Thus, while chemical concentrations in the EPL in the far future decrease to within acceptable limits for the protection of human health, there may be a period of time following closure that EPL water might not be suitable for consumption by humans. The site will be in a transition phase from site closure until the far future when the site ecosystems have matured. Therefore, it is unlikely that the landscape surrounding the EPL will be suitable for habitation by hunter/trappers or for habitation by hunter/trappers or for recreational activities during this time, thereby limiting exposure potential until the far future, when concentrations

Table F1.3-7 Exposure Ratios for Swimming Exposure at Closure and in the Far Future

Chemical/ Receptor	Shipyard Lake (2030-2044)	Shipyard Lake (Far Future)	End Pit Lake (2044-2052)	End Pit Lake (Far Future)
Child - Non-carcinogens				
antimony	(a)	(a)	0.001	0.0001
barium	(a)	(a)	0.0008	0.0004
boron	0.007	0.005	0.06	0.01
lead	(a)	(a)	0.001	0.0001
molybdenum	(a)	(a)	0.07	0.01
strontium	(a)	(a)	0.001	0.0002
vanadium	(a)	(a)	0.006	0.0009
Adult - Non-carcinogens				
antimony	(a)	(a)	0.0001	0.00001
barium	(a)	(a)	0.00007	0.00003
boron	0.0006	0.0005	0.0005	0.001
lead	(a)	(a)	0.00004	0.000006
molybdenum	(a)	(a)	0.006	0.0008
strontium	(a)	(a)	0.00008	0.00002
vanadium	(a)	(a)	0.0005	0.00007
Composite - Carcinogens				
arsenic	0.02	0.02	0.07	0.02
beryllium	0.04	0.04	0.14	0.02
benzo(a)anthracene	(a)	(a)	0.12	4.8E-15
benzo(a)pyrene	(a)	(a)	0.43	3.2E-18
Total Carcinogens	**0.06**	**0.06**	**0.76**	**0.04**

(a) These chemicals were not evaluated since they were not identified in the chemical screening step as requiring further evaluation for Shipyard Lake.

are much lower. Due to the uncertainty associated with predictions of EPL water quality, the conservativism of the assessment, the marginal nature of the ER exceedences, and the probable limited use of the EPL as a water source by hunters/trappers and recreationalists until the far future, the magnitude of the potential impact is not considered to be high at this time. Monitoring of EPL water quality following closure should be conducted to verify predicted water concentrations and to enable informed decisions about whether to limit human access to the EPL.

F1.3.5.2 Part B: Impacts of Chemical Exposures From the Reclaimed Landscape on Human Health

Analysis of Potential Linkages

For some period of time following closure of the Project, the site will be in a state of transition (i.e., settling of CT deposits and capping materials, planting of vegetation), such that it will not be suitable for occupation by hunters/trappers or for foraging by wildlife species that hunters/trappers may consume. However, in the far future following reclamation of the site, hunters and trappers may occupy the reclaimed landscape for extended periods of time. Under this scenario, they may be exposed to chemicals through ingestion of water, fish, plants and game meat, and air inhalation.

Table F1.3-8 Exposure Ratios for Recreational Exposure at Closure and in the Far Future

Chemical/ Receptor	Shipyard Lake (2030-2044)	Shipyard Lake (Far Future)	End Pit Lake (2044-2052)	End Pit Lake (Far Future)
Child - Non-carcinogens				
antimony	(a)	(a)	0.04	0.005
barium	(a)	(a)	0.03	0.01
boron	0.26	0.2	2.2	0.46
lead	(a)	(a)	0.05	0.007
molybdenum	(a)	(a)	2.5	0.34
strontium	(a)	(a)	0.03	0.009
vanadium	(a)	(a)	0.22	0.03
Adult - Non-carcinogens				
antimony	(a)	(a)	0.01	0.002
barium	(a)	(a)	0.01	0.004
boron	0.09	0.07	0.76	0.16
lead	(a)	(a)	0.009	0.001
molybdenum	(a)	(a)	0.87	0.12
strontium	(a)	(a)	0.012	0.003
vanadium	(a)	(a)	0.08	0.01
Composite - Carcinogens				
arsenic	1.3	1.2	5.0	1.2
beryllium	2.8	2.5	10.3	1.6
benzo(a)anthracene	(a)	(a)	0.17	6.8E-15
benzo(a)pyrene	(a)	(a)	0.55	4.1E-18
Total Carcinogens	**4.1**	**3.7**	**16.02**	**2.8**

(a) These chemicals were not evaluated since they were not identified in the chemical screening step as requiring further evaluation for Shipyard Lake.

Linkage Between Changes in Water Quality and Human Health

Potential sources of drinking water associated with the reclaimed landscape include groundwater, wetlands surface water, snow, the end pit lake and nearby waterbodies, such as the Athabasca River and Shipyard Lake. Groundwater derived from the site was excluded as a source of drinking water since the high salinity of natural, regional groundwaters would likely deter potential users. Wetlands are expected to be intermittently dry and stagnant and would not offer good quality water considering the potential for anoxia, warm temperatures and naturally occurring pathogens. Snow is a potential source of drinking water during the winter. It was assumed that the primary source of drinking water would be from the Athabasca River, since it offers a constant and accessible source of water near the reclaimed landscape. Hunters and trappers may also occasionally swim or bathe in the Athabasca River. Chemical concentrations in the Athabasca River are higher than those predicted for Shipyard Lake as a result of elevated background levels, despite the fact that contributions from the Project to the Athabasca River are lower than contributions to Shipyard Lake. Therefore, use of the Athabasca River as a drinking water source is more conservative than using Shipyard Lake. Users of the reclaimed landscape may also potentially drink water from or swim in the EPL. Therefore this water source was also evaluated.

The following chemicals were identified for further evaluation with respect to exposures to Athabasca River or EPL water (as identified in chemical screenings for baseline water quality and future predictions for far future water quality as a result of additional inputs from Project Millennium; Sections F1.2.3 and Part A of this section):

- arsenic;
- benzo(a)pyrene;
- benzo(a)anthracene;
- beryllium;
- cadmium; and
- vanadium.

Hunters and trappers may become exposed to these chemicals via ingestion of drinking water and/or dermal absorption while swimming/bathing. Children are not expected to live in remote locations on the reclaimed landscape (due to educational and social requirements) and, therefore are unlikely to be exposed to Athabasca River water, except during occasional recreational activities, which have been evaluated previously in Part A.

Since elevated chemical concentrations, receptors and exposure pathways may co-exist, a potential linkage exists between water quality changes and human health following closure.

Linkage Between Changes in Fish Quality and Human Health

The validity of the linkage between changes in fish quality and human health was discussed previously for key question HH-1 in Section F1.3.1. This linkage was determined to be invalid, since Project-related chemicals were not elevated in fish tissue; however monitoring of fish tissue residues was recommended for future validation.

Linkage Between Changes in Air Quality and Human Health

Following closure of Project Millennium, there will be no air emissions from extraction, utilities and upgrading operations, or vehicles. In addition, disturbed areas of the site will be capped with a layer of reconstructed soils, reducing the potential for volatile air releases. CT deposits will be capped with lean CT and sand to a depth of 5 to 10 m, followed by a surface layer of reconstructed soils. Although there is some potential for release of volatile chemicals through the capping layer and into the air above CT deposits, these releases are likely to be minimal and will decrease over time as the CT consolidates. In the far future, when people are likely to frequent the reclaimed landscape, volatilization is expected to be negligible. Therefore, this linkage is considered to be invalid for the reclaimed landscape in the far future.

Linkage Between Changes in Soil Quality and Human Health

It is unlikely that people will be directly exposed to CT, because these deposits will be buried beneath 5 to 10 m of sand, muskeg and vegetation. Soil concentrations to which people may be exposed are anticipated to be comparable to natural background levels; hence incidental ingestion of soils will not be a significant source of Project related chemicals. For this reason, a linkage between soil quality and human health was considered invalid.

Linkage Between Changes in Plant Quality and Human Health

Hunters and trappers living on the reclaimed landscape may harvest local plants for food. Some of these plants may be growing on top of capped CT deposits. At equilibrium, the CT will be consolidated below 5 to 10 m of lean CT and sand and a surface layer (i.e., 20 cm) of muskeg. Therefore, plant roots may extend into the sand layer overlying the CT deposit, but would be unlikely to extend into the CT deposit itself.

Xu (1997) measured uptake of metals into the leaves, stems and roots of poplar, willow and reed canary grass from reclamation materials of various composition. For the purpose of this key question, metal concentrations in plants growing on CT, capped with 20 cm of tailings sand and 5 cm of muskeg, were used as conservative estimates of the potential concentrations of plants on the Project Millennium reclaimed landscape. The geometric mean of these data were used for chemical screening and exposure modelling of inorganic chemicals. Since no measured data were available for PAHs in plants growing on reclaimed landscapes, plant tissue concentrations were estimated based on the chemistry of tailings sand and bioconcentration factors (BCF) for plant uptake (Travis and Arms 1988), according to the following equation:

plant concentration = BCF x tailing sand concentration

A chemical screening process was conducted to determine whether the measured and/or predicted plant concentrations may exceed RBCs for plant consumption by humans. Screening tables are presented in Appendix VI.1.3. The following six chemicals were identified for further evaluation in the risk assessment:

- arsenic;
- barium;
- beryllium;
- boron;
- cadmium; and
- vanadium.

Since elevated chemical concentrations, receptors and exposure pathways may co-exist, a potential linkage exists between plant quality changes and human health following closure.

Linkage Between Changes in Game Meat Quality and Human Health

Hunters and trappers may hunt and trap animals from the reclaimed landscape. Mammals and birds exposed to the reclamation deposits may accumulate certain chemicals, thus providing an exposure pathway for people who eat wild game. For this reason, the potential linkage between game meat quality and human health was evaluated.

Limited tissue data are available from bison pastured on tailings sand (Pauls et al. 1995), as well as ducks exposed to CT release water within wetlands (EVS 1996). Results of chemical screening of these data (presented in detail in Appendix VI.1.3) indicated the following five chemicals for further evaluation in the risk assessment:

- cadmium;
- chromium;
- copper;
- molybdenum; and
- selenium.

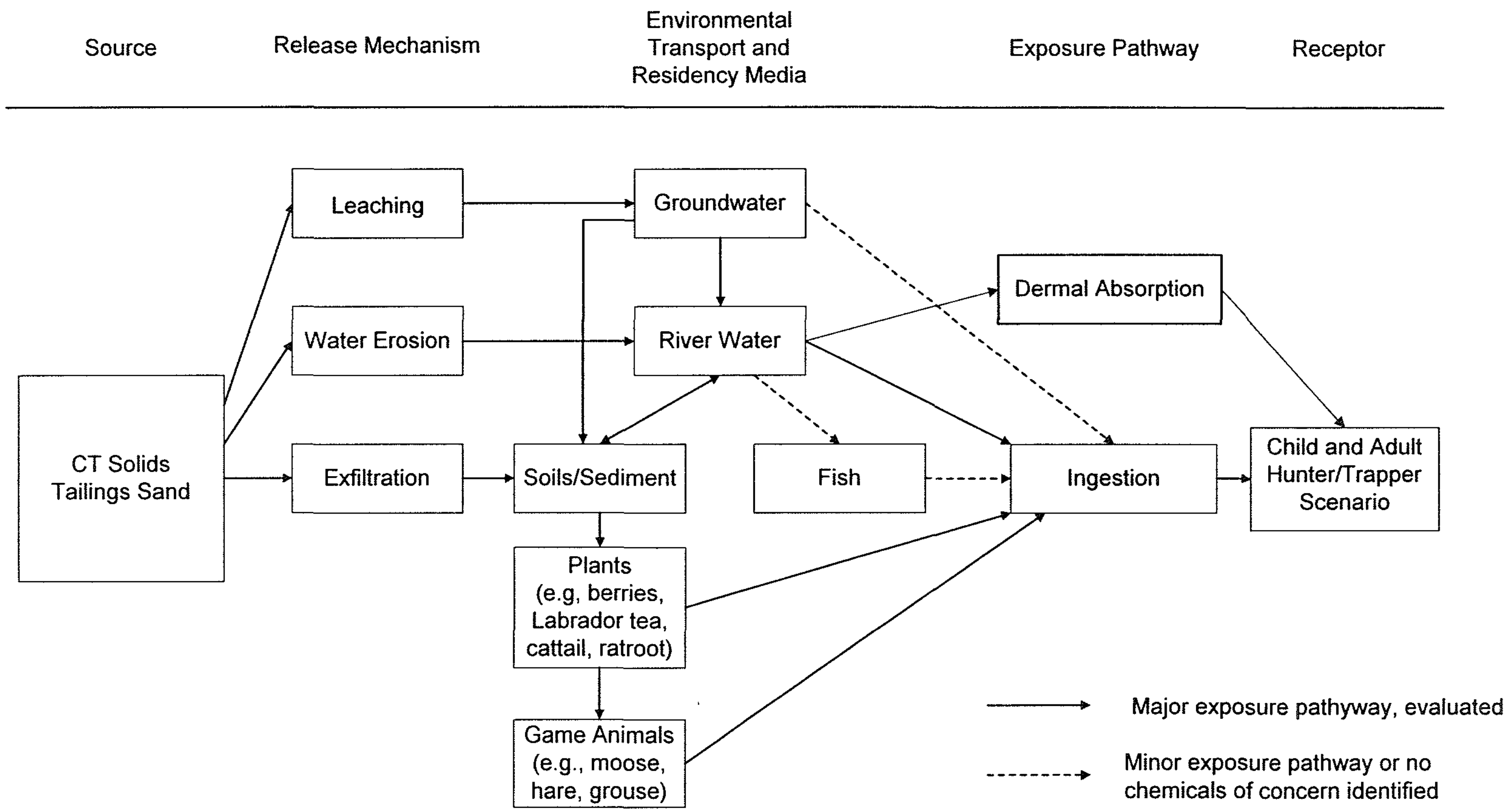
Since elevated chemical concentrations, receptors and exposure pathways may co-exist, a linkage exists between potential changes in game meat quality and human health following closure.

Analysis of Key Question (Part B)

Several chemicals were identified for further evaluation in the risk assessment, based on chemical screening of measured or predicted concentrations in water, plants and game meat. For the purposes of this linkage analysis, any chemical that was retained for one media was evaluated in all media (i.e., water, plants and game meat), where data were available, to achieve a more comprehensive assessment of combined exposure arising from the reclaimed landscape. A quantitative human health risk assessment was conducted for conceptual model HH-5 (Figure F1.3-4) according to the method described in Section F1.1.4.3. Key aspects of the risk assessment are presented here; additional details are presented in Appendix VI.

It was assumed that a hypothetical hunter/trapper would reside on the reclaimed site throughout the year, obtaining a portion of his food (both meat and plants) directly from the site and all drinking water from the Athabasca River or the EPL. This is likely to be a conservative assumption

Figure F1.3-4 HH-5: Conceptual Model for the Reclaimed Landscape Scenario



given the probable seasonal nature of hunting and trapping activities. In addition, it was assumed that children of hunters/trappers would be exposed through consumption of game meat and plants, which were harvested from the reclaimed landscape and brought back to the family.

For carcinogenic chemicals (e.g., benzo[a]pyrene, benzo[a]anthracene, arsenic and beryllium), a composite receptor was evaluated from birth to 70 years of age. This hypothetical composite receptor was assumed to consume plants and game meat from the reclaimed landscape during childhood and become a hunter/trapper at 20 years of age, with exposures to water, plants and game animals from the reclaimed landscape.

It was assumed that game meat would be consumed by hunters/trappers and their families every day of year for their entire lifespan. The fraction of meat that was assumed to be derived from and affected by the reclaimed landscape was 25%. This value was selected based on the following considerations:

- some meat consumed over the course of the year may be derived from outside the region (e.g., retail purchased meat);
- it is unlikely that many of the game animals will live and obtain all food from within the reclaimed area; and
- it is unlikely that on-site residents will obtain a large portion of their food from the relatively small area of the reclaimed site.

Chemical concentrations assumed for meat were based on concentrations measured in the muscle and liver of a wood bison that grazed in a pasture in a reclaimed tailing sands area (previously described in Section F1.2.5). Muscle tissue represents the largest source of edible meat from a bison and therefore was assumed to account for 90% of daily game meat consumption, with the remaining 10% consisting of liver. Several chemicals were not detected in bison tissue and were thus set at zero for multimedia exposure modelling.

It was assumed that local plants would only be available for harvest on a seasonal basis (i.e., 3 months per year) and that plants grown on the reclaimed landscape would account for 10% of the fruit and vegetable component of the diet of hunters/trappers and their families. As discussed previously, metal concentrations in plants were estimated from measured concentrations in plants growing on CT, capped with sand and muskeg (Xu 1997), while PAH concentrations were estimated from chemical concentrations in tailings sand and bioconcentration factors for plant uptake.

Drinking water was assumed to be derived from the Athabasca River, since it offers a hunter/trapper a constant and accessible source of water near the reclaimed landscape. The EPL was evaluated as an alternative drinking water source. Children were assumed to have no exposure to Athabasca River or EPL water, since they would not live on-site with hunters/trappers.

ER values for the hypothetical adult hunter/trapper, child and composite receptor are presented in Table F1.3-9. Further details of daily intake rates are provided in Appendix VI.6.2. ERs for plant and meat exposures to adults and children for non-carcinogenic chemicals were less than 1, with the exception of boron, which marginally exceeds 1 for the child. Given the protective exposure assumptions and inherent margins of safety built into the acceptable exposure rate for boron, this marginal exceedance is interpreted to be without adverse consequences.

Table F1.3-9 Exposure Ratios for Multi-Media Exposures on the Reclaimed Landscape

Receptor/Chemical	ERs for Plant and Meat Exposures	ERs for Plant, Meat and Athabasca River Water Exposures	ERs for Plant, Meat and EPL Water Exposures
Child - Non-carcinogens			
barium	0.17	n/a	n/a
boron	1.75	n/a	n/a
cadmium	0.31	n/a	n/a
chromium	0.21	n/a	n/a
copper	0.19	n/a	n/a
lead	0.04	n/a	n/a
molybdenum	0.29	n/a	n/a
selenium	0.11	n/a	n/a
strontium	0.04	n/a	n/a
vanadium	0.15	n/a	n/a
Adult - Non-carcinogens			
barium	0.05	0.07	0.06
boron	0.45	0.8	1.0
cadmium	0.09	0.13	0.12
chromium	0.07	0.08	0.07
copper	0.07	0.07	0.07
lead	0.01	0.01	0.02
molybdenum	0.1	0.11	0.51
selenium	0.04	0.04	0.04
strontium	0.01	0.02	0.02
vanadium	0.04	0.05	0.07
Composite - Carcinogens			
arsenic	2.0	4.6	4.6
beryllium	1.8	8.4	5.2
benzo[a]anthracene	0.14	0.15	0.14
benzo[a]pyrene	0.29	0.29	0.29
Total Carcinogens	**4.23**	**13.44**	**10.23**

n/a = not applicable, since children are assumed to be exposed only through consumption of plants and meat brought home by their hunter/trapper parents; they are assumed not to be exposed to Athabasca River or EPL water as a primary drinking water source

Hunters and trappers living on the reclaimed landscape may also be exposed to water from the Athabasca River, Shipyard Lake or the EPL as their primary drinking water source. Total ERs for consumption of plants, meat and Athabasca River or EPL water by the adult hunter/trapper are provided in Table F1.3-9. Since water concentrations are lower in Shipyard Lake for these chemicals, ERs for Shipyard Lake would be less than those reported for the Athabasca River. In general, for non-carcinogenic chemicals, exposure to water from all waterbodies does not significantly increase risk estimates, and all ER values are equal to or less than 1. Thus, for non-carcinogenic chemicals, exposures on the reclaimed landscape (including water ingestion) are considered to be acceptable.

With respect to carcinogenic chemicals, ER values for arsenic and beryllium are marginally greater than 1 for plant and meat exposures to the composite receptor. ER values for these chemicals are increased when drinking water exposures from either the Athabasca River or the EPL are included in the multimedia exposures, such that the total carcinogenic ER values are greater than 10. As discussed in the baseline assessment (Section F1.2.3), arsenic and beryllium are naturally elevated in the Athabasca River and concentrations are not predicted to increase as a result of Project-related releases. These naturally elevated water concentrations account for approximately 70% of the total carcinogenic risk for exposures on the reclaimed landscape when Athabasca water is the primary source of drinking water. Thus, although ER values greater than 10 would suggest a moderate magnitude of impact, the impact is considered to be low since the majority of the predicted risk consists of exposure to naturally elevated arsenic and beryllium concentrations, which are not predicted to be increased in the Athabasca River as a result of the Project. With respect to the EPL, the predicted concentrations of arsenic, benzo(a)pyrene and benzo(a)anthracene in far future are equivalent to that found under baseline (i.e., current) conditions for the Athabasca River, while the predicted concentration of beryllium is lower in the EPL, compared to baseline Athabasca River water. Water quality modelling predictions therefore suggest that drinking water from the EPL in the far future is no worse than drinking water from the Athabasca River today. Monitoring of water quality of the EPL following closure is recommended to validate modelled chemical concentrations.

F1.3.5.3 Summary of Potential Impacts at Closure and in the Far Future

The results of Parts A and B of this key question are summarized in Table F1.3-10. This table only shows the ER values for carcinogenic chemicals predicted for recreational and multi-media exposures to water from the Athabasca River and the EPL. ER values for non-carcinogenic chemicals are not tabulated as they are virtually all less than 1. The sum ER values for total carcinogens based on recreational exposures to Athabasca River water at closure and in the far future exceed the critical ER value of 1, but are less than 10, and therefore, given the conservative assumptions, are considered to be marginal risks with low concern, as defined in Section F1.1.4.4. Note that sum ER values for Shipyard Lake (Table F1.3-8) are lower than those reported for the Athabasca River and therefore the same conclusions apply for Shipyard Lake. As discussed in the previous section, multi-media exposures on the reclaimed landscape which include Athabasca River water consumption may result in ER values greater than 10. However, 70% of the

Table F1.3-10 Exposure Ratios for Exposures to Athabasca River and End Pit Lake Water at Closure and in the Far Future

Chemicals	ERs for Athabasca River Exposures			ERs for End Pit Lake Exposures		
	Closure Recreational[a]	Far Future Recreational[a]	Far Future Multi-Media	Closure Recreational	Far Future Recreational	Far Future Multi-Media
arsenic	1.7	1.6	4.6	5.0	1.2	4.6
beryllium	3.2	3.2	8.4	10.3	1.6	5.2
benzo(a)anthracene	0.008	0.008	0.15	0.17	6.8E-15	0.14
benzo(a)pyrene	0.03	0.01	0.29	0.55	4.1E-18	0.29
Total Carcinogens	**4.9**	**4.8**	**13.44**	**16.02**	**2.8**	**10.23**

[a] Results reported for the baseline assessment (Section F1.2.3); predicted concentrations for the Project scenario are unchanged from baseline predictions for these chemicals.

total carcinogenic risk consists of exposure to naturally evaluated concentrations of arsenic and beryllium, which are not predicted to be increased in the Athabasca River as a result of the Project.

With respect to the EPL, the sum ER value for total carcinogens based on recreational exposures at closure is greater than 10, but less than 20, suggesting a potentially moderate risk to recreational users during a period of time between closure and the far future. Since the site will be in a transition phase from closure until the land is fully reclaimed, human use of the EPL for recreation during this time is not anticipated. In the far future, the sum ER value for EPL recreational exposure decreases to less than 10, suggesting only a marginal risk for recreational users in the far future. ERs for multi-media exposures on the reclaimed landscape in the far future equal 10, suggesting a moderate risk to hunters/trappers who live on the reclaimed landscape and drink EPL water as their primary drinking water source. It should be noted that the multi-media ERs were calculated assuming a hunter/trapper would live on the Project Millennium reclaimed landscape every day of the year for 50 years, and drink all water from the EPL. This is a highly unrealistic scenario and extremely conservative, since hunters/trappers are unlikely to take up permanent residence on the reclaimed landscape, but rather would use the area on a seasonal basis. Therefore, ER values are likely to be overestimated in this assessment. For example, if a hunter/trapper were exposed to chemicals from the reclaimed landscape for only 6 months of the year for 50 years, ER values would be one half of those reported in Table F1.3-10 and, therefore would indicate marginal risks for EPL exposures, rather than potentially moderate risks. It should also be noted that predicted EPL concentrations of arsenic and beryllium are equal to or less than present levels of these substances in the Athabasca River. Therefore, the resulting total carcinogenic ER for multi-media exposure including the EPL is not significantly different from that predicted for multi-media exposures including Athabasca River water. Nevertheless, monitoring of EPL water quality should be conducted to verify predicted water concentrations and to enable informed decisions about whether to limit access to the EPL at closure if concentrations are found to be unacceptable for human consumption.

F1.3.5.4 Residual Impact Classification and Environmental Consequence

Impacts were classified according to the information presented in Section A2, Table A2-8. Two impact classifications are provided for this key question which discriminate between the Athabasca River, Shipyard Lake and the EPL as sources of drinking water.

Human health impacts due to recreational exposures to water from the Athabasca River and Shipyard Lake at closure and far future are considered to be negligible. Similarly, consumption of plants, meat and water (Athabasca or EPL) on reclaimed landscapes (i.e., far future) by hunter/trappers and their children is also considered to be a negligible human health impact for non-carcinogenic chemicals. For carcinogenic chemicals, low residual impacts have been identified when either Athabasca River or EPL water is consumed as the regular drinking water source in the far future. Thus, the magnitude of impact for exposures to the reclaimed landscape in the far future has been classified as low. The geographic extent is local, since impacts are restricted to the reclaimed landscape of the LSA. The duration is long-term, since exposures may occur for greater than 30 years. The impact is reversible, since future mitigation may reduce or eliminate exposures. The frequency is moderate, since exposures are likely to occur intermittently. On the basis of these classifications, the environmental consequence is low.

At closure (i.e., 2043), a moderate impact has been identified for recreational exposures to the EPL. The geographic extent is local, since the impact is restricted to the reclaimed landscape of the LSA. The duration is medium-term, since these high exposures may only occur for a short period of time after closure until the site is fully reclaimed. The impact is reversible, since future mitigation may reduce or eliminate exposures. The frequency is moderate, since exposures are likely to occur intermittently. On the basis of these classifications, the environmental consequence is moderate. However, the likelihood of occurrence of this impact is low, since the site will be in a transition phase from closure until the land is fully reclaimed and human use of the EPL for recreation during this time is not anticipated. Furthermore, the potential impact is easily eliminated by preventing access until concentrations are acceptable for human consumption. Therefore, this impact, although moderate in environmental consequence, is not considered to be significant.

Drinking Water Source	Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence
Athabasca River, Shipyard Lake or EPL in far future	Negative	Low	Local	Long-Term	Reversible	Moderate	Low
EPL at Closure (2043)	Negative	Moderate	Local	Medium-Term	Reversible	Moderate	Moderate

Certainty

The assessment of potential impacts to users of the reclaimed landscape was based on a number of conservative assumptions, including the following:

- reasonable maximum measured or predicted concentrations in water, and game meat were used (geometric means of measured data were used for plant concentrations);
- daily ingestion estimates for local foods represent reasonable maximum exposure values for the residents of communities evaluated;
- hunters/trappers were assumed to bring both local plants and game meat home to feed their children;
- combined exposure to water, local plants and game animals was considered; and
- toxicity reference values were set to be protective of sensitive members of the population (i.e., seniors) under chronic exposure conditions.

Due to the conservatism involved in the risk assessment for users of the reclaimed landscape, it is very unlikely that potential risks have been underestimated. However, some uncertainty exists with respect to the following:

- limited data for uptake of chemicals into plants growing on capped CT deposits;
- use of bioconcentration factors for uptake of PAHs into plants grown in reclamation materials due to limited available measured data;
- lack of a toxicity reference value for naphthenic acids;
- possible interactions of chemical mixtures; and
- uncertainties inherent to predictive water quality modelling (refer to Section C3).

As noted in Sections F1.1.4.3, Toxicity Assessment, it is unlikely that interactions of chemical mixtures will affect the conclusions presented above.

In summary, while there is moderate uncertainty in certain information used to estimate risks, there is reasonable certainty that the risks have not been underestimated because of the offsetting effects of the conservative assumptions employed.

F1.3.5.5 Monitoring

There remains some uncertainty associated with uptake of chemicals by plants growing in reclamation materials and the distribution of chemical concentrations in reclamation soils. Suncor is currently conducting a CT study to reduce some of this uncertainty. Refer to Section E of Volume 1 for more details.

As discussed previously, further study has been initiated by Suncor to address the chronic toxicity of naphthenic acids. Refer to Section F1.1.4.3, Toxicity Assessment, for further details.

Finally, monitoring of EPL water quality is recommended to verify predicted chemical concentrations and to enable informed decisions about whether to limit human access if concentrations are found to be unacceptable for human consumption.

F1.4 HUMAN HEALTH CUMULATIVE EFFECTS ASSESSMENT

This cumulative effects assessment (CEA) predicts the effects of Project Millennium plus existing, approved and planned developments (i.e., the cumulative scenario) on human health within the Regional Study Area (RSA). The following developments, as discussed previously in Section A2 are included in the CEA:

- Suncor Lease 86/17
- Suncor Steepbank Mine and Fixed Plant Expansion
- Syncrude Mildred Lake
- Syncrude Mildred Lake Debottlenecking Phase 1/2
- Syncrude Aurora Mines
- SOLV-EX
- Northstar Energy
- Suncor Project Millennium - Mine Expansion and Upgrader
- Muskeg River Mine Project
- Shell Lease 13 East Mine
- Mobil Kearl Oil Sands Mine and Upgrader
- Petro-Canada MacKay River
- JACOS Hangingstone In-situ
- Gulf Surmont In-situ
- Syncrude Project 21 Mildred Lake Upgrader Expansion
- Fee Lot 2 Development, including Novagas Natural Gas Liquids Plant
- Forestry
- Municipalities
- Pipelines/roadways/others
- Municipal Growth

The human health CEA evaluates the following key question:

CHH-1: What impacts to human health will result from chemical exposure related to Project Millennium and the combined developments?

The approach used to assess potential cumulative impacts on human health was consistent with that described in Section F1.1.4. Quantitative data were available to assess water quality and some aspects of air quality; however, due to uncertainty surrounding future developments that have been approved and planned, assessment of other cumulative effects was restricted to a more qualitative nature.

Among the cumulative effects issues is the increasing urbanization of the area (i.e., the expected increase in the population of Fort McMurray). The expected increase in urbanization is a result of all regional developments, and therefore has been targeted as an issue to be addressed by an industry/RMWB committee. While it is possible that increased urbanization may contribute to increases in vehicle emissions, traffic, roads, infrastructure development, water usage, sewage and solid waste disposal, its effect from a human health perspective is beyond the scope of this assessment. Increased urbanization is an issue addressed, in part, under the Socio-Economic Assessment (Section F2).

Cumulative effects assessment of the oil sands region is an evolving process, which will be built upon with each successive development application. As such, this section addresses the potential human health impacts associated with cumulative releases of water and air to the extent that the current database allows.

F1.4.1.1 Analysis and Results

The analysis of this key question is assessed in several steps:

- Step 1: water releases during operation, at closure and in the far future;
- Step 2: air emissions during operation;
- Step 3: plant and game meat consumption during operation;
- Step 4: combined exposures during operation; and
- Step 5: reclaimed landscape exposures in the far future.

The estimated risks predicted in each step are summarized and impacts classified.

Step 1: Water Releases During Operation, at Closure and in the Far Future

Cumulative chemical concentrations were predicted for the Athabasca River, according to the method described in Section C5. Predicted future chemical concentrations in the Athabasca River as a result of the cumulative scenario were compared to predicted concentrations for Project Millennium plus existing and approved developments (i.e., the Project scenario). Where the concentrations for the cumulative scenario were equal to or less than those for the Project scenario, and no unacceptable human health risks were predicted for these chemicals in the baseline and Project impact risk assessments (Sections F1.2.3, F1.3.1 and F1.3.5), these chemicals were excluded from further evaluation in the CEA. In general, concentrations of most chemicals predicted for the cumulative scenario during the operational phase and in the far future were equivalent to those predicted for the Project scenario. However, for several chemicals, cumulative concentrations at closure (2030 to 2044) were greater than those predicted for the Project scenario. Chemical concentrations which exceeded predicted concentrations for the Project scenario were conservatively screened against one-tenth of the Risk-Based Concentrations (RBC). Refer to Appendix VI.1.3 for screening tables. Arsenic and molybdenum were identified as chemicals requiring further evaluation in the risk assessment, since predicted cumulative concentrations at closure exceeded the RBC screening step.

The predicted concentrations of naphthenic acids in the Athabasca River for the cumulative scenario were unchanged from those predicted for the Project scenario during the operational phase, at closure and in the far future. Therefore, the combined release of these substances from Project Millennium and other developments is not predicted to result in a cumulative impact. Thus, naphthenic acids are not evaluated further in the CEA.

The predicted cumulative concentrations were used as exposure concentrations to estimate daily intake rates. The recreational and swimming scenarios, which are the same as those used in the baseline and impact assessments, are described in Sections F1.2.3 and F1.3.1. Cumulative ERs for swimming and recreational exposure at closure are presented in Table F1.4-1.

Table F1.4-1 Cumulative Exposure Ratios for Swimming and Recreational Exposure at Closure

Receptor/Chemical	Swimming Exposure Ratio	Recreational Exposure Ratio
Child - Non-carcinogens		
Molybdenum	0.001	0.05
Adult - Non-carcinogens		
Molybdenum	0.0001	0.02
Composite - Carcinogens		
Arsenic	0.025	1.8

Exposure ratio (ER) values were less than 1 for molybdenum (recreational and swimming exposures) and arsenic (swimming exposure), indicating that these predicted conservative exposures resulting from recreational activities (including occasional ingestion of water and swimming exposure) are well within acceptable limits. ER values for arsenic for the recreational exposure are marginally greater than 1. Based on the conservative assumptions used in the assessment, this marginal exceedance of 1 does not indicate a potential human health concern. Furthermore, the ER predicted for recreational exposure to baseline arsenic in the Athabasca River was 1.4, compared to 1.8 in the cumulative scenario, suggesting that cumulative releases are a minor component of the predicted risk. Thus, no impacts to human health are predicted due to water releases from Project Millennium and the combined developments.

Step 2: Air Emissions During the Operational Phase

A human health risk assessment was conducted to evaluate air quality as a result of airborne chemical emissions from Project Millennium, as well as existing, approved and planned facilities in the oil sands region. In response to interests articulated by stakeholders concerning future air quality when all projects (existing, approved or proposed) are operational, Suncor undertook a stack survey to assist in predictive air quality modelling. While information concerning volatile organic carbon (VOCs) was available and incorporated here, data for particulates and associated PAHs and metals was not. The latter information will be available upon completion of its analysis. Cumulative air concentrations of volatile organic chemicals (VOCs) were predicted at Suncor air stations and at the communities of Fort McMurray, Fort McKay and Fort Chipewyan using air dispersion according to methodologies presented in Section B. The risk assessment calculated risk estimates for children and adults based on these air quality predictions.

The major sources of airborne chemicals included: off-gassing from the tailings pond and mine surfaces, emissions from the vehicle fleet, and emissions from stack and fugitive plant sources. Maximum ground level air concentrations for the chemicals of concern were estimated (Section B) for Fort McKay, the closest residential community to the Project, as well as Fort McMurray and Fort Chipewyan (refer to Section B2 for details). These ambient air concentrations were then used in exposure modelling to determine the estimated daily intake of these chemicals by local residents. In addition, since people may be exposed to airborne chemicals while carrying out activities in areas near the Project site (e.g., hunting/trapping, gathering plants), maximum predicted concentrations at Suncor air stations were also evaluated in the risk assessment. For this assessment, a hunter/trapper was assumed to live temporarily at the location of maximum air concentrations outside the Project Millennium boundaries (i.e., the Lower Camp) for 6 months per year. No differentiation was made between indoor and outdoor air concentrations.

For non-carcinogenic chemicals, potential residential exposure was estimated for children and adults. For potentially carcinogenic chemicals (i.e., benzene), exposure was estimated based on the assumption that an individual lives their entire life in the aforementioned communities (i.e., a composite receptor was evaluated from birth to 70 years of age).

Daily intake rates were estimated for benzene and for various groups of petroleum hydrocarbons as defined by a range of carbon chain lengths and structural similarities. The latter strategy was employed because toxicity data are not available for all components of the hydrocarbon spectrum. Therefore, such chemical exposure and risks were conservatively estimated using the recent methods of the Total Petroleum Hydrocarbon Criteria Working Group (TPHCWG 1997) involving hydrocarbon fractions (i.e., groups of related chemicals) and surrogate or fraction-specific toxicity reference values (see Appendices VI.4 and VI.5.2 for detailed descriptions of chemical groupings and toxicology of the various TPH fractions).

Results of the analyses and the corresponding exposure ratios are presented in Table F1.4-2.

Table F1.4-2 Exposure Ratios for Inhalation of VOCs

Chemical/Group	Fort McKay	Fort McMurray	Fort Chipewyan	Lower Camp
Residential Child and Adult - Non-carcinogens[a]				**Adult Hunter[c]**
C2-C8 Aliphatics[d]	0.005	0.0022	0.00042	0.027
C9-C12 Aliphatics[e]	0.077	0.035	0.0064	0.42
C6-C8 Aromatics[f]	0.024	0.011	0.002	0.13
C9-C12 Aromatics[g]	0.018	0.008	0.0015	0.097
Composite - Carcinogens[b]				**Adult Hunter[c]**
benzene	0.042	0.019	0.0035	1.5

(a) Denotes a child and adult residing in one of the three communities.
(b) Denotes a person exposed to benzene from birth to 70 years of age while residing in one of the three communities
(c) Denotes an adult hunter/trapper temporarily living for 6 months of the year at the location of maximum air concentrations outside of the Project boundaries (Lower Camp).
(d) Includes all straight chain and cyclic alkanes/alkenes with carbon numbers ranging from 2 to 8.
(e) Includes all straight chain and cyclic alkanes/alkenes with carbon numbers ranging from 9 to 12.
(f) Includes all aromatic compounds except benzene with carbon numbers ranging from 6 to 8.
(g) Includes all aromatic compounds with carbon numbers ranging from 9 to 12.

Exposure ratios for non-carcinogenic VOCs (i.e., the grouped hydrocarbons), indicate that the health risks of predicted ambient air quality in the surrounding communities are negligible. This is so, in spite of conservative assumptions arising from air dispersion modelling and exposure modelling, and the assignment of conservative toxicity reference values to hydrocarbon groups (i.e., assumption that chemical constituents within the group are all as toxic as the most toxic member of the group).

The modelled results for benzene indicate that the ER value for lifetime cancer risks associated with ambient air quality in the surrounding communities are less than one and therefore acceptable. For the hunter which was assessed on the basis of air quality and residence adjacent to the Suncor fenceline (i.e., Lower Camp), the ER was 1.5. However, in light of the degree of conservatism inherent in the computation and the provincially acceptable level of incremental risk being one in one-hundred thousand, this is considered to be negligible.

Finally, while the contribution of particulates and associated PAHs and metals requires further resolution (currently in progress following the stack survey), the surrogate data previously discussed in Section F1.3.2.2 do not suggest this is a significant contributing factor to the cumulative risks of airborne contaminants.

Step 3: Plant and Game Meat Ingestion during the Operational Phase

Increased air emissions from the combined developments may contribute to an increase in chemical concentrations in plant tissues. In response to the uncertainties and concerns articulated by stakeholders respecting air deposition of airborne chemicals onto vegetation, Suncor undertook a stack survey to collect information respecting particulate matter, organic chemicals and metals. Information from this study will be used to model the deposition of air contaminants onto vegatation and then interpret this in the context of potential exposure for humans consuming plants from this area. However, the results of the stack survey were not received in time to be incorporated into this section at the time of submission. The results are anticipated to be available in the near future.

In summary, due to this uncertainty, potential linkages between activities of Project Millennium, changes in plant tissue quality and human health were considered valid for further evaluation. The results of the stack survey and ramifications to human health will be available after the analysis is complete.

With respect to game meat, tissue concentrations in animals harvested near the operating oil sands facilities were evaluated in the baseline section, F1.2.5. In general, tissue concentrations of metals in rodents in 1994 were less than those measured in 1987, suggesting that exposures have decreased, despite the increase in development in the oil sands region. This may be due to improvements in pollution control technology. Thus, the current data do not suggest that tissue concentrations in game animals will increase from present levels as a result of operation of Project Millennium and the combined developments. Results of a 1997 animal tissue sampling program completed by Syncrude Canada will provide insight as to whether this decreasing trend is continuing; however, results were not yet available for inclusion in this analysis.

Step 4: Combined Exposure to All Media during the Operational Phase

Due to concerns regarding combined chemical exposures from different sources, incremental risk estimates (ER values) for water and air were summed, resulting in a total ER value for each chemical. Table F1.4-3 presents the total ER values resulting from exposures during the operational phase of combined developments.

Table F1.4-3 Exposure Ratio Values for Children and Adults During Operation

Receptor/Chemical	Water [(a)]	Air[(b)]	All Sources
Child - Non-carcinogens			
molybdenum	0.02	n/a	0.02
C2-C8 Aliphatics[(c)]	n/a	0.005	0.005
C9-C12 Aliphatics[(d)]	n/a	0.077	0.077
C6-C8 Aromatics[(e)]	n/a	0.024	0.024
C9-C12 Aromatics[(f)]	n/a	0.018	0.018
Adult - Non-carcinogens			
molybdenum	0.006	n/a	0.006
C2-C8 Aliphatics[(c)]	n/a	0.005	0.005
C9-C12 Aliphatics[(d)]	n/a	0.077	0.077
C6-C8 Aromatics[(e)]	n/a	0.024	0.024
C9-C12 Aromatics[(f)]	n/a	0.018	0.018
Composite - Carcinogens			
arsenic	1.4	n/a	1.4
beryllium	3.2	n/a	3.2
benzene	n/a	0.042	0.042
Total Carcinogens	**4.6**	**0.042**	**4.64**

(a) ERs for water are the maximum predicted for the Athabasca River duri4.ng the operational phase.
(b) ERs for air are the maximum predicted for residential air exposure in Fort McKay, the nearest community, during the operational phase.
(c) Includes all straight chain and cyclic alkanes/alkenes with carbon numbers ranging from 2 to 8.
(d) Includes all straight chain and cyclic alkanes/alkenes with carbon numbers ranging from 9 to 12.
(e) Includes all aromatic compounds except benzene with carbon numbers ranging from 6 to 8.
(f) Includes all aromatic compounds with carbon numbers ranging from 9 to 12.
n/a no data available or not applicable.

Exposure ratios for non-carcinogenic chemicals indicate that the combined health risks of predicted ambient air and water quality are negligible. This is so, in spite of conservative assumptions arising from water quality, air dispersion and exposure modelling, and the assignment of conservative toxicity reference values to hydrocarbon groups (i.e., assumption that chemical constituents within the group are all as toxic as the most toxic member of the group).

The results for total carcinogens indicate that the ER value for lifetime cancer risks associated with ambient air and water quality are marginally greater than one for people living in the surrounding communities. However, in light of the degree of conservatism inherent in the computation and the provincially acceptable level of incremental risk being one in one-hundred thousand, this is considered to be negligible. Further, the carcinogenic risks are virtually entirely due to waterborne arsenic and beryllium, which reflect naturally occurring background concentrations.

Step 5: Reclaimed Landscape Exposure

In the Project impact analysis for the corresponding key question HH-5 (Section F1.3.5), impacts to human health were considered to be negligible for non-carcinogenic chemicals and low for carcinogenic chemicals. This was based on exposure to Athabasca River or Shipyard Lake water as a drinking water source. The overall environmental consequence was considered to be low, rather than negligible, due to uncertainty associated with naphthenic acids and elevated background concentrations of carcinogenic chemicals.

The results of the impact analysis for a hypothetical hunter/trapper living for extended periods of time on the reclaimed Project site would be applicable to reclaimed landscapes of the combined developments. This assumes chemical releases from the reclaimed landscapes of other developments are not significantly greater than those predicted for Project Millennium. Similar exposure scenarios evaluated for the reclaimed landscapes of the Steepbank Mine, Aurora Mine and the Muskeg River Mine Project indicated a similarly low probability of potential impacts to human health (Golder 1996k, BOVAR 1996e, Shell 1998).

For the reasons outlined above, the exposures derived by a hunter/trapper and his/her children from ingestion of plants and game animals on the reclaimed landscape of the Project were assumed to be similar for reclaimed landscapes of combined developments. If it is also assumed that the source of drinking water is the Athabasca River, predicted cumulative water concentrations would not significantly increase risk estimates. Thus, chemical releases from multiple reclaimed landscapes within the RSA are not anticipated to result in increased exposures for individuals frequenting reclaimed areas. Rather, due to the larger area of reclaimed landscapes in the Athabasca Oil Sands Region, there is a greater likelihood for a hypothetical hunter/trapper to live and hunt/trap in a reclaimed area. Therefore this exposure pathway becomes more likely, but the health risks are not significantly increased.

Residual Impact Classification and Environmental Consequence

Based on the results of the risk assessment of cumulative air quality, water quality and the consideration of surrogate data respecting airborne particulates with PAHs and metals, impacts to human health are predicted to be low during operation and closure of the Project and are summarized as follows:

Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence
Negative	Low	Regional	Long-Term	Reversible	High	Low

Impacts were classified according to the information presented in Section A2, Table A2-8. The direction of the impact is negative, because some chemical concentrations will increase as a result of the combined developments, thereby increasing exposures to people. The magnitude of impact for the chemicals evaluated is low, because ER values were less than zero or only marginally greater than one (refer to Section F1.1.4.4 for more details). The geographic extent is regional, since exposures may occur outside the LSA. The duration is long-term, since exposures may occur for greater than 30 years. The impact is reversible, since future mitigation options and continually improving technology will be considered as necessary to reduce exposures. On the basis of these classifications, the environmental consequence is low. Further resolution of this conclusion is in progress with analysis of the recently conducted Suncor stack survey.

Certainty

The quantitative aspects of the CEA (i.e., air and water exposures) were analyzed conservatively, such that it is unlikely that risk estimates have been underestimated. The conservative assumptions used in the cumulative effects risk assessments for water and air are the same as those used in the impact assessment, as listed for each key question in Section F1.3. However, some uncertainty exists with respect to the following:

- future airborne particulates and associated PAHs and metals from increased production of the combined developments;
- future plant and game meat tissue concentrations as a result of air deposition from increased production of the combined developments;
- possible interactions of chemical mixtures; and
- uncertainties inherent to predictive air and water quality modelling (refer to Sections B and C3).

In predicting the magnitude of the impact, there is a reasonable degree of confidence that the high degree of conservation offsets the uncertainty arising from limited information available for naphthenic acids and airborne particulates and associated PAHs and metals, pending the analyses that are in progress.

F1.5 HUMAN HEALTH CONCLUSIONS

F1.5.1 Introduction

Project Millennium will release substances into the air and into the waters of the Athabasca River and Shipyard Lake while it is in operation between the years 2000 and 2033. After 2033, Suncor will close the development by completing reclamation and other closure activities. It is intended that the site will become a primarily forested area again, re-inhabited with native plants and animals. The human health impacts of the Environmental Impact Assessment (EIA) evaluated whether health effects would occur to people who live near the Project site, during the operational phase and after closure, when the area is fully reclaimed.

Project Millennium has been designed to mitigate human health impacts through:

- controlling air emissions and water discharges; and
- designing closure landscapes to ensure acceptable risk.

Issues

The human health assessment evaluated the effects of the Project by considering:

- The Project's potential environmental emissions in combination with existing and approved oil sands developments;
- Recreational exposure to Athasbasca River and Shipyard Lake water (e.g., fishing, boating, swimming, hiking) and ingestion of fish during the operational phase;
- Inhalation of airborne chemicals during the operational phase of the Project;
- Ingestion of local plants and animals which may have been exposed to water and air emissions from the Project during the operational phase;
- Combined exposure to water, air, plants and animals during the operational phase;
- Exposure to chemical releases from the reclaimed landscape in the far future; and
- Cumulative effects associated with chemical releases from Project Millennium in combination with other existing, approved and planned developments in the area.

Special consideration was given to aboriginal lifestyles and health concerns voiced by the people of Fort McKay and Fort Chipewyan. The assessment recognizes that local people value being able to collect plants and animals from the land for traditional purposes. To evaluate this, blueberries, Labrador tea leaves and cattail root were collected and tested for levels of metals and other oil sands-related substances. In addition, small mammals were captured and tested for levels of metals. This information was used, together with information on the amount of local plants and animals people usually eat, to determine whether there is a chance for the health of aboriginal people to be impacted from eating foods from areas near the Project site.

In addition, during the consultation process it was recognized that several stakeholders were concerned with air quality issues. In response to these concerns, Suncor undertook a stack emission survey to gain further insight. Although some aspects of this undertaking are still in the analysis stage, some of the data (specifically volatile organic carbon emissions) was available in time for integration into the assessment. Results for other substances (i.e., particulates, PAHs and metals) will be available when the analysis is completed.

Methodology

The chance of health effects occurring to people is called a *health risk,* and the method of evaluating whether health risks will occur is called *risk assessment.* In order for a health risk to occur, people must first come in contact with (i.e., be exposed to) substances released from the Project.

The first step in the risk assessment was to determine three things:

- the substances that will be released from the Project;
- the people that might come in contact with the substances (for example, children, adults, the elderly); and
- the types of activities people may do that may cause them to come in contact with these substances (for example, food gathering, hunting, fishing, swimming).

The next step was to calculate the levels of substances people may come in contact with as a result of their activities. These levels were then compared to levels that are safe for people to be exposed to, without having health problems. These safe levels were derived from scientific studies and will protect even the most sensitive people (for example, the elderly, infants and young children). If the levels in the environment are less than safe levels, health problems should not occur. On the other hand, if levels in the environment were excessively higher than safe levels, the risk assessment would predict that health problems may occur.

F1.5.2 Impact Assessment

The residual impact classifications for each key question are summarized in Table F1.5-1.

Table F1.5-1 Summary of Residual Impact Classifications and Environmental Consequences

Key Question	Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence
HH-1	Negative	Low	Local	Long-Term	Reversible	Medium	Low
HH-2	Negative		Regional	Long-Term	Reversible	High	Low
HH-3	Negative		Local	Long-Term	Reversible	High	Low
HH-4	Negative		Local	Long-Term	Reversible	High	Low
HH-5 (far future)	Negative	Low	Local	Long-Term	Reversible	Medium	Low
HH-5 (EPL at closure)	Negative	Moderate	Local	Medium-Term	Reversible	Medium	Moderate
CHH-1	Negative		Regional	Long-Term	Reversible	High	Low

The above issues were framed and addressed through the key question approach in the EIA, and are summarized as follows:

HH-1: What impact will chemicals in operational water releases from Project Millennium have on human health?

The levels of substances in the water of the Athabasca River and Shipyard Lake as a result of the Project are predicted to be safe for occasional swimming and drinking during recreational activities. The levels of Project-related substances in fish are also predicted to be safe for eating. However, there is some uncertainty associated with the toxicity of naphthenic acids to people, and therefore the residual impact was classified as a low environmental consequence, rather than negligible. Further studies are being conducted to help resolve this uncertainty.

HH-2: What impact will chemicals in operational air emissions from Project Millennium have on human health?

The levels of substances in air are predicted to be safe for people living in the communities of Fort McKay, Fort Chipewyan and Fort McMurray. In addition, breathing air while outside in areas closer to the Project site (for example, while hunting, fishing, boating, gathering plants) is not predicted to result in health problems. Analysis of the recently conducted Suncor stack emissions survey is in progress to provide further resolution on this topic.

HH-3: What impact will consumption of local plants and game animals exposed to operational water releases and air emissions from Project Millennium have on human health?

The levels of substances in traditional plants and animals are predicted to be safe for eating by local aboriginal people, based on information on Fort McKay and Fort Chipewyan eating patterns and the levels of metals and other substances currently observed in local plants and animals. Analysis of the recently conducted Suncor stack emissions survey to predict future possible air deposition and resultant plant and game meat tissue quality is in progress to provide further resolution on this topic.

HH-4: What impact will the combined exposure to water, air, plants and game animals have on human health during the operational phase of Project Millennium?

Based on the previous analyses of HH-1, HH-2 and HH-3, the combined exposure to substances in water, air and traditional foods is not expected to result in health problems for local people. As noted previously, analyses of the recently conducted Suncor stack emission survey will provide further resolution of this topic.

HH-5: What impact will the release of chemicals in soils, plants and waters of the Project Millennium reclaimed landscape have on human health?

This assessment included an evaluation of a hunter/trapper who may live on the site after it has been cleaned up and returned to a forest. This hunter/trapper was assumed to consume local plants, game animals and water from the Athabasca River, Shipyard Lake or the end pit lake (EPL). The levels of substances in water from the Athabasca River and Shipyard Lake, in air and soils on the site, and in plants and animals harvested from the site, are not predicted to result in impacts to the health of hunters/trappers who live on the site for long periods of time. The levels of substances on the site after closure of the Project are also not predicted to result in health effects for people who occasionally use the Athabasca River or Shipyard Lake for recreational activities following closure of the Project.

A potential impact to human health was identified if people use the EPL for recreational activities at the start of the closure period. Although the environmental consequence of this impact is considered to be moderate (Table F1.5-1), it is not considered to be significant for the following reasons:

- there will be a Suncor monitoring presence at the end pit lake to establish whether the water quality is not acceptable; and
- the potential impact can be mitigated by restriction of access until the water quality is acceptable.

CHH-1: What impacts to human health will result from chemical exposure related to Project Millennium and the combined developments (cumulative effects)?

Based on the available data, air and water releases from Project Millennium, combined with releases from other developments in the area, are not predicted to result in health problems for people living in the oil sands area. Analysis of the recently conducted Suncor stack emissions survey is in progress to provide further resolution of this topic.

F1.5.3 Monitoring

The following are key areas of monitoring and research identified or discussed in the Human Health Assessment:

- continue to monitor the levels of substances in the water, air, soils, plants and animals that people may be exposed to, both while the Project is operating and after closure;
- monitoring of end pit lake water will be conducted, and, if necessary, human access to this water body will be restricted or future mitigation measures will be implemented to reduce or eliminate the impact.
- continue further research to determine the potential for toxicity of naphthenic acids and interpret the new information as it relates to this EIA; and
- continue to participate in regional studies related to ecological and human health, such as the Alberta Oil Sands Community Exposure and Health Effects Assessment Program, the Regional Aquatics Monitoring Program (RAMP) and the Wood Buffalo Environmental Association (WBEA).

F2 SOCIO-ECONOMIC IMPACT ASSESSMENT

F2.1 INTRODUCTION

This section of the report presents the findings of the socio-economic impact assessment of Suncor's Project Millennium, a $2.2 billion mine and upgrader expansion project. Project Millennium will be located at the site of the existing Suncor operations, 35 kilometers north of the urban service area of Fort McMurray and 20 kilometers south of Fort McKay.

The socio-economic impacts discussed in this section include the following:

- the new employment and contracting opportunities that are created by the project;
- changes in population that are associated with employment growth;
- changes in demand for services from local and regional social, educational, health, and other service providers; and
- changes in fiscal capacity of the municipal, provincial, and federal government.

Where appropriate, this section discusses the impacts on the urban service area of Fort McMurray separately from those on the communities of Fort Chipewyan, Fort McKay, Janvier, Anzac, and Conklin. It also discusses separately the impacts of Project Millennium and those of the full range of oil sands developments that have been announced.

F2.2 METHODOLOGY

F2.2.1 "With" and "Without" Project Cases

The impact of Project Millennium is the difference between the socio-economic conditions as they are expected to be if the Project proceeds and those as they would be if the project does not go ahead. The first case is referred to interchangeably as the "with" project case or the Suncor Development Scenario. The latter is the "without" project or base case. These cases are described in more detail as follows:

- the "without" or base case includes all existing economic activity in the area – including the Suncor and Syncrude facilities, the ongoing forestry, tourism, mining exploration, service sector and other industries – and the Suncor Steepbank Mine and the Syncrude Aurora Mine North. Both of these projects have regulatory approval; and
- the "with" or Project Millennium Case includes all economic activity captured in the base case plus Project Millennium.

The environmental impacts of Project Millennium will only occur when the Project is being built and is operational. However, the socio-economic impacts are already occurring to some extent. The urban service area of Fort McMurray has experienced a significant population increase over the past 18 months. This is driven by residential and commercial construction anticipating future growth of the community and by exploration and pre-construction activities associated with Project Millennium and others, including Shell's Muskeg River Mine Project and the Syncrude 21 suite of projects. The socio-economic impact assessment is different from the biophysical assessments in that current conditions have anticipated more development than would have been appropriate in the base case.

Because the current socio-economic situation in the study area has changed in response to announcements of oil sands projects, the base case becomes the situation that would have been if no new projects had been announced beyond the Steepbank Mine and the Aurora North Mine. The most comprehensive description of these expected socio-economic conditions is contained in the Socio-Economic Impact Assessments (SEIA) of the Steepbank Mine and Aurora Mine projects. The base case population estimate has been restated subsequent to these SEIAs, using the Urban Population Impact Model that was developed for the Regional Infrastructure Working Group (RIWG). RIWG is discussed in more detail below and the Urban Population Impact Model is described in Appendix VIII.

The socio-economic impact assessment presents as well a Cumulative Impact Case, an analysis of the expected impacts of a wide range of oil sands projects on the human environment in the Regional Municipality of Wood Buffalo. The methodology used for this assessment is identical to the impact assessment for Project Millennium, except that the "with" case now includes the following projects:

- Suncor's Project Millennium;
- Shell's Muskeg River Mine Project;
- Syncrude Upgrader Expansion and a first train of the Aurora South Mine that are part of the Syncrude 21 suite of projects;
- Gulf's Surmont Commercial Oil Sands Project;
- Mobil's Kearl Oil Sands Mine;
- Petro-Canada's McKay River Project; and
- Japan Canada Oil Sands' Hangingstone Project.

Mobil Oil is examining the economics and location of an upgrader. It is currently considering five possible locations, two of which are within the study area. No announcements about the location of the Mobil upgrader are expected before June or July 1998 and the cumulative socio-economic assessment presented here limits the Mobil project to the Kearl Mine only.

F2.2.2 Issue Identification and Assessment

This socio-economic assessment focuses on the key issues. These were identified through:

- ongoing consultation between Suncor and key stakeholders in the context of Project Millennium and the normal conduct of company business;
- discussions with regional service providers as part of a study of the current socio-economic conditions undertaken on behalf of RIWG, of which Suncor is a member; and
- review of socio-economic studies, especially the work conducted by Fort McKay and Fort Chipewyan on the socio-economic conditions in the outlying communities of the Regional Municipality of Wood Buffalo and SEIA reports prepared for the Steepbank Mine, Aurora Mine, and Muskeg River Mine projects.

The key issues or questions brought forward can be summarized as follows:

- What are the employment and contracting opportunities associated with Project Millennium?
- What will the population impact of the Project be?

- What impacts can be expected on local and regional service providers in the areas of education, health, social services, and emergency services?
- What impacts are expected in the area of transportation and other infrastructure?
- How much of the economic benefits will accrue to the local economy and how much to the Alberta economy?

Respondents do not generally differentiate between the impacts of different projects and tend to discuss the impacts they anticipate in cumulative terms. It follows that the identified issues are identical for the project-specific and cumulative assessments.

The key issues are subjected to an assessment process that ranges from extensive quantitative analysis to more qualitative approaches. The choice of assessment methodology depends on the issue and the availability of data. For example, anticipated population impacts are addressed by means of a computerized Urban Population Impact Model, while the impacts of population change on service levels is approached through discussions with service providers, including health, education, social, emergency, and other service agencies. The anticipated geographic distribution of project expenditures is addressed through an analysis of procurement patterns of Project Millennium and other similar projects. An analysis of company economic data underpins the assessment of the total wealth creation associated with the project, presented under the heading of Net Social Benefits.

The assessments presented are based on information gathered from the affected communities, agencies, and groups. Where possible they have been verified through subsequent discussions. In some cases, the impact assessment is an on-going process, as is the case with the work of the Regional Communities Committee of the Regional Infrastructure Working Group, discussed below. In the final analysis, however, the assessments presented here are those of the consultant.

F2.2.3 Regional Co-operation

The socio-economic assessment methodology outlined here and the issue identification process are similar to those followed by other recent assessments, including the Shell Muskeg River Mine, Aurora Mine, and Steepbank Mine SEIAs. Similar as well is the level of cooperation between oil sands proponents, which is evidenced by extensive information sharing and joint commissioning of parts of the socio-economic analysis.

Co-operation in the past, when there were only two developers, was mostly on an ad hoc basis. Now it has become more formalized. The focus of cooperation among oil sands developers in the area of socio-economic assessment is RIWG, consisting of representatives of oil sands developers (Imperial Oil, Japan Canada Oil Sands, Gulf, Mobil, Petro-Canada, Shell, Suncor, and Syncrude) and the Regional Municipality of Wood Buffalo. The main purpose of this group is to identify priority items with respect to physical and social infrastructure, scope out the challenges, and identify the responsible authority. If appropriate, RIWG works with the responsible authorities to identify options.

The first project undertaken by RIWG was the development of an Urban Population Impact Model and associated socio-economic baseline study for the Fort McMurray area. This model and baseline are shared among the participants in RIWG. Key stakeholders, including the Northern Lights Regional Health Authority, the Fort McMurray School District, the Fort McMurray Roman Catholic Separate School District, and Keyano College, have been provided with the model software to assist them in their planning. Other stakeholders have been provided with the summary output of the model.

The operating practice of RIWG is to strike subcommittees for particular issue areas and invite stakeholders to become members of these subcommittees. Projects currently being conducted by subcommittees of RIWG include:

- an analysis of highway transportation issues, particularly with respect to Highway 63, north of Fort McMurray. The *Transportation Committee*, which includes the participation of Alberta Transportation and Utilities, is expected to come forward with recommendations in the middle of May;
- an assessment of job opportunities and associated skill requirements implied in the announced new oil sands plants. The *Jobs and Education Committee* is working with Keyano College and other educational institutions to ensure that the most up-to-date and accurate work force information can inform skills development initiatives, especially those focused on the local labour force; and
- an analysis of socio-economic baseline information of and impacts on the small communities in the region. The *Regional Communities Committee*, which includes representatives of aboriginal groups, has compiled summary information on all proposed projects and is working with community leaders to develop a basis for an assessment of potential impacts.

Through the activities of RIWG and its subcommittees, the socio-economic assessments of individual projects have a shared and common baseline database, population forecasts, and information on transportation issues and options. In addition, the stakeholders in the region have a common population forecast to assist them with planning and meeting the challenges posed by growth.

Regional co-operation extends beyond RIWG. The Athabasca Oil Sands Development Facilitation Committee (AOSDFC) has been struck to facilitate regional economic development. The AOSDFC consists of vice-presidents of Gulf, Mobil, Shell, Suncor, and Syncrude, the Members of the Legislative Assembly for the region, and a Regional Councilor, also representing the Standing Committee for Oil Sands Development of the RMWB. The oil sands developers have hired a full-time coordinator to facilitate the work of AOSDFC, RIWG, and its subcommittees, as well as joint activities in the area of environmental assessment.

F2.3 SOCIO-ECONOMIC SETTING

This section gives a short and general description of the history, economy, and current socio-economic conditions in the study area. Additional detail is provided in Section F2.6 and in Appendix VII.

F2.3.1 Study Area

Figure F2-1 shows the boundaries of the socio-economic study area. They are coincident with those of the Regional Municipality of Wood Buffalo and reflect the trading, traffic and communication patterns in the region. As shown on the map, the study area encompasses the following population centres:

- the urban service area of Fort McMurray and associated rural residential communities of Saprae Creek and Gregoire Lake
- Fort Chipewyan
- Fort McKay
- Anzac
- Janvier
- Conklin

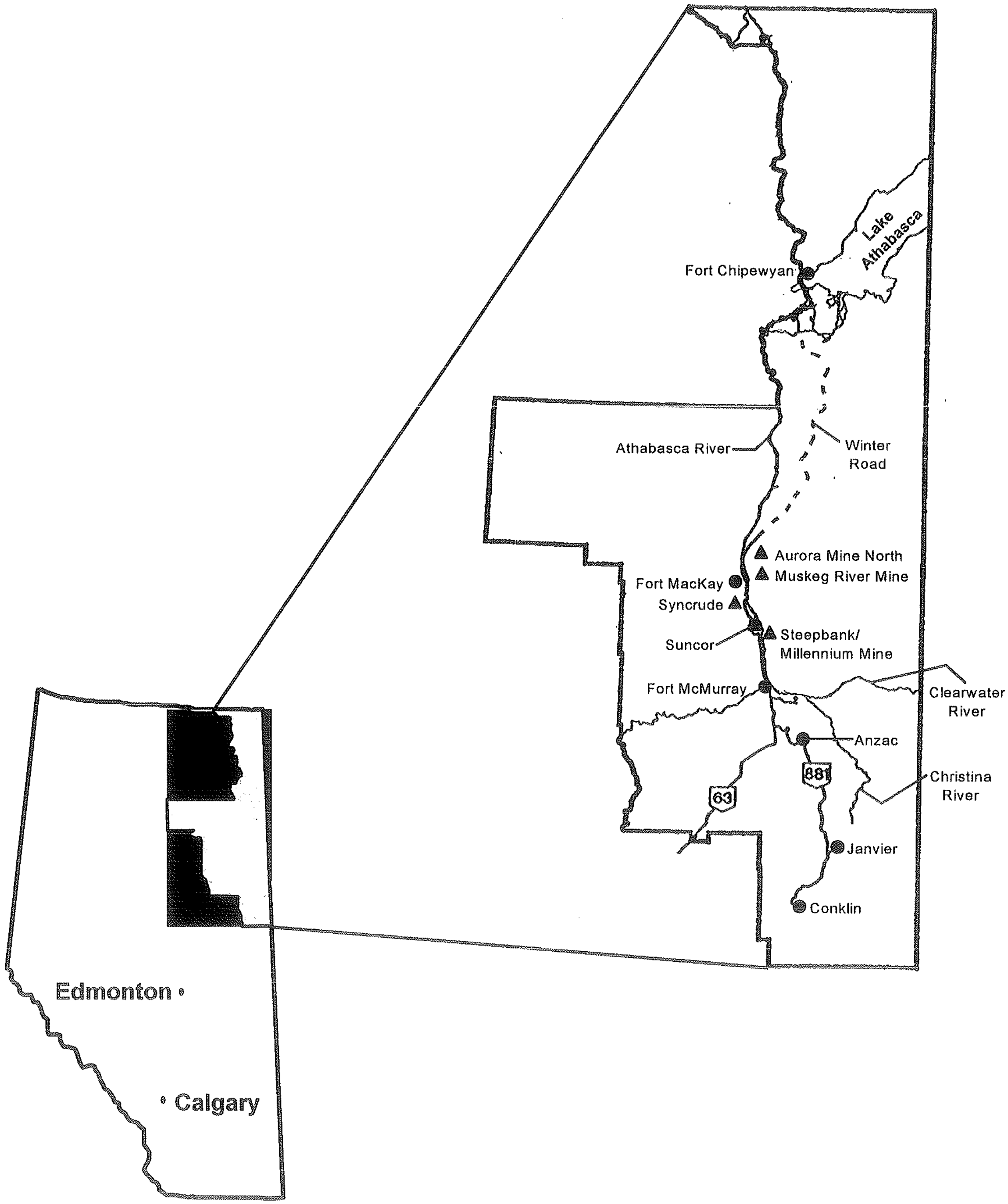
The study area includes the reserve lands located within the Regional Municipality of Wood Buffalo. These include reserve lands of the Mikisew Cree First Nation, the Athabasca Chipewyan First Nation, the Fort McKay First Nation, the Fort McMurray First Nation, and the Chipewyan Prairie First Nation.

F2.3.2 Historical Setting

F2.3.2.1 Earliest Development

Human habitation of northeastern Alberta dates back 10,000 years or more. The region played an important role in the early years of European settlement of western Canada as a centre for the fur trade, as evidenced by a number of fur trading posts, including Fort Chipewyan, Fort McKay, and Fort McMurray. This latter community developed into a rail and river transportation link and construction staging point to the north in the 1940s.

Figure F2-1 Study Area



F2.3.2.2 Oil Sands Development

Commercial interest in the oil sands resources of the region emerged in the 1920s and a number of attempts were made to develop the resource starting in the 1930s. These early efforts culminated in the construction and operation of the Great Canadian Oil Sands Plant (now Suncor) in the mid-1960s and the construction of the Syncrude facility during the 1970s. Thesedevelopments accelerated the population growth in the region. This growth has been further supported by subsequent expansion of those commercial oil sands facilities, combined with new experimental oil sands operations, increased natural gas exploration, forestry development, tourism, and support industries.

After the initial construction of the Suncor and Syncrude plants, the oil sands industry developed in an incremental fashion. Suncor and Syncrude expanded their production through debottlenecking and other improvements to processes and facilities. Industry employment has not increased in proportion with production and in the 1986-1996 period, oil sands industry employment actually fell marginally through the productivity improvement measures.

The currently announced developments signal a new era of oil sands development. The existing Suncor and Syncrude plants are slated for major expansions and developers, such as Shell and Mobil, are working towards new greenfields mining-based operations. In addition and reflecting advances in drilling and recovery techniques, several *in situ* projects are proposed in the area by Petro-Canada, Gulf, PanCanadian, and Japan Canada Oil Sands. If all these projects proceed, the long-term operational employment and consequently the population levels will expand.

F2.3.2.3 Development of Municipal Governance

In the late 1960s and 1970s, Fort McMurray was the only incorporated municipality in the study area. It was a "New Town", under the New Towns Act, which allowed for extensive involvement of the provincial government in administration, planning, and community development. Fort McMurray attained city status in 1980, giving more autonomy to the local government authorities.

Alberta Municipal Affairs administered Improvement District 18 (ID 18), which comprised the rural area and the hamlets in the study area. Residents of ID 18 had an advisory role in the conduct of municipal affairs by means of two Advisory Committees.

This situation changed in 1995 with the creation of the Regional Municipality of Wood Buffalo. It comprises both the City of Fort McMurray (now the urban service area of Fort McMurray) and the rural area, including the hamlets of Fort Chipewyan, Fort McKay, Anzac, Janvier, and Conklin. Both the urban and rural areas have formal representation on the Regional Council. With the creation of the Regional Municipality, the role of the provincial government with local government is now the same as in other areas of the province.

F2.3.3 Regional Economy

The regional economy has four major pillars.

- The oil sands industry is the economic mainstay of the region. Most of the oil sands activity is located near Fort McKay, but a new node of development is proposed near Anzac and Conklin. The oil sands industry is supported by a range of contractor and support services, some of which are located near the existing plants, others in the MacKenzie Industrial Park and generally within the urban service area of Fort McMurray.
- Forestry is an important part of the regional economy, especially in the southern half of the study area. The ALPAC Forestry Management Area (FMA) extends into much of the study area and logging takes place throughout the region. Northlands Forestry Products, a Fort McMurray-based operation, is another forestry company active in the area.
- Conventional oil and gas exploration and production takes place in the southern half of the study area. The pipeline industry, carrying oil and gas products to southern markets is active as well.
- Tourism takes place throughout the region, supported mostly from Fort McMurray where most of the hotels and other tourism infrastructure, such as restaurants, charter airlines, and tour operators are located. Gregoire Lake is a favourite recreational place for local residents and Fort Chipewyan is a staging point for trips into Wood Buffalo National Park.

Other, smaller economic activities in the region include mineral exploration, commercial fishing, hunting, and trapping. All these activities are supported by a range of contracting and other service providers, in the area of transportation, construction, logistics, wholesale and retail trade, and others.

F2.3.4 Current Conditions

The urban service area of Fort McMurray is a thriving community, which is looking forward to a sustained period of growth and development. The population growth it has experienced in the last two years and the further growth that is expected is posing challenges, but generally the public and private sector agencies are positioned to deal with these challenges. There is a well-developed social fabric and a sense of cohesion, experience with growth from past development periods, enthusiasm, and lots of talent and energy to deal with the current challenges.

Fort McMurray has developed into an urban area that offers a wide range of services and amenities. The size and sophistication of the retail sector has increased over the past years, the business sector is growing, and the leisure and recreational opportunities are varied. The recent influx of people into the urban service area has increased housing prices and created a tight housing market, contributing to an increased cost of living.

Although optimism about the contracting and employment opportunities in the oil sands colour the outlook of the community, there are concerns as well. As is the case in many resource-based economies, there are in effect two parts to Fort McMurray; one affluent and vibrant because of the oil sands and one stressed and marginalized. The latter part is populated by people without the requisite skills for oil sands or other employment, who experience the increasing cost of living without the benefit of high incomes. In between is the middle class of public sector and service sector workers whose incomes are on par with their counterparts elsewhere in the province, but whose cost of living is higher.

Differences among them notwithstanding, the outlying communities generally have not shared in the economic development in the region. Although some individuals and community-based companies are part of the oil sands industry, the communities as a whole are separate and removed from the optimism and vibrancy of the urban service area. Some community members, including elders, see economic development of the oil sands industry resulting in a decline of the traditional way of life and contributing to social dislocation. The housing, municipal, social, and recreational infrastructure of these communities is by and large not well developed, and they rely extensively for health, social, educational, and recreational services on Fort McMurray. The cost of living in these communities tends to be higher than in Fort McMurray, reflecting in part their isolation. Price levels in Fort Chipewyan, which does not have all-weather road access, have been estimated at 20% higher than in Fort McMurray. Price levels in the other outlying communities are between 6% and 12% higher than in Fort McMurray (Nichols Applied Management 1994).

F2.4 EMPLOYMENT AND POPULATION IMPACTS

The key socio-economic impact of Project Millennium is an increase in regional employment. This, in turn, is expected to lead to an increase in population. This relationship between employment and population implies that with some exceptions, people come to and stay in the region for jobs. The exceptions include:

- aboriginal people
- dependent children
- retirees who remain in the region

The essentially stable population of the urban service area of Fort McMurray between 1986 and 1996, a period in which no new oil sands jobs were created, illustrates the basic linkage between employment and population.

F2.4.1 Employment Impact

F2.4.1.1 Construction

Construction of Project Millennium is expected to create 5,300 person-years of on-site work in the 1998 to 2001 period. As shown in Figure F2-2, the on-site work force is estimated to exceed 1,000 workers from the third quarter of 1999 through the second quarter of 2001. The average quarterly on-site work force is expected to peak at 2,200 workers in the fourth quarter of the year 2000. Short-term peaks may exceed the 2,200 estimate and Suncor is anticipating as many as 3,000 workers on site for short periods of time.

Figure F2-2 Project Millennium, Construction Work Force, 1998 - 2002

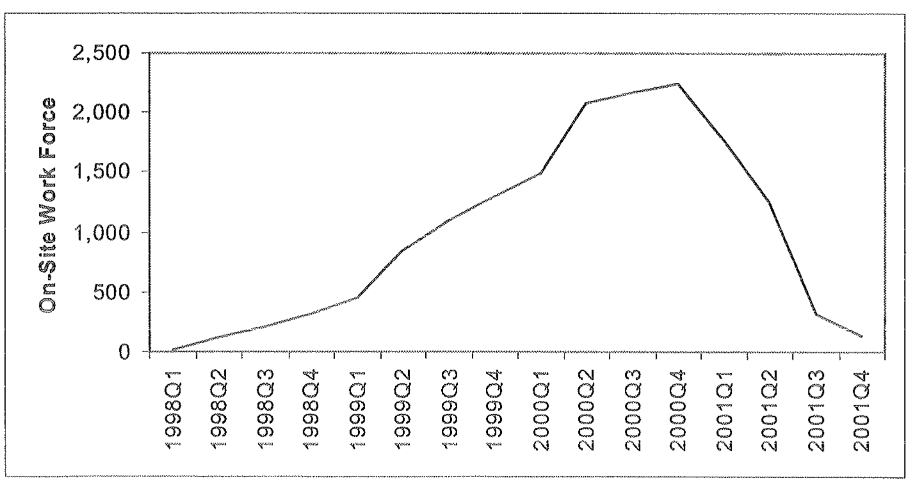


Table F2-1 presents the estimated breakdown of the on-site work force by trade. It shows that the key construction trades required are pipe fitters/welders, electricians, and labourers.

Table F2-1 Construction Work Force, by Type

Category	Percentage of Total
Boilermaker	4%
Carpenter	9%
Cement Mason	2%
Electrician	12%
Instrumentation	1%
Ironworker	9%
Labourer	15%
Millwright	2%
Plant Operator	9%
Equipment Operator	1%
Painter	1%
Sheet Metal	>1%
Pipeftter/welder	29%
Insulator	1%
Teamster	4%
Other	1%
Total	**100%**

Note: Percentages do not total to 100% because of rounding.

F2.4.1.2 Operations

Total employment at the Suncor plant is always fluctuating, although within a narrow margin. On average the Suncor work force is 1,600 full-time workers. In addition, there are 380 full-time contractors on site. The Millennium project is expected to increase these numbers by 800 permanent Suncor employees. Table F2-2 provides a detailed breakdown of the type of jobs that will be created by Project Millennium.

The table shows that almost half of all new Suncor positions are operations workers, either heavy equipment or process operators. More than a third of the new jobs are expected to be in the maintenance trades, with the balance (or 16%) made up by administrative, technical, managerial, and professional persons.

Table F2-2 Operations Work Force, by Type

Category	Number
Heavy Equipment Operator	296
Process Operator	90
Welder	40
Millwright	42
Heavy Duty Mechanic	88
Electrician	26
Pipefitter	46
Instrumentation Technician	22
Maintenance Worker	22
Engineer	42
Engineering Technologist	22
Supervisor/Manager	29
Professional/Administrative Support	25
Emergency Services Technician	10
Total	**800**

Work force estimates are subject to change as the Project prepares detailed engineering and staffing plans.

F2.4.1.3 Local Employment Initiatives

Currently, only about four percent of the Suncor work force is aboriginal and most aboriginal people work in entry-level jobs. The aboriginal involvement in the Suncor work force is a concern for both the company and the aboriginal communities.

The new employment opportunities created by both Project Millennium and the replacement hiring for employees who retire or leave provide an opportunity for Suncor to work towards its work place diversity objectives. The company recognizes that its work force has fewer aboriginal persons than the general population and is committed to changing this situation. The target for aboriginal hiring is to achieve an aboriginal work force participation rate of 12% by 2002. Although ideally these aboriginal persons would come from the region, some will likely come from elsewhere as well. The work force diversity initiative will be closely monitored and reported on and will be supported by company activities in the area of education. These issues will be discussed in more detail in Section F2.5.2.

Local employment initiatives are expected to provide benefits beyond workplace equity. For example, locally hired persons know the community and the region and will likely make an easier transition into the Suncor work force than persons from elsewhere. Local hiring also minimizes recruiting and relocation costs.

Related to local employment initiatives the company has activities to reduce turnover and retain valued workers. Examples include the Employee and Family Assistance Program, which is available to employees and contractors and their families and incentive plans that tie cash and stock payment to the company and business unit results. In a more general sense, the company makes an effort to accommodate individual and family circumstances, for example by means of part and flex time where it can be accommodated.

F2.4.1.4 Cumulative Employment Impacts

Although Project Millennium is one of the larger new projects to be announced in the Regional Municipality of Wood Buffalo, it is by no means the only one. Table F2-3 gives an overview of the construction work forces of the oil sands projects that are being considered as part of the cumulative impact analysis. The table indicates that the Suncor construction work force demands are roughly one-fifth of the total over the 1998-2007 period. The work force estimates presented here should be interpreted as order-of-magnitude numbers only as there will be quarterly or monthly variations in the numbers. More importantly, Table F2-3 assumes that all announced projects will go ahead in their current configuration and timeline and that no others will come forward. As none of the projects, except the Steepbank Mine and Aurora Mine projects, has regulatory approval, and all face internal company decision points, the cumulative employment numbers are subject to uncertainty.

The regional work force will grow because of additional long-term operational employment. The cumulative operational work force is estimated to grow by 3,000 workers. Table F2-4 shows that the estimated 800 new operational positions at Suncor are about one-quarter of the total new operational oil sands employment in the region. As with the construction work force estimates, the operations work force numbers are subject to uncertainty.

Table F2-3 Cumulative Construction Work Force Estimates

	Suncor	Syncrude	Shell	Mobil	Gulf	Petro-Canada	JACOS
1998	600	1,100	10			10	10
1999	900	1,800	600		300	160	10
2000	2,000	2,000	1,300	10	400	130	
2001	900	2,200	400	200	300		10
2002		1,600	100	600	200		
2003		700		500	400		
2004		1,200			300		
2005		1,100			400		
2006		100					
2007		100					

Construction work force estimates are subject to change as individual projects prepare detailed engineering and staffing plans.

Table F2-4 Cumulative Operations Work Force Estimates

	Suncor	Syncrude	Shell	Mobil	Gulf	Petro-Canada	JACOS
1998							20
1999							10
2000					70		
2001	800					50	10
2002		250	800		70		
2003		200		600	70		
2004							
2005					70		
Total	**800**	**450**	**800**	**600**	**280**	**50**	**40**

Operations work force estimates are subject to change as individual projects prepare detailed engineering and staffing plans.

Both the operational and construction phases contribute to the overall demand for skilled workers in the province. Generally, the demand for skilled workers, especially in the trades, is expected to grow by 4% or 5% annually until the year 2005. If all projects throughout the province go ahead at their currently announced schedules, there may be spot shortages in key trades, such as welding, throughout the construction period.

F2.4.2 Population Impact

F2.4.2.1 Base Case and Current Situation

Urban Service Area

The base case population, or the population levels that would be attained if only the Steepbank Mine and Aurora Mine projects were to proceed, is estimated using the Urban Population Impact Model, developed for RIWG. This model, discussed in more detail in Appendix VIII, estimates the in- and out-migration as well as the natural population growth under various scenarios, including the base case. It takes as its starting point the 1996 Statistics Canada Census population estimate of 34,100 (May 1996). At that time, projects in addition to the base case ones had not yet gained widespread attention.

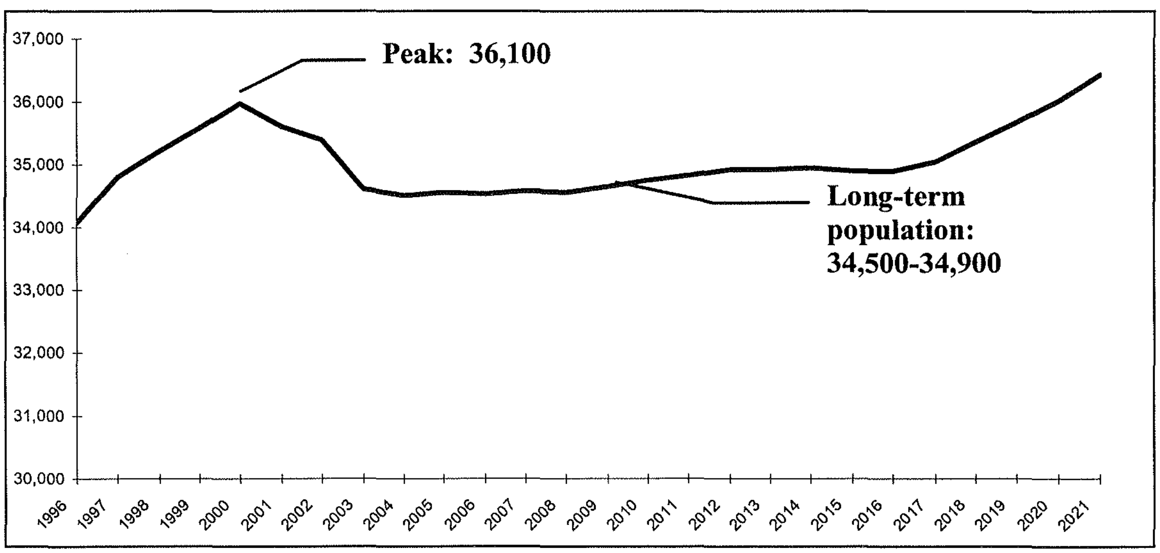
Figure F2-3 shows how the population of the urban service area of Fort McMurray would likely have reacted in the absence of further oil sands projects. It shows an initial increase in population as the two base case projects are constructed and employment grows as construction support jobs increase. At the end of the construction period, employment and population would be expected to fall back close to its 1996 level as little or no new operational employment is created by those two projects. The base case population forecast for the period beyond 2016 shows some increases as workers who are now 35 to 45 years old reach retirement age. Some of these retirees may choose to remain in the region, increasing population without an underlying increase in employment. This increase is expected to level off when the current group of 35 to 45-year olds has reached retirement.

The population of the urban service area of Fort McMurray has already increased in anticipation of a range of announced oil sands developments, including Project Millennium. The population of the urban service area is estimated to be 38,700 (fall 1997), an increase of 14% over the 1996 census estimate. This estimate is based on an analysis of reduced dwelling vacancies and new house construction. It incorporates an increase in the number of persons per dwelling, reflecting the anecdotal evidence of families taking in boarders, renting out rooms, and accommodating friends and relatives. The population growth estimate is in line with the increase in demand for services experienced by the Emergency Department of Northern Lights Regional Health Authority.

Outlying Communities

Total operational employment and the associated population levels would only increase marginally under the base case and most of it is expected to accrue to the urban service area of Fort McMurray. The population of Fort McKay, Fort Chipewyan, Anzac, Janvier, and Conklin would not have been affected by oil sands development if only the Steepbank Mine and Aurora Mine would have proceeded. No new permanent jobs were forecast for these projects.

Figure F2-3 Urban Service Area, Base Case Population Forecast



Note: Base case includes existing oil sands plants, plus Steepbank Mine and Aurora Mine 1997 actual is estimated at 38,700 and includes impacts of other anticipated projects.

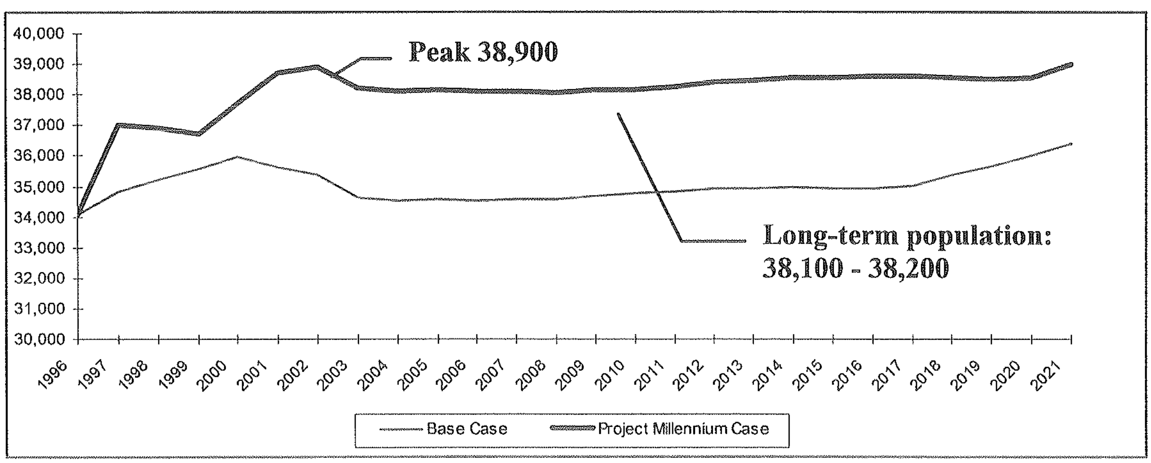
There could be a demographic shift in the outlying communities as the large contingent of young people ages and enters adulthood. It is not clear if this demographic shift will mean a natural increase in population or an increased out-migration as young people pursue job opportunities elsewhere.

F2.4.2.2 Project Millennium Case

Project Millennium creates construction and operations jobs and these, in turn, will bring people to the region. The population impact of Project Millennium is the difference between the population forecast assuming Project Millennium and the base case. The Urban Population Impact Model yields the results graphed in Figure F2-4, showing both the base case and Project Millennium case.

The analysis indicates that the Project Millennium Case population estimate increases to 38,900 during the height of the construction period and settles back to a level of 38,100 during the operational phase of the Project. The same demographic shift with respect to retirees occurs under this scenario, but the effect is overshadowed by new people coming into the region (Appendix VIII).

Figure F2-4 Urban Service Area, Base Case and Project Millennium Case Population Forecast



Outlying Communities

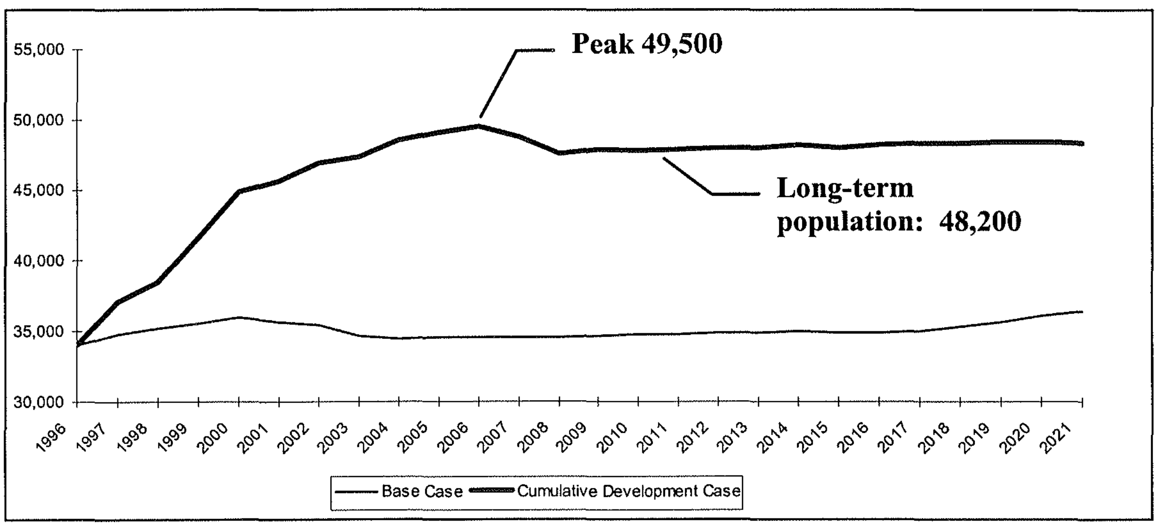
Project Millennium will likely have some population impact on the outlying communities, especially Fort McKay, because it provides Suncor with an opportunity to pursue its workplace diversity objectives and increase the participation of aboriginal persons in its work force. This may lead to families moving to the urban service area of Fort McMurray for jobs, access to services, and transportation to the plant. Conversely, it may lead to people returning to their home communities as the cost of housing becomes more expensive in Fort McMurray. On balance there is emerging evidence that the population of the outlying communities will increase. It is not possible, however, to distinguish between the impact of Project Millennium and other projects and this population increase is discussed below as part of the Cumulative Impact case.

F2.4.2.3 Cumulative Impact Case

The Urban Population Impact Model has also been used to estimate the population levels in the urban service area of Fort McMurray, assuming the full range of projects discussed in Section F2.2 proceed. The results of the analysis are presented in Figure F2-5.

The figure shows that the population of the urban service area of Fort McMurray is expected to reach 48,200 persons when all projects are operational. During the construction period, the population may reach 49,500. The analysis suggests that the urban service area of Fort McMurray may have an average annual growth rate of 6.5% in the period 1997-2001, resulting in a population increase of 10,000 or more over the next six years.

Figure F2-5 Urban Service Area, Base Case and Cumulative Case Population Forecast.



Outlying Communities

As discussed in more detail in Section F2.5.1, the anticipation of new oil sands projects has created a tight housing situation in the urban service area of Fort McMurray. This is expected to remain the case for at least five or more years as the local housing market adjusts to the increased demand for housing. This appears to be one of the underlying reasons for some population increases in the outlying communities, especially Fort McKay: information from Fort McKay suggests that an estimated 40-50 more people are requiring housing as compared to a year ago.

There is evidence as well of increased housing demand in Anzac. Two rural residential subdivisions are being contemplated there with a total of 90 lots. It is unclear, at this time, if the apparent demand for this development will materialize or how quickly. In addition, it is not clear if the demand will come from local people or from families moving into the region from elsewhere.

F2.5 IMPACTS ON SERVICE PROVIDERS

The population increases induced by oil sands development will increase demands on local and regional service providers. This section outlines these impacts. For each issue area, it provides some background on the base case and current situation, discusses the Project Millennium case, and outlines the impacts associated with the Cumulative Case.

F2.5.1 Housing

Base Case and Current Situation

The housing inventory in the Regional Municipality of Wood Buffalo, including the outlying communities, is summarized in Table F2-5. The table presents as well comparable data for Grande Prairie and Red Deer and suggests that the number of row houses as well as the number of apartments are not out of line with these communities. The number of single family homes (detached and semi-detached) is marginally lower than in the other communities. The approximately 390 single family houses built in Fort McMurray in 1997 has increased the relative size of that segment of the market.

Wood Buffalo stands out in the 12% of the total housing stock that consists of mobile homes. This high percentage is related to the mega project nature of past development. This contributed to the need to build a lot of houses quickly, thus biasing the development towards mobile homes.

Table F2-5 Housing Stock, Wood Buffalo, 1996

	Red Deer		Grande Prairie		Wood Buffalo	
	No.	%	No.	%	No.	%
Single (semi)detached	13,155	59%	7,525	69%	6,310	53%
Row Housing	2,785	12%	510	5%	1,335	11%
Apartments	5,660	25%	2,620	24%	2,815	24%
Mobile Homes	800	4%	175	2%	1,370	12%
Total	22,415	100%	10,830	100%	11,840	100%

Source: Statistics Canada, 1996 Census

Assuming the base case, in which only the Aurora Mine and Steepbank Mine projects proceed, the population increases only marginally and the housing market in the urban service area of Fort McMurray would be expected to strengthen as confidence in the longer term future of the region increases. The housing situation in the outlying communities would not be affected by the projects.

With respect to the current situation, Table F2.6 shows that prices for single family homes in the urban service area of Fort McMurray have increased by more than 40% over the past 12-18 months, albeit from a depressed level. The average price for a detached single family home was $155,000 in September 1997. Rental accommodation has also become more expensive, with rents for two-bedroom units increasing by 23% between October 1996 and October 1997. Rates for three-bedroom units increased by 12% over the same period.

Table F2-6 Urban Service Area, Selected Real Estate Statistics

	1996	1997	Increase
Average price (single family home)	$108,500	$155,000	43%
Average rent, bachelor apartment	$349	$397	14%
1-Bedroom apartment	$426	$524	23%
2-Bedroom apartment	$516	$629	22%
3-Bedroom apartment	$625	$702	12%

- Average price increases are influenced by the depressed prices in the pre-1996 real estate market and the upscale nature of the houses that have been built in 1996 and 1997.
- Sources: ReMax, Fall 1997. Quarterly Report, Real Estate Market Synopsis and Outlook. Canada Mortgage and Housing Corporation, November 1997. Rental Market Report.

The average prices of houses sold in the last quarter of 1997 increased beyond the levels indicated in Table F2-6. This increase appears to be influenced mainly by the high-end type of houses sold during the period.

The urban service area of Fort McMurray has experienced a significant increase in housing starts in 1997. Indications are that about 390 houses were built in the area, which, together with commercial developments, fully utilized the local construction industry. A new mobile home park has been completed and the first modular houses and trailers have been moved into position. As evidenced by the current construction activity, the market anticipates housing demand from operational phase employees of projects, which will not become operational until the year 2001/2.

The current housing construction activity is to some degree speculative. As mentioned before, except for the Steepbank Mine and Aurora Mine Projects, the announced developments do not have either regulatory approval or the final go-ahead of their owners. It is possible that not all projects will proceed in their currently announced scope or timelines. The real estate development industry will likely react quickly to any changes in development outlook.

The Urban Population Impact Model developed for RIWG captures this behaviour of the real estate market by treating the residential and commercial building activity as a separate project starting in 1997. The model recognizes that the housing and commercial construction is in anticipation of spending on housing by project and other workers and relates the total number of housing units needed to the expected long-term operational phase population estimate.

Currently, there is a housing shortage as evidenced by:

- 0.6% vacancy rates in apartment buildings and a quick turn-over of housing offered for sale; and
- anecdotal evidence of increased numbers of persons per dwelling as families take in boarders or rent out rooms and basement suites.

The estimated 1997 population implies that the average number of persons per dwelling has increased by 5% to 7%.

Virtually all housing construction in 1997 has been single family houses. The rental segment of the housing market has been stagnant and the multi-family projects that are under consideration are being developed for sale, rather than for rent.

Rising rental rates have increased the demand for subsidized housing, which the Fort McMurray Housing Authority administers on behalf of Alberta Municipal Affairs. To date, the Housing Authority has been able to keep up with this increase in demand, which is in part related to:

- the well-established relationships between the agency and some of the larger landlords in the area; and
- the ability of Alberta Municipal Affairs to fund an increased number of subsidized units.

Some of the outlying communities have started to feel some increased pressure on housing as families move back to their home communities to avoid the increasing housing costs in Fort McMurray. This emerging trend exacerbates the already noted housing shortage in many of these communities. There are plans for new rural residential subdivisions, totaling 90 lots, near Anzac.

Project Millennium Case

The housing demand associated with Project Millennium is estimated at about 1,050 dwellings. This demand is estimated on the basis of the 800 new long-term permanent positions the Project creates directly as well as the additional jobs that are created indirectly. Considering that there were approximately 500 vacant dwellings in the area in early 1996, an estimated 550 new housing units will need to be constructed. Since 1996, some 400 houses were built, suggesting that the long-term housing demand related to Project Millennium alone is nearly satisfied. Project Millennium will induce some additional demand during the construction phase, but this demand is for a limited time only.

In reality, the new houses were built mostly for existing Fort McMurray residents desiring move-up housing and most of the apartments filled up with people working in the area in preparation and anticipation of a range of oil sands projects. The housing impacts already experienced in the area are really of a cumulative rather than a project-specific nature.

In view of the fact that no new rental accommodation was developed, it is expected that the rental market will remain tight and that rental rates will remain at the current levels or higher in the near future. The demand for subsidized housing will be met without great difficulty, considering that the population estimate associated with the Project Millennium Case is in line with the population impact already experienced in anticipation of multiple projects proceeding. The current demand for subsidized housing is by and large being met.

Cumulative Development Case

The cumulative demand for new dwellings is estimated to be over 3,600, of which some 400 have been built over the past two years. This estimate of new dwelling units relates to the long-term stable population only. If the current level of building activity is sustained over time, the residential and commercial construction period will likely extend for a 10 or 11-year period. The number of dwellings built per year may increase as more construction resources that were allocated to commercial construction become available for the residential market. This will reduce the period of shortage.

Assuming that an average of 350 single family dwellings will be built per year, housing supply and demand is expected to be roughly in equilibrium by 2008. The period of shortage will be shorter if the number of dwellings built per year increases. Additional demand for housing will emerge during the period of sustained plant construction. This demand is of a temporary nature, but will contribute to the expected shortage.

Housing will remain in short supply during this 11-year period, necessitating a continued reliance on basement suites and rental room accommodation for a portion of the population. Housing shortages may slow in-migration of people, which may leave some jobs, especially lower-paid service sector jobs, vacant.

Rental rates will remain at or above the levels experienced in 1996 and 1997 and additional demands will be placed on the rental subsidization program administered by the Fort McMurray Housing Authority. Using the current ratio of subsidized units to total population as a benchmark, an additional 20 units may be required in the rental subsidy program to accommodate the long-term population. There will be demand for an estimated 50 units of subsidized housing during the construction period. These increases should be placed in the context of the 55 units that were added to the rent subsidy program over the past year. The current complement of subsidized dwellings is 324 units.

Mitigation

Suncor will operate camps for the duration of the construction period. These camps will be sized to accommodate workers associated with the plant and mine construction. The company is committed to providing housing for permanent Suncor employees and their families, if needed, until the new house construction has caught up with demand.

The company is cooperating with the municipality on housing issues and is a member of the Mayor's Task Force on Housing, established in mid-1997. In addition, it is continuing to explore opportunities to cooperate with other oil sands developers with respect to camp issues.

F2.5.2 Education

Base Case and Current Situation

There are two school boards in Fort McMurray delivering primary and secondary education; the Fort McMurray School District (the public school board) and the Fort McMurray Roman Catholic Separate School District (the separate school board). There is a francophone school, a charter school, and a private Christian school.

The public school board operates 10 schools and has one additional school building in excess of current needs. The separate school board, which operates eight schools, has recently expanded its high school, freeing up space that was used by high school students in other schools.

Northland School Division delivers primary and secondary education in the outlying communities. The following grade levels are available in the different communities:

- Fort McKay: Early Childhood Education (ECS) through grade 9. High school students attend school in Fort McMurray;
- Anzac: ECS through grade 6. Students in higher grades attend school in Fort McMurray;
- Janvier: ECS through grade 9. First Nation students can attend school in the community through grade 12. Other high school students attend school in Fort McMurray;

- Conklin: ECS through grade 9. High school students attend school in Fort McMurray; and
- Fort Chipewyan: ECS through grade 12.

Keyano College is the primary post-secondary education institution in the region. It has two campuses in Fort McMurray and operates a satellite campus in Fort Chipewyan. The college provides a broad range of educational services, including:

- Academic upgrading;
- Career certificate and diploma programs;
- Trades and technology programs;
- University studies, including some degree programs;
- Range of non-credit programs of both an employment and personal development nature; and
- Customized training for employers.

The marginal increase in population associated with the base case suggests relatively minor impacts on the educational system. The Urban Population Impact Model suggests that the primary and secondary education systems in the urban service area of Fort McMurray can expect a decrease in enrollments in the absence of oil sands projects beyond the Steepbank Mine and Aurora Mine projects. The number of school-aged children is estimated to decline from the 1996 estimate of 8,300 to an estimated 7,100 in 2010. This relates to the fact that the children of people who are now in their late thirties and early forties, currently the most numerous group in Fort McMurray, are about to complete their secondary education. In the absence of new families with young children entering the community, the school system will graduate more students than it will take in. The decline will reverse itself starting in 2014 as the number of persons retiring from the existing plants increases and the companies hire younger workers with young families to replace them.

School enrollment in the outlying communities is not expected to increase under the base case, but enrollments can be expected to increase as community members move back to the outlying communities.

With respect to the current situation, the increase in population experienced by the urban service area of Fort McMurray has not yet translated into a corresponding increase in enrollment at the primary and secondary school level. The 1997/98 enrollment numbers for public and separate school boards were 8,425, up by only 4% over the previous year.

Project Millennium Case

Although Project Millennium will bring new young families into the urban service area of Fort McMurray, the number of school-aged children is estimated to decrease marginally from the 8,400 in 1997 to 8,100 in 2010 (as predicted by population model). The number of school-aged children under the Project Millennium Case is between 900 and 1,000 higher than under the base case, indicating that the Project will mitigate against the enrollment decrease anticipated in the base case. Enrollment will show a temporary peak of 8,900 in the year 2000, when construction of Project Millennium is well advanced.

The enrollment decrease expected in the base case will be avoided if Project Millennium proceeds. An estimated 30 to 33 classrooms with an average class size of 30 pupils, and a similar number of teachers will need to remain within the systems. These resources will likely be required at the primary level in the near term, but as the students age, the resources required by them will shift to the junior high and high schools.

With respect to the physical infrastructure, the school systems are expected to be able to deal with the temporary increases associated with Project Millennium. The public school board has one school building in excess of current needs and increased busing, especially at the high school level, can be used to accommodate the increase in demand. The separate school board has recently expanded their high school, freeing up space that was used by high school students in other schools. Considering that most residential construction takes place in the Timberlea area, there will likely be a need for some additional facilities such as portable classrooms there. Because Project Millennium will mitigate the decrease in enrollment expected under base case conditions, it will help avoid school building surpluses.

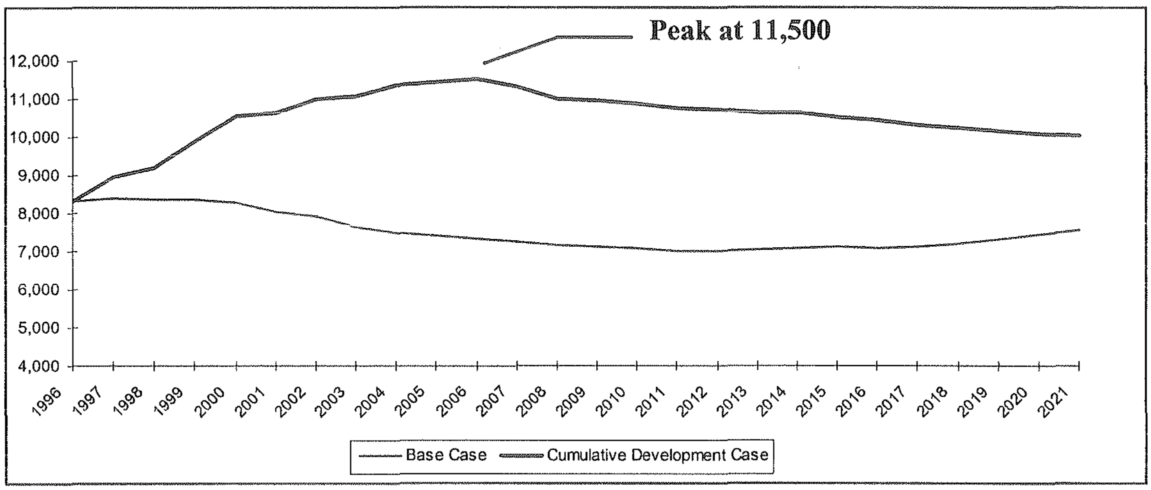
Impacts on the school system in the outlying communities is expected to be small because the overall population increases due to Project Millennium by itself will remain modest. Any changes in enrollments due to Project Millennium are likely to be small in comparison.

Project Millennium and the associated population increase will have an impact on Keyano College and other post-secondary education institutions. These impacts include more contract training opportunities and likely more demand for general interest courses in line with the population increase.

Cumulative Development Case

Assuming all projects in the cumulative development case proceed, the school systems in the urban service area of Fort McMurray will experience a marked increase in enrollments. Figure F2-6 shows that the number of school-aged children is expected to increase significantly from the 1997 estimate of 8,400 to 10,800 in 2010. The temporary peak of school-aged children is estimated at 11,500 in 2005. This increase of 2,400-3,100 children in the relevant age category represents a 30%-35% increase over eight years. This level of increase in school-aged children translates roughly to 80-100 classroom teachers and associated facilities over and above the current resources.

Figure F2-6 School-Aged Population Projection, Urban Service Area Base Case and Cumulative Development Case



Note: Base case includes existing oil sands plants, plus Steepbank Mine and Aurora North Mine Development scenario includes Muskeg River Mine, Mobil Kearl Oil Sands Mine, Suncor's Millennium Project, Syncrude 21 suite of projects, Gulf Surmont and some smaller *in situ* projects.

The increases in enrollment are more dramatic when compared with the base case conditions, which imply a decline in enrollment. The difference between enrollments in the base case and the cumulative development case is estimated to be 3,700 pupils in the year 2010.

The timing, not the magnitude, of the impact of the population increase under this scenario is sensitive to the age and family profile of the new workers attracted to the region. Discussion with representatives of Alberta Advanced Education and Career Development suggest that the new workers will be between 25 and 40 years old, with a bias towards the 30-40 year age groups. This profile, which is incorporated into the Urban Population Impact Model, means that many new families will likely have school-aged children, causing an immediate impact on the school systems. If most of the workers attracted to the area are in their early twenties, the impact on the school system would be delayed by five to ten years.

The Northland School Division, servicing the outlying communities, will likely experience increased enrollments as well. The size of these increases cannot be determined at this time. They depend on the relative size of the out-migration to take up employment elsewhere and the in-migration to avoid the increasing housing costs in Fort McMurray.

Post-secondary educational institutions can expect an increase in demand for general interest courses in line with the forecasted population growth. The increasing number of oil sands developers also expands the opportunities for contract training. The expansionary outlook for the regional work force is likely to attract students into post-secondary programs, especially those that tie in directly with the type of work available in the region.

Mitigation and Enhancement

RIWG, of which Suncor is a member, has supported the development of the Urban Population Impact Model, which estimates population by age group and provides detailed planning inputs to the educational institutions in the area. The development and maintenance of this model can aid the institutions with a range of issues, including facility and human resources planning.

Suncor is furthermore represented on the Education and Jobs Committee, a subcommittee of RIWG. The work of this committee focuses on providing educational institutions with detailed information about the number and types of operational jobs that may be created. It will furthermore attempt to identify any gaps between the educational and skill requirements associated with the new jobs and the training and education programs currently offered.

Suncor is currently and will remain involved with the education system in a number of ways, including support of:

- the Careers: The Next Generation Foundation, which runs a program to move young people into the trades and technical careers by giving information, work experience, and educational opportunities in 23 communities in Alberta. Suncor supports the foundation financially and a representative of the company sits on the foundation's board;
- the Fort McMurray Partners in Education Council, a partnership between industry and educational institutions under the umbrella of the Careers: The Next Generation Foundation. The Council sponsors a Co-op and RAP Apprenticeship program. A Suncor representative sits on the Council's board and the company has committed to four Co-op apprentices and six RAP students. Another inititative of the Council, supported financially by Suncor, is the Career Preparation program. This program is designed to give work experience and applied curriculum to high school students;

- support of the University of Alberta's co-op engineering program and Keyano College's co-op computer technician and office administrator programs; and
- educational initiatives at Mount Royal College and of a distance learning centre at Keyano College.

F2.5.3 Social Services

Base Case and Current Situation

The urban service area of Fort McMurray has a well-developed network of governmental and non-governmental social service agencies. These range from Alberta Family and Social Services and the municipality's Family and Community Support Services to the Fort McMurray Food Bank, the Salvation Army, and the Fort McMurray Crisis Centre.

Social services in the outlying communities are less well developed, especially in Fort McKay and the southern communities that have ready access to Fort McMurray. The social service delivery system outside the urban service area of Fort McMurray reflects the relationship between the Federal Government and the region's aboriginal people and involves the First Nations and the Department of Indian and Northern Affairs. Family and Community Support Services runs some programming in Anzac (e.g. homemaker and seniors' transportation services) and Fort McKay (e.g. Drug and Alcohol Program). Fort Chipewyan has a more developed social service network with service provision by provincial, municipal, and First Nations' agencies.

Under the assumptions made for the base case, most social service agencies could anticipate relatively stable demand for their services in line with the relatively stable anticipated population.

Services to seniors, including housing and health care, are expected to expand even under the base case assumptions. Currently, the number of seniors in the urban service area of Fort McMurray, defined here as people 60 years of age and older, is estimated to be slightly over 1,000. That number is expected to increase to 1,500 in the year 2006 and 3,500 in 2021. In addition, the senior population may increase as families bring elderly parents to live with them. The numbers presented here are critically dependent on the number of seniors who decide to remain in the area after their retirement. Currently, people providing services to seniors, such as respondents associated with the Golden Years Society, anticipate that an increasing number of seniors will do so, especially those who have strong roots and children and grandchildren in the area. The number of seniors remaining in the area may reach 30 to 40% of all retirees.

Social services delivery in the outlying communities, assuming the base case, is not expected to be affected significantly. Changes are required to improve the social situation in these communities, but these changes are not affected by the base case development, which is not expected to have a population impact in these communities.

The current situation is that most social service agencies have experienced an increase in the demand for their services over the past year and a half. Much of this increase in service demands relates to the estimated 14% increase in population in the area. In addition, a number of service providers are going through system-wide structural changes. For example, child welfare services are being regionalized and Alberta Family and Social Services in general has seen a range of changes over the past few years aimed at reducing the number of welfare cases.

Social services delivery in the outlying communities is increasingly stressed. There are indications of increased crowding, which is expected to increase stress on families and hence on the social services delivery system. Demand for services is high and there are concerns that the growth of Fort McMurray may decrease the access that people from the outlying communities may have to social services in the urban centre.

Project Millennium Case

The population forecast associated with the Project Millennium Case brings the long-term population of the urban service area of Fort McMurray to 38,100 in the year 2010. This estimate is roughly similar to the estimated 1997 population, which anticipates a broader range of projects. It is expected that the long-term stable population of about 38,000 associated with the Project Millennium Case will actually have fewer impacts on social agencies than is currently being experienced. At least part of the current demand is caused by unqualified job seekers coming to the region in anticipation of a broad range of projects.

Agencies are expected to confront a number of issues related to increased service demands. Caseloads for a number of agencies, such as Family and Community Support Services and AADAC, are high. Budgets for certain services, such as the Unity House shelter program and the Salvation Army Start program are fully allocated. Respondents voice the concern that volunteerism, on which many agencies depend both in terms of program delivery and fund raising, may decline in the near term as people in the community become busier.

If Project Millennium were the only project to go ahead, the impact on the population of the outlying communities is expected to be similar to the effect that is already being felt due to the range of developments that have been announced. Thus demands for social service in the communities should remain relatively constant compared to the current situation if only Project Millennium proceeds.

Cumulative Development Case

Social service agencies have already experienced some of the impacts associated with the Cumulative Development Case. The estimated 14% population increase in the urban service area of Fort McMurray in 1997 as compared to 1996 relates to the positive outlook for the oil sands sector in general and anticipates a range of projects, both expansions of existing plants and new operations. A lthough not without strain, the social service agencies are by and large coping with the cumulative impacts to date. For example, the Salvation Army Shelter and Unity House alternate between having some spare capacity and filling up. The Fort McMurray Housing Authority is able to keep up with the demands for subsidized housing.

Several agencies anticipate a relatively linear relationship between population levels and service demands. For example, AADAC, the YMCA, and counseling-related services can expect increases in demand of 20%-25%. Because the population increases are fuelled by new employment growth in the region, agencies such as the Salvation Army and the Food Bank may not see a corresponding increase in demands in the long run. However, they are expected to feel the impacts during the near term as the construction phase of the range of projects attracts speculative workers to the region.

Demand for social services in the outlying communities will likely increase as their populations increase. Beyond the population growth, there are at least two ways in which the level of demand for social services will be affected:

- the increasing job opportunities in the region provide a real opportunity for increasing the income levels in the outlying communities; and
- increased crowding that will occur if the housing demands associated with returning community members are not met, may increase stress on families.

The question of the impact of resource development on the health of the small and mostly aboriginal communities – and thus on social service agencies -- is very complex. There is no doubt that these communities are going through a major and very rapid transition. As recently as the early 1950s, the aboriginal people in the region lived mostly traditional lives, centred on hunting and gathering, and including complex social relationships characterized by veneration of elders and resource sharing. A number of factors, such as compulsory schooling for the children, the introduction of the money economy, and the growth of the non-aboriginal presence, contributed and continue to contribute to the decline of the traditional economy and social relationships. In its stead emerged an as yet uneasy mixture of traditional and, for lack of a better word, western European influences. Hence, aboriginal people now live in settlements, but retain a strong linkage to the traditional lands; elders are revered but, at times, politically and socially marginalized; and private wealth accumulation exists side-by-side with traditional ideas of sharing.

The extent to which the communities themselves will be able to resolve these tensions will determine the demand that will be placed on their social services. Other factors, such as adequate housing, municipal infrastructure, and recreational opportunities play a role as well.

Mitigation

The key mitigative measure proposed by Suncor is the use of a full-service camp throughout the construction period. This camp will be sized appropriately to accommodate construction workers. The presence, location, and operational practices of the camp minimize the likelihood that construction workers will come to town. Extended work schedules interspersed with long breaks to provide enough time for home visits, including the possibility of transportation of construction workers back and forth to Edmonton, will further reduce the impacts on the region.

With respect to the operational phase workers, Suncor has in place the following measures:

- an employee orientation program, outlining the range of services available in the community and how to gain access to them; and
- a company-sponsored Employee and Family Assistance Plan to assist families.

Individual agencies benefit from Suncor's charitable donations as well as from the volunteer efforts and donations of Suncor employees. Suncor charitable donations reached $450,000 in 1997, a number that is expected to increase to $600,000 over the next year. Part of these donations are directed towards social service agencies.

F2.5.4 Health Services

Base Case and Current Situation

The Northern Lights Regional Health Authority provide a wide range of health services to the region, including:

- Community/Preventive health services;
- Diagnostic and therapeutic services;

- Acute care (on an emergency, in-patient, and out-patient basis);
- Continuing care; and
- Home Care (long and short term, including palliative care).

It operates an 86-bed hospital with medical staff of 22 persons, covering all areas of specialization and a Continuing Care Centre with 30 long-term bed and one respite bed. Most patients requiring tertiary health care are moved to Edmonton.

Health services in the outlying communities are largely dependent on the facilities in Fort McMurray. The regional health authority provides periodic visits of a community health nurse to Conklin, Anzac, Janvier, and Fort McKay. The Medical Services Branch of Health Canada provides a range of health services on reserves, including addictions counseling and medical and mental health referrals. Health services in Fort Chipewyan are provided by the Nunee Health Authority and include a nursing station and the Noel and Isabel McKay Healing Centre.

Few impacts on health service delivery are anticipated under the base case. The population impacts under the base case assumptions are too small. Over time, health service demands are likely to change in all cases including the base case. This is a result of the demographic shift towards more seniors, which has health service implications in terms of type of illnesses that present themselves, demands on long-term care, and funding.

The Northern Lights Regional Health Authority has a number of concerns with respect to the current situation. The key ones relate to health care and its funding in general, including population-based funding. Greatly simplified, the population-based funding formula results in lower pe r capita funding for the Northern Lights Health Authority as compared to the provincial average, because the formula adjusts for the age and gender of the population. Although the introduction of this funding system will by itself not reduce the total funding to the health authority, it does mean that future funding will not keep pace with any population increases. The health authority is expecting a deficit for the 1998/99 budget year and anticipates increasing deficits or reduced services as the regional population grows.

Other concerns relate to the fact that the funding formula:

- does not reflect the cost of service delivery in the Regional Municipality of Wood Buffalo as compared to the rest of the province;
- relies on Alberta Health care statistics that reflect the population in the region in an incomplete and lagging manner.

The recruitment and retention of medical and administrative personnel are other issues faced by the health authority. Other health regions in rural Alberta face similar challenges and a new fund of $2.5 million has been established to help health authorities in the rural parts of the province with doctor recruitment. Half a million dollars from this fund was allocated to the Northern Lights Regional Health Authority.

Another health care concern is the total number of physicians. The number of persons per physician in the region is roughly 1200, compared to the provincial average of 610 (Alberta Physician Resources Planning Group Report 1997). This is partly because of the difference in age profile between the Wood Buffalo population and that of the province as a whole, as well as the fact that some patients are transferred to Edmonton-area tertiary care facilities. These caveats notwithstanding, these numbers suggest a shortage of some 20 physicians in the region.

Project Millennium Case

The impact of the population growth implied by the Project Millennium Case is not expected to increase health service demands beyond those that are currently experienced. Even during the temporary presence of construction workers between 1998 and 2002, the total service population of the health region is not expected to increase significantly beyond the current level.

The limited impact of Project Millennium on health services means that the Project will not change the current situation. As mentioned above, there are a number of concerns, including the funding structure and the difficulties to attract and retain medical and administrative personel and these concerns will remain under the Project Millennium Case.

Cumulative Development Case

Assuming the Cumulative Development Case, the total service population of the health region will likely grow to more than 50,000 persons during the operations phase of the projects. During the peak of the construction phase, the total population is estimated to increase to 53,000, including 5,500 persons in camps.

Without adjusting the analysis to the demand for individual services, the anticipated population level of 50,000 persons will require 70 physicians to keep the number of persons per physician at around 700 (compared to the current provincial average of 610). This implies an increase of at least 35 physicians over and above the current complement of 32-36. The demand for medical services will be higher during the 1999-2005 construction period, as the population peaks.

Mitigation

Suncor will attempt to minimize the impact on the existing health services by continuing to provide on-site basic emergency medical services to all workers. The construction camp(s) will have basic medical services for workers as well.

The company, through RIWG, is working with the health authority to assist it in its planning. Northern Lights Regional Health Authority has received a copy of the Urban Population Impact Model, which incorporates the most up-to-date project information and the anticipated impact on population (by age group). If necessary, the AOSDFC can assist the health authority with defining and presenting its case with respect to funding to Alberta Health.

Finally, Suncor assists with the recruitment of medical personnel by offering jobs to partners where possible. In addition, the company is working on a local recruitment video, specifically aimed at professionals, including physicians.

F2.5.5 Emergency Services

Base Case and Current Situation

Ambulance and fire fighting services in the Regional Municipality of Wood Buffalo are integrated under the umbrella of the Fort McMurray Fire Department. It maintains a professional cadre of fire fighters and emergency service technicians in the urban service area of Fort McMurray and supports the volunteer fire departments in the outlying communities.

Police services are provided by the Royal Canadian Mounted Police, which has both an urban and a rural detachment in the region. In line with funding arrangements in the rest of the province, the cost of the urban detachment are allocated against the municipal budget, while the rural detachment is paid for by the province.

The base case is expected to have a marginal impact on the regional population. This indicates that the resources of the ambulance, fire, and police system would be generally adequate if only the Steepbank Mine and Aurora Mine projects will proceed. Service levels under the base case assumptions would be similar to those experienced in the years up to 1996.

The current situation with respect to emergency services suggests that the resources are stretched as a result of the estimated 14% increase in population in the urban service area of Fort McMurray and to a lesser degree by the number of camps in the rural area. The Fort McMurray Fire Department has received additional resources in the 1998/1999 municipal budget, including eight Fire Fighter/Emergency Medical Technicians, a Medical Training Officer, a Safety Codes Officer, and a Director of

Disaster Services. The stated justification is to reduce work loads and response times to acceptable levels and ensure that training of emergency personnel is up-to-date and in line with their responsibilities. This includes airport emergency response.

The Royal Canadian Mounted Police has received an additional six officers for the urban service area, which will reduce the caseload per officer closer to the provincial average, based on the current population estimate of 38,700.

Project Millennium Case

The anticipated population levels, assuming that only Project Millennium will proceed, are roughly similar to the currently estimated 38,700 It follows that this scenario does not imply service demands beyond the ones experienced now.

New housing developments are concentrated in Timberlea, at the edge of the urban service area. This may require the construction of a new fire/ambulance station in the area, or an expansion of the existing station in Thickwood Heights.

Cumulative Development Case

The demand for emergency services is expected to increase with the population. In the short term and especially during the construction phases of the announced projects, the population (including the construction camps) will show a temporary increase in the number of young males. As a group, young males traditionally increase demands on emergency services as they tend to drink more, drive more recklessly, and are more prone to violent and criminal behaviour. The police and fire department already report an increase in these types of behaviour. Police, fire, and ambulance service will need to grow to meet the anticipated increases in the population. Assuming a roughly linear relationship, the population growth may imply a 30%-35% increase in the demand for emergency services. This would have implications not only for manpower, but also for facilities and equipment. The RCMP already reports that the current facilities, including office space and holding cells, are inadequate for the anticipated demands.

The proliferation of oil sands projects throughout the Regional Municipality of Wood Buffalo will bring basic emergency medical services to areas that currently have none. Mutual aid agreements and possibly further integration of municipal and company-based emergency services is expected to increase the fire and ambulance coverage in most of the outlying communities.

After a period of adjustment, the oil sands industry expansion is expected to contribute positively to the fiscal health of the municipality. Subject to the political process, this means that the fiscal resources will be available to provide appropriate emergency service coverage.

Mitigation

Construction camps are the key mitigative strategy with respect to emergency services. Full-service camps and the anticipated long construction shifts minimize the number of persons who will come to Fort McMurray to shop, recreate, or conduct business. Camp security will take on in part the role that the RCMP fills in the urban service area.

Suncor provides fire protection on its site and ambulance services for its on-site workers. The company will look to extending existing mutual aid agreements with the fire department of the Regional Municipality of Wood Buffalo and Syncrude to any new oil sands developers that may become operational in the area, thus creating increased fire and ambulance coverage in the rural area.

F2.5.6 Highway Transportation

Base Case and Current Situation

The region is connected with the rest of the province by Highway 63. This highway runs from the southern boundary of the study area, through the urban service area of Fort McMurray, north past the Suncor and Syncrude plants and to Fort McKay. The highway is paved up to the Peter Lougheed bridge over the Athabasca River just north of Fort McKay. Beyond the bridge, the road is graveled and becomes part of the winter road to Fort Chipewyan.

The other access into the region is via secondary Highway 881, which is a gravel road from the southern boundary of the municipality to Anzac, and paved from there to the intersection with Highway 63 just south of the urban service area of Fort McMurray. Other highways include Highway 69, which connects Saprae Creek and the airport to Highway 63, just south of Fort McMurray.

Under the base case assumptions, the highway transportation is not expected to be affected significantly. The exception is the construction period, which would see increased truck and bus traffic as construction materials, equipment and workers are brought to the Steepbank Mine and Aurora Mine sites.

With respect to the current conditions, there are a number of concerns with respect to the Highway 63 north of Fort McMurray, including:

- Peak hour traffic early in the morning and late in the afternoon. This issue relates to:
  - human safety;
  - the potential for lost work-time at the plants if the highway is blocked;
  - length of the average work-day if the commute time is extended due to traffic problems; and
- Transportation of industrial materials and bulk commodities through the urban core of Fort McMurray.

Oil sands developers have expressed concern that any construction activity on the highway, including rehabilitation work on the bridges over the Athabasca River, should be scheduled to minimize the impacts on the movement of people and goods. Current planning is to conduct repairs to the bridge carrying northbound traffic in 1998, necessitating the closure of one lane. The bridge carrying southbound traffic is in need of a deck replacement, which will block both lanes. The timing of this work is uncertain and may be done in 1999.

Road issues south of the urban service area of Fort McMurray include:

- reliance on a single main highway link to the rest of the province and the implied vulnerability of the region to disruptions of traffic;
- the volume and speed of travel on Highway 63 on Friday afternoons when people leave for Edmonton; and
- increased traffic on Highway 881.

Table F2-7 presents the average annual daily traffic counts (AADT) collected by Alberta Transportation and Utilities for 1995, 1996, and 1997, which are the latest available data.

Table F2-7 Average Annual Daily Traffic Counts (AADT)

Location	1995	1996	1997
Highway 63, South of Suncor Turnoff	3,600	4,300	5,100
Highway 63, North of Suncor Turnoff	2,500	3,200	N/A
Highway 63, North of Syncrude Turnoff	690	1,340	N/A
Highway 63, South of 69	2,860	2,980	N/A

Traffic of Highway 63, north of Fort McMurray is related to the Syncrude and Suncor plants and local traffic to Fort McKay. Highway 63, south of Fort McMurray services local traffic to Anzac, Janvier, and Conklin as well as through-going traffic to Lac la Biche area, Edmonton, and beyond.

These numbers count every vehicle movement. Assuming that virtually all vehicle movements are part of a same-day return trip, mostly during rush hours, this means that the busiest stretch of highway accommodates 2,500 vehicles in the morning and again in the late afternoon. The numbers show that traffic in 1997 has increased by 19% as compared to 1996 levels, which are a 20% increase over 1995. These increases are related to the high level of production achieved by the existing plants, the trucking of some by-products, such as coke, and the pre-construction activities associated with the announced projects. For example, Petro-Canada and Shell had winter drilling programs to delineate the resource and Shell is installing a pilot plant on its Lease 13 site in 1998.

Project Millennium Case

Project Millennium will contribute to the traffic on the highway south and north of Fort McMurray and in the urban service area itself. An estimated 20,000 trucks will be required to bring the materials and equipment to the mine site over the two-and-a-half year construction period. Many of these trucks will originate from the Edmonton area. T his estimate translates into an average of 40 construction-related trucks, or 80 vehicle movements, per day, during peak construction. Traffic data indicate that traffic volumes tend to be lowest on Mondays and highest on Thursdays, suggesting that on peak days as many as 50 trucks (or 100 vehicle movements) can be expected.

These truck movements do not include smaller delivery trucks, contractor pick-ups moving goods and personnel, and other construction- and operations-related travel. Taken together, traffic during the construction phase may reach an average of 5,600 vehicle movements, an increase of 30% over the 1996 numbers and a 10% increase over the 1997 numbers. This means that on the busiest days, the highway between Fort McMurray and Suncor is expected to accommodate 6,500 vehicle movements per day. Operations-related traffic on Highway 63 south of the Suncor turnoff is expected to be in line or marginally lower than the 5,100 vehicle movements experienced in 1997.

Traffic on Highway 63 south of the urban service area is expected to increase in line with the anticipated population. Additional construction traffic will influence the traffic flows as well, but these are relatively minor compared to the general traffic level. This traffic stream is not expected to increase significantly over the currently experienced numbers because the population of the Project Millennium Case is not expected to be much more than 1997 levels.

Cumulative Case

Expected average traffic volumes south of the Suncor turn-off may reach over 6,800 vehicle movements during the peak construction period in the year 2000 and 2001. This is an increase of about one-third over the 1997 number of 5,100. The traffic counts will fall to approximately 5,500 after the construction period as the number of persons on site decreases. This represents a lasting increase of 8% over the 1997 level. These numbers are averages and mask the inter-week variation. Adjusting the estimates for the fact that Thursdays tend to be busier than the average by about 15%, there will be days that the highway will need to accommodate an estimated 7,700 vehicle movements during the construction period.

Traffic volumes on highway 881 will increase as well as *in situ* projects are developed in the Anzac area.

One of the uncertainties with respect to highway transportation relates to the movement of bitumen from *in situ* producers. It is currently not known how the smaller projects, such as Petro-Canada's Fort McKay River project and the JACOS Hangingstone project, will bring their product to market. This could involve a considerable number of truck movements if it involved any kind of road transportation. A 20,000 barrel/day *in situ* project will require some 80 truckloads per day to move production off site.

Mitigation

Suncor and other developers will seek to minimize the impact of their projects on the highway system by:

- having a camp for construction workers, thus minimizing the number of workers commuting
- scheduling construction materials/equipment delivery in off-peak periods;
- busing workers during both the construction and the operations phases;
- actively discouraging private vehicle use by construction workers; and
- co-operating with other oil sands developers to consider modifying work hours and a park-and-ride concept.

RIWG, of which Suncor is a member, has initiated a traffic study with a view to 1) document the traffic situation, 2) investigate available traffic management and infrastructure options, and 3) recommend solutions. This study, which was initiated in early February 1998, will bring a cleared focus to traffic issues and provide an implementation plan to optimize the highway system. Although in an early stage as this report is prepared, the traffic study has identified a number of mitigative measures including:

- twinning the highway between Fort McMurray and the Suncor turnoff;
- reconfiguring the intersection of Confederation Way and Highway 63 and the UTF turnoff;

- constructing a merger/left turning lane at the Suncor turn-off;
- reconfiguring the busing system, including:
  - construction of a staging area on the north side of Fort McMurray
  - allowing contractors on the company buses
  - integrating bus service to Saprae Creek and Anzac
  - other incentives to increase bus usage, such as limiting plant-site parking; and
- revisiting the shift schedules to minimize overlap of traffic peaks.

The study will also provide some preliminary assessment of the viability of extending the rail system to the plants. The rail system currently ends just south of Fort McMurray.

F2.5.7 Other Infrastructure

Base Case and Current Situation

Much of the infrastructure of the urban service area of Fort McMurray was developed in two distinct waves. The first wave of development in the mid-1960's was associated with building the Great Canadian Oil Sands (now Suncor) plant. Most of the residential, commercial, and industrial development at that time was concentrated in and around the lower town site. The second wave was in the mid-1970's when the Syncrude plant was constructed and became operational. At that time development spread to north of the Athabasca river. Some infrastructure is of more recent vintage. The water treatment plant, for example, was commissioned in 1988.

Much of the urban service area's municipal infrastructure was sized to accommodate a population in excess of 55,000-60,000, a population level that assumed a number of oil sands projects that did not materialize. The current population forecasts remain well below the previously anticipated 60,000 level. This relates in part to the fact that improvements in technology, such as truck and shovel mining methods, and hydro transportation of ore, have reduced the number of workers per unit of output as compared to the earlier projects. It follows that considerable capacity in much of the municipal infrastructure remains.

There is sufficient land available for development, but much of it is controlled by Alberta Municipal Affairs. Discussions are ongoing about how much, how fast, and by which means this land should be made available to the municipality or developers. As new lands are brought onto the market, there will be a need to provide servicing. The current inventory of serviced lands is being depleted by the ongoing development.

Under the base case assumptions, the general infrastructure of the urban service area of Fort McMurray is generally adequate. Normal and continuing upgrading and maintenance would be expected to take place, including the rehabilitation of the bridges over the Athabasca River. No major municipal capital projects were anticipated in reaction to the development of the Steepbank Mine and Aurora Mine projects.

The current situation, characterized by an increased population in anticipation of a number of oil sands projects, brings infrastructure issues more in focus. The following issues have been identified:

- a new water supply line and booster station will be needed to service Timberlea and Thickwood Heights;
- Confederation Way, a major access road to Timberlea, may require twinning to keep up with increased traffic volumes;
- some intersections may require upgrading to accommodate additional traffic; and
- the bridges over the Athabasca River will require rehabilitation (see discussion of highway transportation above).

Other areas that merit mention are the ongoing work towards a new regional solid waste disposal site and the stress on the planning infrastructure of the municipality. Planning and approval activities have gone up over the past 18 months, placing stress not only the planning department of the municipality but also on other departments that provide inputs into the planning process. The 1998 budget includes provision for additional planning resources.

The municipal infrastructure in the outlying communities is not as well developed as that of the urban service area. For example:

- Anzac has a water treatment plant and a sewage lagoon, but water is hauled from the treatment plant to the homes and businesses and sewer removal depends on truck service;
- some homes in Janvier are not connected to the central water or sewer systems;
- there is no central sewage system in Conklin;
- Fort McKay has central treatment plants for water and sewer but water quality and sewer system capacity are recurring concerns expressed by residents; and
- the Allison Bay and Doghead reserves near Fort Chipewyan are not connected to the central water and sewer systems of the community and the local landfill is nearing capacity.

These municipal infrastructure issues are independent of oil sands development, although any in-migration into the communities will make these issues more acute (see below).

Project Millennium Case

The population estimates associated with the Project Millennium Case do not reach critical municipal infrastructure thresholds. The change from a stable population and outlook to one of population growth and optimism, partly due to the anticipation of Project Millennium, has brought general infrastructure needs more in focus and the municipality is in the process of reviewing its infrastructure planning assumptions.

Generally, it is difficult to separate Project Millennium and cumulative impacts. Insofar as Project Millennium will increase the population in the outlying communities, especially Fort McKay, the municipal infrastructure will be put under increasing stress.

Cumulative Development Case

The population forecast, assuming that all announced oil sands projects go ahead, is tending towards 50,000. Although this is below the critical threshold for major new water and sewer system development, the existing systems will be much more fully utilized than is currently the case. It is likely that the infrastructure issues described in the *Base Case and Current Situation* section will be executed, while other minor infrastructure bottlenecks will be identified. Infrastructure issues in the outlying communities will be put under increasing stress as their populations increase.

As will be discussed in more detail in Section F2.5.8, the cumulative development scenario is expected to increase over time the municipal fiscal capacity and thus the ability of the municipality to meet infrastructure needs.

Mitigation

As with many traffic issues, municipal infrastructure development is outside the scope of activities of oil sands developers. The Suncor site has its own infrastructure, including roads, water, and sewer systems. Infrastructure issues are under discussion in the context of RIWG and, if necessary, the AOSDFC may provide its support to the municipality to bring infrastructure issues to the attention of the province.

The Regional Communities Committee, a sub-committee of RIWG, will likely touch upon infrastructure needs as it works with the communities to gather baseline information and assess impacts.

F2.5.8 Municipal Fiscal Situation

Base Case and Current Situation

The Regional Municipality of Wood Buffalo came into existence in 1995 when the City of Fort McMurray and most of Improvement District 18 were amalgamated. The size and the inclusion of both a well-developed urban centre and a number of small outlying communities set the Regional Municipality of Wood Buffalo apart from most other municipalities in Alberta. Only Strathcona County similarly straddles both urban and rural areas.

The relative fiscal health of the municipality can be gauged by comparing Wood Buffalo to, for example, all cities, all rural municipalities (counties and municipal districts), and to Strathcona County. As evidenced by the following comparisons, Wood Buffalo falls in between the averages of all cities and rural municipalities on a number of municipal financial variables, reflecting the hybrid nature of the municipality:

- the equalized assessment per capita in Wood Buffalo is $87,300 as compared to $50,400 for all cities and $142,000 for all rural municipalities (1997 data, relating to property assessments done in 1996);
- Wood Buffalo's expenditures per capita are $1,200, as compared to $950 for all cities, $1,300 for all rural municipalities, and $920 for Strathcona County (1996 data);
- the debt per capita of Wood Buffalo stands at $650, as compared to an average of $860 for all cities, $80 for all rural municipalities, and $500 for Stathcona County (1996 data); and
- the reserves per capita of Wood Buffalo are $700, as compared to an average of $330 for all cities, $1,400 for all rural municipalities, and $450 for Strathcona County (1996 data).

Tax and utility levels on a standardized dwelling with an equalized assessment of $100,000 are $2,200 for Wood Buffalo, similar to the city average, but higher than the $1,600 average of all rural municipalities:

Wood Buffalo is relatively more dependent on non-residential assessment than most other municipalities. Seventy five percent of the assessment base of Wood Buffalo relates to non-residential properties as compared to 63% for all rural municipalities, 31% for all cities and 46% for Strathcona County's (1997 data, relating to property assessments done in 1996). Suncor's facilities constitute approximately 14% of the rural assessment in the municipality and almost 10% of the total assessment base (urban and rural).

Under the base case the financial capacity of the municipality is expected to increase because the Steepbank Mine and Aurora Mine projects increase the assessment base without adding significantly to the municipal costs. These two projects and the associated residential and commercial developments are expected to increase the total rural and urban assessment base by 3%-4%.

The current situation with respect to municipal financial situation is characterized by:

- increasing costs as the municipality copes with an increasing population and the requirements to deal with planning, as evidenced by the 9% increase in the municipal budget from $47 million in 1997 to $52 million in 1998; and
- increasing revenue as new houses, commercial, and industrial properties are developed.

The key concern is that municipal costs outstrip the increased revenues at least in the short term. In addition, there is the possibility that not all developments proceed as planned. This could mean that the municipality spends now to deal with future growth that may not materialize to the extent anticipated.

Project Millennium Case

Project Millennium will increase the assessment base of the municipality in two ways:

- directly by means of capital expenditure on assessable property; and
- indirectly by stimulating the expansion of residential, commercial, and industrial property development.

The Project is estimated to increase the assessment base of the Regional Municipality of Wood Buffalo by 30% or more when operational. In addition, the Project will induce construction of an estimated 550 dwellings, which will add to the assessment base as well. It will also increase the municipal costs, although it is difficult to separate out the incremental municipal costs associated with Project Millennium from the cost related to the cumulative oil sands developments.

In greatly simplified terms, the municipal costs and benefits associated with Project Millennium can be summarized as follows:

- increases in municipal costs are likely in line with the 10% increase experienced in the 1998 budget; and

- increases in the municipality's assessment base and thus in its fiscal capacity are in the order of 30%-35% by the time Project Millennium is operational.

Although it is fully within the jurisdiction of the Council of the Regional Municipality of Wood Buffalo to determine municipal service levels and set mill rates, it appears likely that mill rates on residential, non-residential, or both types of property will trend downward over the medium term. In the near term, the fiscal capacity of the municipality is not expanding as quickly as the demand for services, creating a short term financing issue.

Cumulative Case

With over $12 billion worth of projects anticipated within the boundaries of the Regional Municipality of Wood Buffalo over the next eight to ten years, the fiscal capacity of the municipality may expand by 190% or more. Cumulatively the population of the region is expected to increase by roughly one-third, increasing municipal costs in the same order-of-magnitude. Taken together, the almost doubling of the fiscal capacity and the 30% increase in population indicate that Wood Buffalo is well positioned financially to deal with growth. The key issue remains how to bridge the immediate need for growth related spending and the assessment base increases expected in four or five years.

F2.6 REGIONAL, PROVINCIAL, AND NATIONAL ECONOMIC IMPACTS

This section outlines the impacts of Project Millennium in economic terms. This is in contrast to the previous sections, which focus mainly on the societal effects of the project. The economic analysis includes an examination both of the broad income and employment impacts of the project and of the economic efficiency of the project as measured by net social benefits.

Although this section treats Project Millennium as a single project, it consists of two parts. The first part is known as the Production Enhancement phase or PEP, a $200 million project to bring the throughput of the current upgrader from 105,000 barrels per day to 130,000 barrels per day. The second phase will expand the upgrading and mining facilities to take the facility to a capacity of 210,000 barrels per day at an estimated cost of $2 billion. Both phases will be designed and constructed using contractors with extensive experience in the engineering, construction, procurement, and management (ECPM) of large industrial projects. Separate ECPM contractors will be working on the upgrader, the mine, and the energy services parts of both phases.

The PEP phase will be conducted by the ECPM contractors independently of each other. That means that their individual hiring, procurement, and management practices will prevail. The Project Millennium phase, the larger of the two, is being designed and contracted by an alliance of engineering, manufacturing, construction contracting, and EPCM companies. One of the aspects of the alliance is that the partners coordinate procurement and rationalize purchases across the whole project.

Subject to minor modification, the general approach to contracting and procurement will be to hire, contract, or procure locally first, provincially second, nationally third, and internationally if necessary. This general approach is always subject to availability, quality (product and service), and price.

F2.6.1 Regional and Provincial Income Impacts

Construction

Table F2-8 presents an estimate of the local/regional income impacts of the construction of Project Millennium. The table also shows the income impacts on the rest of Alberta, Canada, and other countries.

Table F2-8 Construction Expenditure by Geography

	Region	Other Alberta	Other Canada	Outside Canada	Total
			(1998$'000)		
Engineering	6,700	217,300	12,000	12,000	248,000
Labour	169,000	457,000	56,000		682,000
Equipment	52,900	98,200	119,000	409,000	679,100
Materials	159,200	295,800	143,000	9,000	607,000
Total	**387,800**	**1,068,300**	**330,000**	**430,000**	**2,216,100**
	18%	**48%**	**15%**	**19%**	**100%**

The table shows that an estimated 18% of the direct construction spending will accrue to *** and thus constitute income for *** local and regional companies and workers. Much of this income impact leaks out of the region, for example by remittances of construction workers to their families out of the region. The Alberta economy, including the Regional Municipality of Wood Buffalo, is expected to receive 66% of all construction expenditures, with an additional 15% accruing to the rest of Canada. The balance or 19% is expected to accrue to foreign suppliers.

The following comments should be considered in interpreting this information:

- competitive pressures and capacity constraints of the provincial manufacturing base may alter procurement patterns. The analysis presented here assumes that traditional supplier relationships will remain valid throughout the construction period; and
- the analysis recognizes and adjusts for the fact that much of the locally procured goods are manufactured elsewhere. Part of the remaining expenditures accruing to regional economy will "leak" out of the region and province in the form of manufactured inputs that suppliers obtain from out-of-region and out-of-province sources.

The foreign content of the overall project expenditure relates in large part to the procurement of mining equipment, such as heavy haulers and shovels – which are not made in Canada.

The construction expenditures of Project Millennium constitute income for the worker and revenues for the contractors that build the plant. Contractors, in turn, spend on materials and equipment, thus compounding the impacts. Project workers and those employed by suppliers to the project spend their income in part on goods and services, thus compounding the direct income impacts as well.

Table F2-9 provides estimates of the direct and of the aggregate (direct, indirect and induced) impacts of the construction phase based on published multipliers (Alberta Treasury, 1996). The total income impacts of the project are expressed in terms of GDP and household income. The analysis indicates that the project will increase the province's gross domestic product by a cumulative $1.79 billion and household income by $1.2 billion in the period between 1998 and the year 2002.

Table F2-9 Project Millennium Total Construction-Related Income Impacts to Alberta 1998-2001

	Direct Impact	Direct, Indirect, Induced Impacts	
		GDP	Household Income
	---------1998 $ million-----		
Project Millennium	2,217	1,790	1,224

Operations

Table F2-10 presents an order-of-magnitude estimate of Project Millennium's average annual operations expenditure and its geographic allocation. Operations expenditures vary year-by-year, depending, for example, on plant turn-arounds, sustained production levels, and variations in major input prices, such as natural gas. It follows that the numbers presented in Table F2-10 cannot be construed as the expected operating cost of Project Millennium for any particular year.

Table F2-10 Average Annual Operations Expenditure by Geography

	Local	Other Alberta	Other Canada	Outside Canada	Total
			(1998$'000)		
Labour	96	12	1		109
Energy	10	9			19
Goods and Services	28	63	31	33	156
Total	**134**	**84**	**32**	**33**	**284**
	47%	**30%**	**11%**	**12%**	**100%**

The table indicates that, on average, almost half of the operations expenditures accrues to workers and suppliers in the region. These numbers are adjusted for the fact that most of the expenditures on goods is expected to 'leak" out to the region even if the supplier is Fort McMurray based. In total an estimated three-quarters of the annual operating expenditure (or $220 million) accrues to the provincial economy.

Suncor maintains a close relationship with local contractors and suppliers. For example, it issues a Bid Information Report every two weeks, holds quarterly meetings with the Tri-Association, consisting of the Fort McMurray Chamber of Commerce, the Construction Association, and the Northeastern Alberta Aboriginal Business Association, and chaired the Buyers Guide and Business Registry Committee. The company has developed a set of "best practices" for its dealings with local suppliers. These "best practices" include:

- open and transparent communications, supported by training if required;
- consistent application of principles and policies; and
- early communication of opportunities.

These activities and initiatives include aboriginal companies, several of which have long-term business relations with Suncor. The volume of contracts with aboriginal suppliers reached $16 million in 1997, up over 50% over the year previous. These contracts cover a broad range of goods and services, including:

- electrical services;
- transportation;
- equipment rental;
- custodial services;
- dry cleaning;
- asphalt paving; and
- limestone crushing.

Suncor is actively working with existing and other aboriginal suppliers to develop and strengthen business relations.

As with the construction related expenditure, the operations expenditure is compounded by the subsequent re-spending by suppliers and workers on a broad range of goods and services. Table F2-11 presents estimates of the total direct, indirect, and induced income impact of the annual operational spending of Project Millennium, based on published multipliers (Alberta Treasury 1996). The table indicates that the project will contribute an estimated $270 million annually to the provincial GDP and $140 million to household incomes in the province.

Table F2-11 Project Millennium Average Annual Operations-Related Income Impacts to Alberta

	Direct Impact	Direct, Indirect, Induced Impacts	
		GDP	Household Income
	---------1998 $ million-----		
Project Millennium	280	270	140

F2.6.2 Provincial Employment Impact

The local and regional employment impacts have been discussed in Section F2.5. This section outlines the employment impact on the province.

Construction

The total direct employment impact of Project Millennium is equal to the on-site work force and the engineering work force that is mostly located in Alberta but off-site. T he construction phase is estimated to require 6,900 person years of engineering and on-site construction work in the province. This direct employment will also generate indirect employment or employment with suppliers to the project and induced employment or employment in the general economy driven by the personal spending of the direct and indirect workers. The total direct, indirect, and induced employment impacts is estimated at 15,000 person-years over the 3-year construction period.

Operations

Project Millennium will add approximately 800 persons to the Suncor operations work force (direct employment). T he economic activity that is generated by the Project will create employment with suppliers to Suncor (indirect employment) and, through the spending of workers employed as part of Project Millennium and its suppliers, in the general economy (induced employment). The total direct, indirect and induced employment associated with Project Millennium is estimated at 2,100 person-years annually.

F2.6.3 Net Social Benefit

The Net Social Benefit (NSB), presented in Table F2-12, is a measure of the new wealth that is created by the project. It is derived by taking an estimate of the total revenue stream of the project and netting out the total production costs. The NSB is then divided into its constituent parts indicating the recipients of the new wealth created. Table F2-12 indicates that the Project will create an estimated $8.3 billion of net social benefits over the life of the project. These estimates of the NSB relate to Project

Millennium only and do not include the royalties and taxes paid by the current facility.

Table F2-12 Project Millennium Net Social Benefits by Recipient

	Total	NPV @ 8%
	-----1998 $ million ---	
Provincial Royalty	1,370	450
Federal Income Taxes	1,860	530
Provincial Income Taxes	1,050	300
Owners Net Cash Flow	4,060	680
Total	8,340	1,960

The benefits accrue over time and it is appropriate to express the future flow of benefits in present value (NPV) terms. As shown in Table F2-12, the NPV of the net social benefits is estimated (using a real discount rate of 8%) at $1,960 million over the 1998 to 2022 period. On a NPV basis, the provincial government captures $750 million in royalties and taxes (or 38% of the NSB), while the federal government captures $530 million or 27% by way of corporate income taxes. Together 65% of the NSB accrue to the provincial and federal governments. The municipal government will also receive tax income.

The NSB estimates presented here do not account for additional spending on the part of the municipality or the provincial governments on infrastructure. These latter expenditures, which could include, for example, the cost of upgrading the highway system in the area, would decrease the NSB. It is instructive to place the $30 million preliminary cost estimate for upgrading Highway 63 between Fort McMurray and the Suncor turnoff in the context of the government royalty and tax income from oil sands development. The highway upgrade, which would serve as well the Mobil, Petro-Canada, Shell, and Syncrude projects, is less than 5% of the royalty and provincial tax income of Project Millennium alone.

F2.6.4 Other Impacts and Benefits

The development of Project Millennium will bring provincial economic benefits beyond the employment and income impacts and the net social benefits discussed above. These benefits are summarized below:

- Provincial economic goals and objectives. The project constitutes new investment, diversifies and sustains the economy through the upgrading of resources and the expansion of non-conventional oil development, increases exports, and promotes economic growth in the rural area of the province. All these are in line with general provincial policy goals;

- Provincial fiscal objectives. The project will contribute directly to the resource revenues received by the province and will increase personal, corporate, and other tax revenues through the employment and economic activity induced by the project. The oil sands industry now accounts for roughly one-tenth of non-renewable resource revenues;
- Oil sands industry development. The project is the second largest of the currently announced commercial oil sands projects, effectively doubling the capacity of the Suncor facility. Suncor's activities, including the Fixed Plant Expansion, the Steepbank Mine, and Project Millennium make an important contribution to the change in outlook in the region, and will make additional projects more likely. Further expansion in the oil sands is important to off-set declines in the province's conventional oil industry; and
- Secondary industry development. The oil sands industry in general, and the Suncor operation specifically, provide a base load for the Albertan and Canadian manufacturing base. Suncor co-operates with its suppliers to meet the specific challenges placed by the oil sands environment, stimulating technological innovation. Although the impact on the secondary industry covers both the construction and operations phase of the projects, it is especially important with respect to the increasing operational scale of the industry. The total Suncor operations, including Project Millennium is expected to spend in excess of $700 million per year in operating expenses, some 20% of which is related to parts and supplies.

Suncor's research and development activities support scientists, technologists, and support personnel and the firm participates extensively in collaborative research initiatives through universities and government research organizations and with others in the industry. Suncor was the first oil sands firm to adopt truck and shovel mining methods and has adopted the commercial use of hydro-transportation, which is replacing conveyor belt systems to move mined oil sand. These and other innovations have contributed to the incremental reduction of per unit production costs, which, in turn, are one of the reasons behind the current interest in oil sands development.

These economic benefits, expressed in qualitative terms, reinforce and compound those more explicit measurements of project economic impacts described earlier in the document.

F2.7 CONCLUSION

Project Millennium creates significant employment, household income, and government fiscal benefits to the region, the province, and the country. It is a cornerstone project in the resurgent interest in developing the oil sands resources in northeastern Alberta.

The population growth induced by Project Millennium can be accommodated by the regional service providers. Indeed, the urban service area of Fort McMurray is already coping with population increases of similar magnitude in anticipation of a range of oil sands projects. The outlying communities, especially Fort McKay, which is located in close proximity to the Suncor plant, will likely experience a modest increase in population as well. This could create additional stress on their physical and service infrastructure.

Cumulatively, the region is preparing for a population increase of about one-third. This will create challenges for the municipality and the local and regional service providers. The current development phase of the oil sands industry is different from those in the past due to the scale of the total investment and the number of companies involved. This increases the need for regional cooperation between project proponents, the Regional Municipality of Wood Buffalo, and service providers. This cooperation is already emerging through the work of the Regional Infrastructure Working Group (RIWG) and the Athabasca Oil Sands Development Facilitation Committee (AOSDFC) and will need to be continued throughout the construction and operations phases of Project Millennium and the other proposed projects.

The main regional concerns include local employment, housing, education, social services, health services, emergency services and highway transportation. A summary of the socio-economic impact assessment is presented in Table F2-13. Sub-committees of the RIWG have been struck to develop resolution strategies. With respect to Project Millennium, Suncor has specific initiatives to ensure regional committees participate in the project to the fullest extent possible. One example is to target work force diversity consistent with regional demographics.

The challenges of growth notwithstanding, Project Millennium will have a positive socio-economic impact on the region and the project is desirable from the perspective of the region, the province, and the country

Table F2-13 SEIA Summary

Issue Area	Concerns	Millennium Case	Cumulative Case	Mitigation
Local Employment	• Number of aboriginal workers at Suncor (4% of work force) does not reflect demographics in the region.	• New hiring as part of Project Millennium provides opportunity to increase work place diversity.	• Opportunity for increased involvement of aboriginal workers and contractors. • Some lead-time to align education levels and work place requirements; • Some lead-time for business development initiatives.	• Concerted effort to increase workplace diversity, including aboriginal workers. • Strategic target is to have workforce demographics in line with regional demographics by 2002. • Continued work with communities to develop local business opportunities. • Collaboration with other developers with regard to aboriginal business development • See also: Education
Housing	• Housing shortages; • Increase in house prices and rents (affordable housing): • Lack of new rental accommodation	• **Urban:** Operational employment and associated indirect and induced employment will require an estimated 1050 housing units. The real estate market is already reacting to this increased demand as evidenced by decreased vacancy rate and increased building activity. • **Rural:** Outlying communities may experience a marginal increase in housing demand as community members return from Fort McMurray to avoid increasing housing costs and obtain work from the project (directly or indirectly) while remaining in the community.	• **Urban:** Regional Development Scenario implies approximately 3,600 units to house in-migrants into the urban service area. Assuming housing construction at 350/year, housing shortage through 2007/8. • **Rural:** Fort McKay and other communities will likely experience increased housing demands as community members return from Fort McMurray to avoid increasing housing costs and obtain work from the project (directly or indirectly) while remaining in the community.	• Use of construction camp(s) will limit demands on housing in Fort McMurray by direct construction workers. • Ongoing cooperation with the municipality with respect to housing issues (e.g. Mayor's task force on housing). • Ongoing consultation among developers with respect to co-operation on camp issues. • Commitment to assist operational phase workers with housing until new house construction has caught up with demand.
Education	• Enrollment increases as population grows; • Training needs of aboriginal and other youths to ensure linkage to employment opportunities in the oil sands. • General trend towards increased educational requirements to reflect increased job complexity.	• **Urban:** In migration is expected to translate into keep enrollment numbers approximately at 1997 levels. Project Millennium mitigates against an expected decrease in enrollment in the base case and means that teaching and classroom resource related to 30-33 classes of children (assuming 30 children per class) will not become surplus. • **Rural:** Minor increases in enrollments in community-based schools as population increases.	• **Urban:** In migration is expected to increase enrollments by 2,400-3,100 students over eight years. This translates into 80-100 additional classes 30 children, starting out in primary school. • **Rural:** Increases in enrollments in community-based schools as population increases.	• Development of Urban Population Impact Model to aid school boards and Keyano College with planning. • Involvement with and support to school systems in terms of Career Preparation and other programs (Careers, the Next Generation Foundation). • Collaborative efforts in the context of the Training and Education Working Group, a sub-committee of the RIWG, working towards providing institutions with information on type of operational jobs and their skill requirements. • Sponsorship of educational initiatives at Keyano College, U. of A., and Mount Royal College.

Issue Area	Concerns	Millennium Case	Cumulative Case	Mitigation
Social Services	• Population growth is stretching the resources of many agencies, although, by and large, current needs are being met.	• **Urban:** Millennium-induced population growth is roughly similar to the increase in population between 1996 and 1997. No additional impact over those currently experienced is expected if Millennium is the only project to proceed. • **Rural:** Anticipated minor increase in population of Fort McKay is expected to increase demands for social services in that community.	• **Urban/Rural:** Increased demands for the services of many agencies (e.g. AADAC, FCSS) in line with increased population numbers (25%-30%). • Employment growth may limit the demand for services of food bank and Salvation Army shelter to less than population increase over the longer term. In the short and medium terms these services may see demand increases in excess of population growth during construction phases.	• Full service camp during construction will limit the demands of construction workers on social service agencies in Fort McMurray. • Orientation program for new operations phase employees; • Employee and Family Assistance program; • Corporate charitable donation policy, expected to increase from $450K in 1997 to $600K in 1998.
Emergency Services	• Fire, ambulance and police services received additional resources in the 1998 municipal budget to cope with currently experienced increases in demands. Further growth may increase resource requirements.	• **Urban:** Millennium-induced population growth is roughly similar to the increase in population between 1996 and 1997. No additional impacts over those currently experienced are expected if Millennium is the only project to proceed. • **Rural:** Anticipated minor increase in population of Fort McKay is expected to increase demands for emergency services in that community.	• Demand for emergency services will increase in line with population. • May require new fire/ambulance station in Timberlea area and a new RCMP facility. • The number of plant-based emergency response equipment (fire, ambulance) in the rural area will increase as existing plants expand and new projects come on stream.	• Construction camp will minimize impact of construction workers on emergency services. • Suncor provides basic medical services to workers at the plant site. It has existing disaster and emergency plans in place and has a mutual aid agreement with RMWB and Syncrude. • Suncor is interested in extending mutual aid agreements to new plants in the region.
Health	• Difficulty of attracting and retaining medical and administrative personnel. • Shortage of physicians. • Funding formula does not reflect the cost of service delivery in Wood Buffalo	**Urban:** Millennium-induced population growth is roughly similar to the increase in population between 1996 and 1997. No additional impacts over those currently experienced is expected if Millennium is the only project to proceed. **Rural:** Anticipated minor increase in population of Fort McKay is expected to increase demands for health services in that community.	• Long-term population of the Wood Buffalo region may reach 50,000 and will be higher during the construction phase. A rough estimate of the required numbers suggests the need for 30 additional physicians.	• Basic medical services for workers on site during construction and operation. • Cooperation with regional Health Study • Participation with planning committee fo the Northern Lights Regional Health Services.
Highway Transportation	• Highway safety during peak hours; • Truck traffic through the urban area; • Vulnerability of one major highway link to rest of province.	• Traffic on Highway 63 to Suncor Turnoff may increase by 30% over 1996 base case numbers during construction. • Operations-related traffic may increase traffic counts by 18% over the 1996 estimate and be roughly in line with the 1997 numbers. • Traffic pattern will conform by and large to current peak-hour pattern.	• Compared to the 1996 base case numbers, highway traffic between Fort McMurray and Suncor, the busiest stretch, may increase by 60% in 2000, when construction peaks and by 30% when projects are in production. • Much of the increased usage will be during the peak hours. • Traffic on Highway 63 south of Fort McMurray is expected to increase in line with population growth.	• Suncor will have on-site camps for construction workers to minimize commuting traffic. • Scheduling of materials/equipment delivery during off-peak hours. • Continuation of bussing for employees; • Continuing cooperation with other developers regarding scheduling of work hours. • Cooperation with other developers and RMWB in Infrastructure Working Group, which is sponsoring a traffic study.

Issue Area	Concerns	Millennium Case	Cumulative Case	Mitigation
Other Infrastructure	• Water and sewer infrastructure is sized for population of 60,000, but a supply line/booster station may be required to service Timberlea. • Current inventory of serviced lands is being depleted, new lands may have to be opened up for housing development. • The manner and volume in which the province will sell land for development is uncertain.	• **Urban**: Population growth induced by Millennium will not reach infrastructure thresholds with respect to water and sewer systems. • **Rural:** Even the expected marginal population increases in the outlying communities will place stress on water and sewer systems.	• **Urban:** Cumulative population growth will remain below levels for which water and sewer systems have been built. The cumulative development scenario will place additional stress on the planning and engineering functions with the RMWB. • **Rural:** Upgrade and expansion of municipal infrastructure will be required to accommodate population growth and improve service delivery standards.	• Cooperative efforts in the context of the Regional Infrastructure Working Group and the Athabasca Oil Sands Facilitation Committee to identify infrastructure issues and assist the RMWB in addressing these if appropriate. • Continuing cooperation with the outlying communities to indentify infrastructure issues and to assist in identifying appropriate mitigative actions.
Municipal Finance	• Municipal costs increase before tax income rises. • Growth may bring some infrastructure need into focus.	• Project Millennium may add 30% to the assessment base of the municipality. In addition new housing for new employees will add to the property tax assessment base. Considering the adequacy of urban water and sewer infrastructure, Millennium is expected to improve municipal financial position. • Most of the assessment base increase will not materialize until 2001 or 2002.	• Assessment base of the municipality may increase by 190% over the next 10 years, while municipal costs will likely increase roughly in line with population growth. • Most of the assessment base increase will not materialize until plants become operational in the 2002-2006 period.	• Collaboration with other developers and the RMWB to identify issues related to municipal financing. • Investigation by the Regional Infrastructure Working Group of financing alternatives for selected infrastructure items.

F3 TRADITIONAL LAND USE AND RESOURCE USE

F3.1 SCOPE OF ASSESSMENT

F3.1.1 Introduction

This section of the Project Millennium (the Project) EIA provides information on Traditional Land Use and Resource Use as required by the Project Terms of Reference. This section of the EIA addresses the following:

- Identify the existing and historical aboriginal land uses, including fishing, hunting, traditional plant harvesting, cultural use and outdoor recreation. Determine the impact of development on these uses and identify possible mitigation strategies.
- Identify the land use, resource management, planning and other initiatives pertinent to the Project. Consider the Fort McMurray-Athabasca Oil Sands Subregional Integrated Resource Plan (IRP). Demonstrate that the development is consistent with the guidelines and objectives of this policy. Identify the criteria and assumptions used in locating the major project components with consideration of the IRP. Identify any mitigation or research requirements proposed to satisfy the IRP guidelines.
- Indicate the proposed setbacks from the Athabasca and Steepbank Rivers, and demonstrate that the location of proposed facilities comply with the setbacks established in the IRP.
- Identify unique sites or special features in the Study Area, such as Natural Areas, Environmentally Significant Areas or Heritage Rivers. Discuss any impacts of the Project on these features. Indicate the location and significance of any Special Places candidate sites, if present.
- Identify the existing land uses, including oil sands development, tourism, forestry, fishing, hunting, cultural use, and outdoor recreation. Determine the impact of development on these uses and identify possible mitigation strategies.
- Discuss implications of the Project for regional recreational activities, public access and other land uses, during and after development activities. Identify anticipated impacts on public access for land use in the region.
- Discuss how reclamation will replace existing land uses.

This traditional land use and resource use section is divided into two main sections: Traditional Land Use and Resources Use. Included in sections F3.2, and F3.3 are discussions on the traditional land use baseline and impact assessment. Following those sections, discussions on resource users are provided in Sections F3.4 and F3.5. A final conclusion for this section of the EIA is presented in Section F3.7.

F3.1.2 Potential Linkages and Key Questions

This section of the EIA focuses on how Project activities impact use of the area's resources by traditional (aboriginal) and non-traditional users.

The impact to traditional land users is evaluated through an understanding about how they have and do use the resources of the area.

The resource use aspect is evaluated through examination of linkages between project activities and various resource uses. Figure F3.1-1 presents these linkages.

Key questions were defined to reflect the traditional land use (TLU) and resource use (RU) issues.

The questions include:

TLU-1: What impacts will development and closure of Project Millennium have on traditional land use practice?

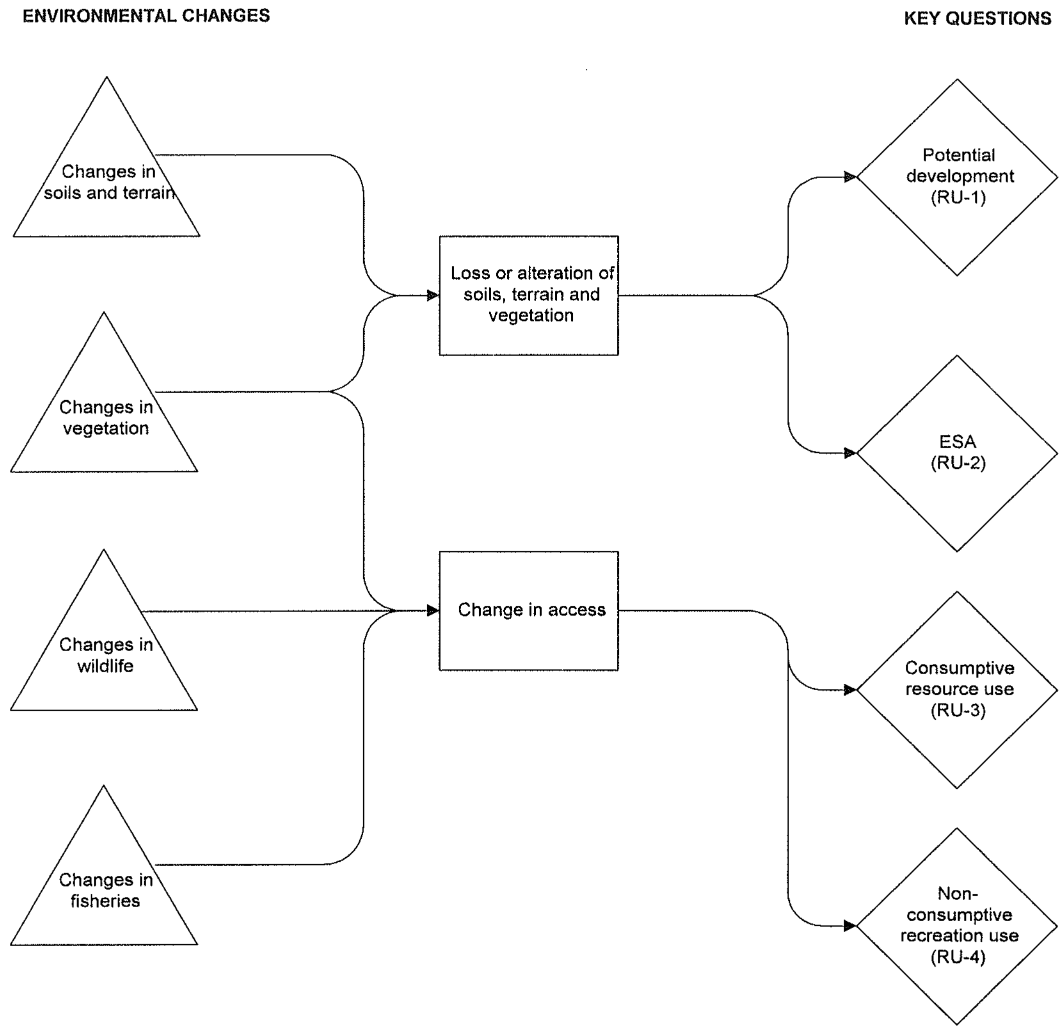
RU-1: What impacts will development and closure of Project Millennium have on potential development of surface and mineral material extraction activities, agricultural developments and forestry operations?

RU-2: What impacts will development and closure of Project Millennium have on Environmentally Significant Areas?

RU-3: What impacts will development and closure of Project Millennium have on consumptive resource use, including berry-picking, hunting, fishing and trapping?

RU-4: What impacts will development and closure of Project Millennium have on non-consumptive recreational use?

Figure F3.1-1 **Linkage Diagram for Resource Use for Construction, Operation and Closure Phases of Project Millennium**



F3.1.3 Study Area

The study area for traditional land use and resource use includes both the aquatic and terrestrial local study areas (LSAs), as described in Section A2 of this EIA. Regional considerations are completed for the regional study area (RSA), as described in Section A2.

F3.1.4 Methodology

The methodology for completing the assessment of Project impacts on traditional land use and resource use included:

- review of available reports on current and past use;
- review of information available on specific uses of the Steepbank Mine and Project Millennium development areas; and
- discussions with regional residents and regulatory representatives.

Impact Analyses

Analysis of identified impacts considered the immediate impact of the Project on TLU and RU and the potential for mitigation of that impact through planned reclamation and closure activities.

Also included in the assessment is consideration of Suncor's participation in:

- agreements with aboriginal communities for cooperative activities associated with the development;
- agreements with specifically impacted traditional land users (ie., trapline holders) to provide compensation for loss of the trapline areas;
- agreements with forestry users to salvage development area merchantable timber resources; and
- efforts to ensure development area granular resources are identified and used properly.

F3.2 TRADITIONAL LAND USE BASELINE/ENVIRONMENTAL SETTING

F3.2.1 Introduction

The aboriginal communities of North America traditionally practice ways of life intimately tied with the landscapes on which they live. The resources provided by the land allow these communities flourish and to maintain their traditional way of life. A detailed understanding of the environment and its resources is important for ensuring the identity of these communities today, when non-aboriginal commercial and recreational uses increase, and frequently compete with traditional uses of the land.

The regional aboriginal community closest to Project Millennium is Fort McKay, which includes both Chipewyan and Cree Treaty Indians, non-status Indians and Metis who live in and around the community of Fort McKay. Fort McKay has become a permanent base of residence in recent times for this community, as schools, government services and employment opportunities have gained importance for community members. However, this area has always served as a focal point in the seasonal round of traditional activities associated with hunting, trapping and fishing, practiced for generations throughout the surrounding region. With the signing of Treaty 8 in 1899, along with the establishment of three reserves situated in their traditional territory, this community's rights to hunt, trap and fish throughout their traditional lands was recognized and affirmed.

Natural resources make a significant contribution to the economic, social and spiritual life of aboriginal communities. Understanding these contributions provides a basis for developing a strategy to allow multiple land uses to be accommodated and the interests of all parties to be satisfied.

Several studies focusing on Fort McKay and other regional aboriginal communities and their traditional land use have been completed since the early 1980s. Some of these have been regional in scope while others have targeted particular areas in response to specific development proposals. These studies represent the baseline information on which the current study seeks to expand. Studies reviewed below include:

- From Where We Stand (Fort McKay Tribal Administration 1983);
- There Is Still Suvival Out There (Fort McKay First Nations 1994);
- Report of Wisdom Synthesized From the Traditional Knowledge Component Studies (NRBS 1996b);
- Survey of Consumptive Use of Traditional Resources by the Community of Fort McKay (Fort McKay 1997a);
- Steepbank Mine studies (Fort McKay 1996b, 1996d, 1996f);
- Aurora Mine studies (Fort McKay 1996a, 1996c, 1996e);
- Muskeg River Mine Project study (Fort McKay 1997b); and
- Communty Profile and Attitudes and Perceptions 1995-1996 (Fort Chipewyan 1996).

In addition, as part of a regionally oriented traditional land use study undertaken for Project Millennium, a sampling program of the records maintained by the Hudson Bay Company at their archives in Winnipeg was undertaken (Golder 1998q). The objective of this program was to assess suitability of these meticulous records relating to fur harvest and food provisioning in the region since 1783 for delineating evolving patterns of traditional land use and resource consumption over a longer time period than is available elsewhere. A long-term perspective is necessary to place documented regional traditional and non-traditional landuse patterns on a firmer basis, and to provide a context for improved understanding of the combined effects of recent and planned changes.

F3.2.2 Previous Regional Studies

Aboriginal peoples have made use of bitumen seeps in the region for centuries. European explorers noted and described their presence as early as the late 1700s (e.g., Mackenzie 1971). However, it was not until the late 1960s that technology advancements allowed large-scale industrial exploitation. As industrial development progressed in the region, and immigration to the area increased, the region's aboriginal people realized their lifestyles were changing significantly. This recognition led to efforts to document the character of the regional aboriginal communities, their traditional economy and system of land use (Fort McKay Tribal Administration 1983). This information provided both the means for understanding the impacts of modern industrial development, and the basis for developing strategies to lessen those impacts and allow survival of these communities.

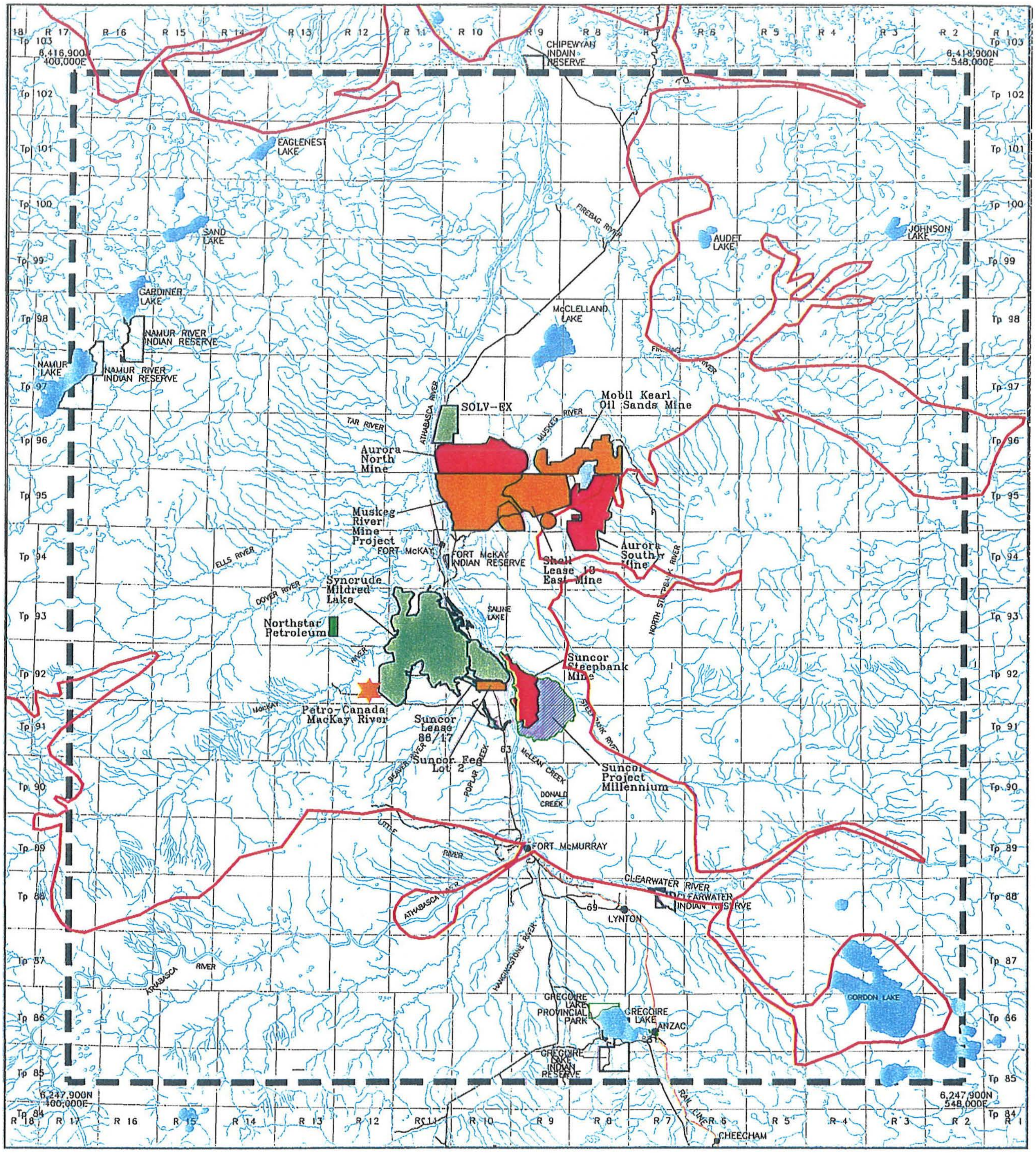
From Where We Stand

In 1983, the Fort McKay Tribal Administration released a document "From Where We Stand", which presented the results of a comprehensive 18-month study outlining a broad spectrum of issues relating to the Fort McKay community. Among the objectives outlined for this study was a detailed identification, assessment and mapping of traditional resource use and harvesting patterns.

This objective was accomplished by completing a literature review, interviewing 53 adult community members, including elders, and constructing and compiling land use maps.

One of the significant outcomes of this study was comprehensive definition of the lands considered to represent the traditional territory of the Fort McKay communities, through collection of information related to hunting, trapping, fishing, plant harvesting and cabin locations (Figure F3.2-1). This area includes the Project Millennium development area. Another important outcome was definition of two patterns of seasonal activities of the traditional lifestyle (called seasonal rounds), one for periods before 1960, and one for periods after 1960 (Figures F3.2-2 and F3.2-3). The difference between these two maps shows the centralizing influence of the services provided at Fort McKay (e.g., schools, health services, housing, employment) and the ongoing participation in the "bush economy." In these figures, the village of Fort McKay is represented by the centre of the circle.

One of the most important results of the study is documentation of the significant role the "bush economy" plays in the overall life of Fort McKay residents, in spite of the numerous restrictions that accompany the increasing non-traditional land uses in the region.



LEGEND

- EXISTING DEVELOPMENTS
- APPROVED DEVELOPMENTS
- PLANNED DEVELOPMENTS
- PROJECT MILLENNIUM
- REGIONAL STUDY AREA BOUNDARY
- ROADWAYS
- TRADITIONAL HUNTING AREAS

0 10 20 30 40 50km

SCALE 1:1,000,000

SUNCOR ENERGY

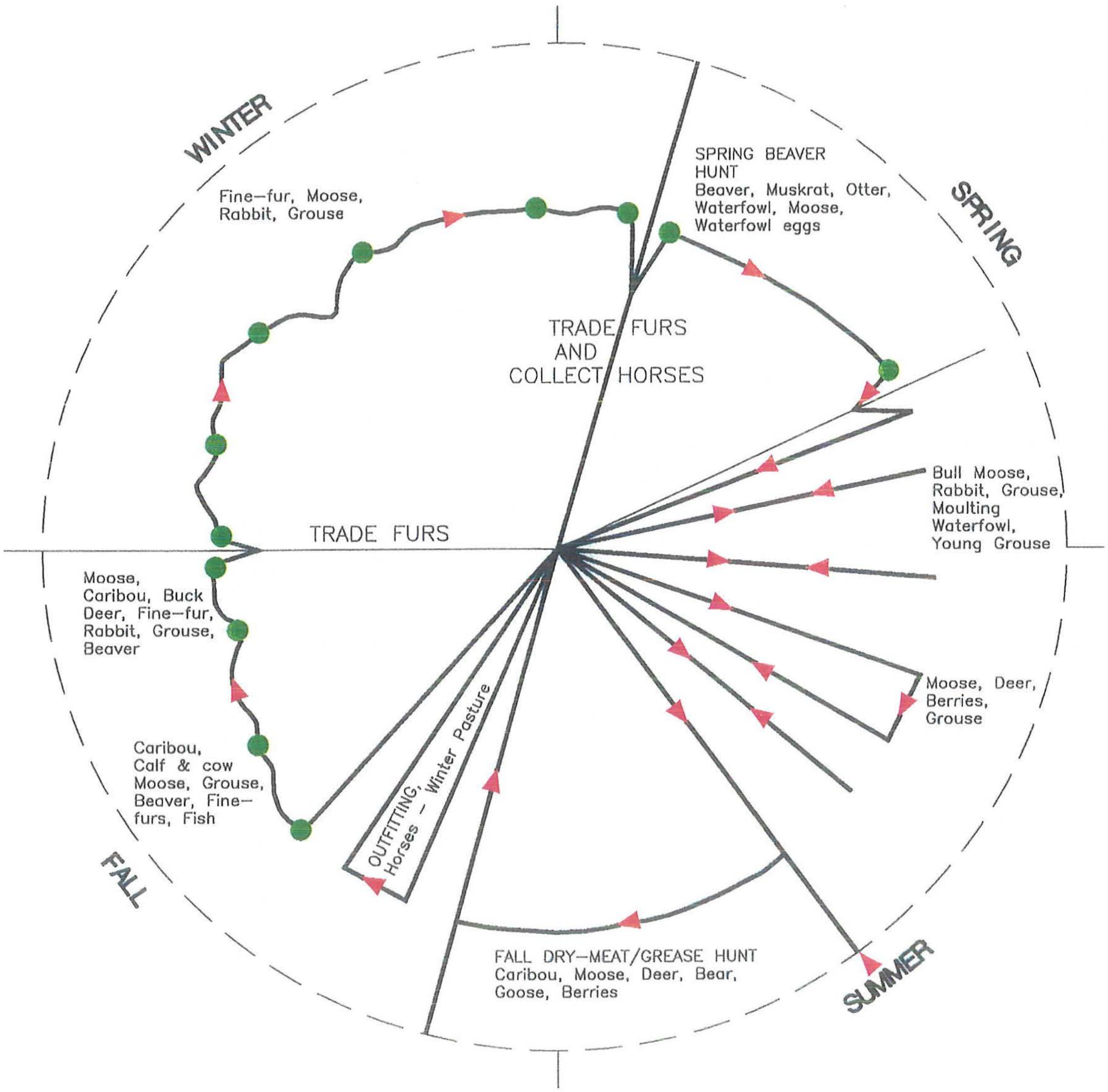
Project Millennium
Taking Suncor into the 21st Century

TRADITIONAL HUNTING AND TRAPPING TERRITORY OF THE FORT McKAY COMMUNITIES (After "From Where We Stand" 1983)

13 Apr. 1998	Figure F3.2-1	DRAWN BY: RFM/CG

REFERENCE

DIGITAL DATA SETS 74D, 74E, 74I
84A AND 84H FROM RESOURCE DATA DIVISION
ALBERTA ENVIRONMENTAL PROTECTION, 1997.
DATUM IS IN NAD83 UTM PROJECTION



REFERENCE

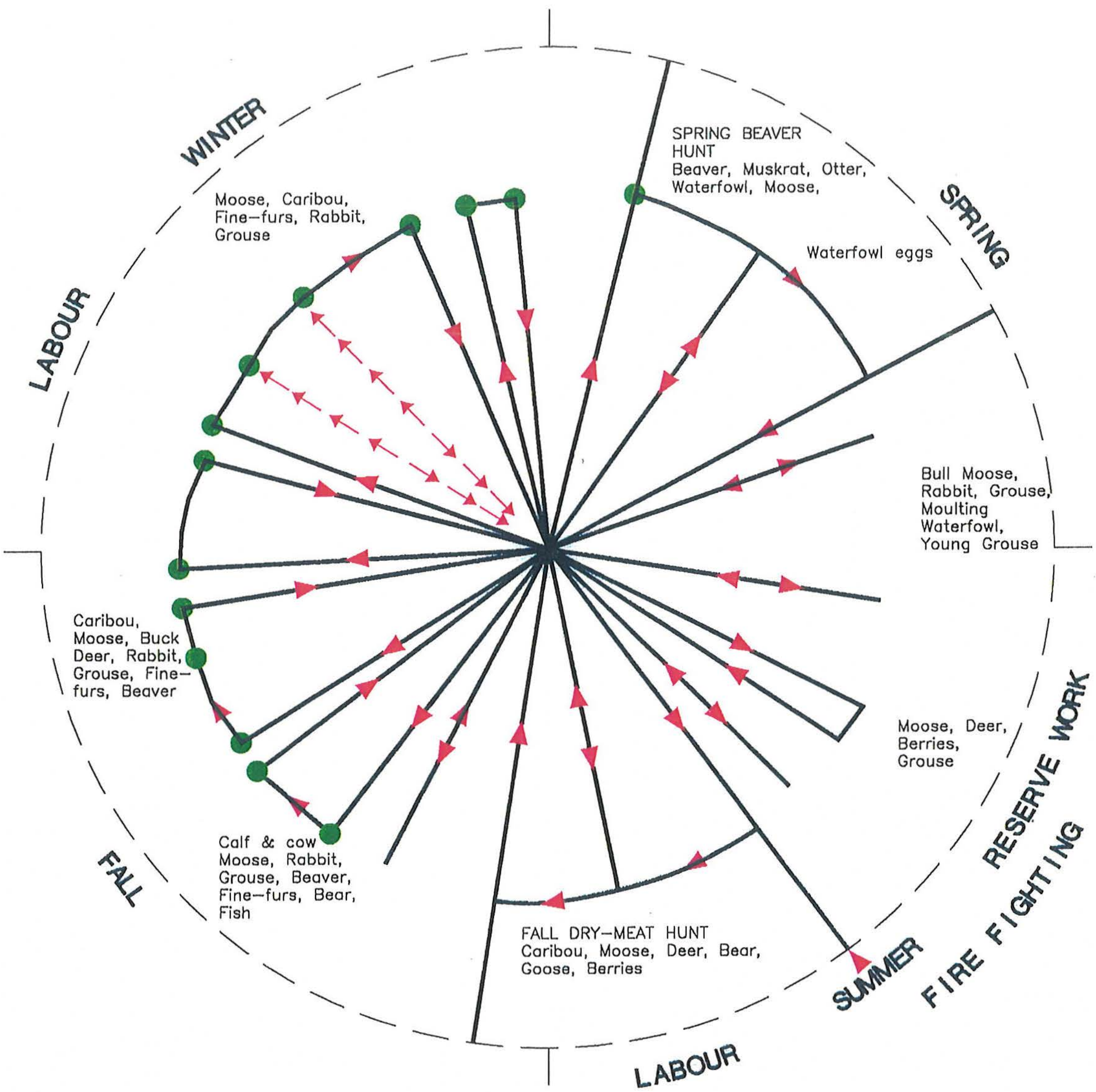
FORT McKAY TRIBAL ADMINISTRATION, 1983. "FROM WHERE WE STAND".

SUNCOR ENERGY

Project Millennium
Taking Suncor into the 21st Century

SEASONAL ROUND PRE-1960

05 Apr. 1998	Figure 3.2–2	DRAWN BY:	TM



REFERENCE

FORT McKAY TRIBAL ADMINISTRATION, 1983. "FROM WHERE WE STAND".

SUNCOR ENERGY

Project Millennium
Taking Suncor into the 21st Century

SEASONAL ROUND POST-1960

05 Apr. 1998	Figure 3.2-3	DRAWN BY: TM

There Is Still Survival Out There

Results of a second regional level study conducted within the Fort McKay community were published in 1994 with the title "There Is Still Survival Out There" (Fort McKay First Nations 1994). This study built on the previous work, but adopted a study area boundary that corresponded to the 1:250,000 scale national topographic system, Birch Mountain Firebag River map. This map includes the Project Millennium area and indicates that the development falls within the traditional lands of the Fort McKay communities.

This study involved 67 First Nations people using an interview process that employed question sheets identifying use of specific resources: big game, furbearers, fish, waterfowl, fruit plants, birds, herbs, roots, plants, trees and shrubs. Questions were asked about special products sought, special areas, places, names and especially productive habitat. The interviews were taped for archival purposes and were transcribed from Cree and Chipewyan by the interviewers. Another result of the study was the creation of a map series that used symbols to denote locations where certain resources were obtained. The outcome was a detailed inventory of resources used and the locations where they were harvested, as well as the names and locations of special sites and areas.

The mapped information from this study, called traditional environmental knowledge (TEK), is provided for the following land use categories: trails and cabins, spiritual (grave) and habitation sites, furbearers, big game, fish, birds, berries, trees and plants, place names and traplines. Important ethnographic information is also provided relating to resource harvesting and processing techniques.

Northern River Basins Study

A third regional level study was the Report of Wisdom Synthesized from the Traditional Knowledge Component Studies of the Northern River Basins Study (NRBS 1996b). This was published as part of a wide ranging study sponsored by the Governments of Canada, Alberta and the Northwest Territories. The study incorporated Traditional Environmental Knowledge (TEK) information from interviews with elders and other recognized traditional land users within the Peace, Athabasca and Slave River basins. Within the Project Millennium regional study area (RSA), information was obtained from residents of Fort McMurray through interviews with 24 elders and analysis of 35 questionnaire responses. Information was gathered on traditional resource and land use, documentation and mapping of harvest locations and special places, attitudes toward the environment, and concerns with respect to observed changes.

For the purposes of this EIA, the information reported in this study is less specific and detailed than that generated by the other studies. Fewer respondents actually lived from the land and lower proportions of the respondents reported participation in traditional practices, such as hunting and trapping, or use of the land as a source of income. According to the report, the Fort McMurray respondents "seem to have acquired the least amount and fewest number of traditional skills, subsistence or supplemental, of all the people interviewed" (NRBS 1996b, page 259).

Survey of Consumptive use of Traditional Resources by the Community of Fort McKay

Finally, on a regional scale Syncrude commissioned a 1997 study by Fort McKay Environment Services Ltd. to assess health concerns within the Fort McKay communities. The study reviewed consumption of food resources traditionally harvested throughout the Oil Sands region, and the presence of trace metals and other contaminants (Fort McKay 1997a). The study provides relatively recent information on the types and quantities of traditional food resources consumed by the members of the Fort McKay communities.

This study employed a questionnaire and interview program to acquire information from a cross section of elders and other community members. Information sought included the degree of reliance in the community on traditional food products, concerns for contamination, and types and portions of resources consumed.

The conclusions and recommendations arising from this study indicate that the Fort McKay communities still rely on food resources harvested from their traditional lands. However, it was documented that there is widespread concern for potential contamination from industrial developments in the region and for the increasing non-traditional use of the region.

F3.2.3 Regional Traditional Land Use

Consolidating information presented in the above studies, a table was created identifying plant and animal species mentioned as being of use in traditional lifestyle of the region (Table F3.2-1). Rankings (high, medium and low) were given to the individual species based on the number of times a particular species name was referred to and the number of times a species was indicated on the traditional land use maps or tables that accompany the studies. These rankings are not meant as a reflection of the importance of specific resources or to imply that certain species are unimportant. They only provide an indication of the extent of their harvest and use. It is important to remember that not all plant and animals species used may have been mentioned during the studies. Some species may have gone out of use, their use may have been forgotten at the time interviews were conducted, or the use may be spiritual in nature and not discussed because of the sensitivity of this information. The names of plants and animals provided in Table F3.2-1 are the names used by aboriginal people.

The people who traditionally occupied the Regional Study Area were nomadic hunting and gathering groups whose seasonal round of activities covered relatively extensive areas (see Figures F3.2-2 and F3.2-3). These groups used a wide variety of plant and animal species found throughout the region. The species mentioned were (and still are) harvested for numerous purposes including: food, drink, medicines, ceremonial uses, firewood, smoking and curing food, clothing, decoration and building materials. Recently, some of the traditional practices have become modified with the increased accessibility of some regions. Traditional use of established trails for traplines and travel routes has been replaced with use of seismic lines. Participants in the surveys conducted for those studies often stated that certain plants or animals were important resources, but harvesting locations and some types of uses were not always recorded. The absence of data in certain regions, therefore, does not necessarily imply that an area was not used traditionally.

Flora

Both deciduous and coniferous tree species are commonly mentioned. Coniferous species include lodgepole pine obtained in the Birch Mountains, and jack pine, tamarack, balsam fir, and white and black spruce available throughout the region. The deciduous species include balsam poplar, aspen poplar, paper birch, willow and alder. The people speak of these species being used for medicine, food, drink, construction supplies, firewood, curing and smoking meat. Birch bark is used as a fire starting material and syrup is made from the tree sap. Willow bark is boiled for a tea and used as a medicine to relieve colds, headaches and stomach ailments. Portions of the balsam fir, jack and lodgepole pine, birch, poplar and other trees were also listed as having medicinal properties, particularly as salves or in poultices. Log cabins are constructed principally of coniferous wood, although birch and balsam poplar are also used as building materials. Deadfall traps for bear are also commonly constructed of large coniferous logs.

Shrubs and grasses have traditionally been used for food, drink, medicinal and ceremonial purposes. Small plants have also been used to make functional items such as twine and basketry. Some of the plants that were frequently referred to include: blueberry, cranberry (bog and low-bush), strawberry, rose, bearberry (kinnikinik), rat root, wild mint, Labrador tea, muskeg (sometimes also called Labrador tea), moss, sweet grass and certain types of fungi.

Many of these plants (e.g., blueberry, strawberry, cranberry) were often eaten raw or as sauce or jam. Some were also boiled and consumed as tea (Labrador tea). Some were mixed with dried meat and white grease to make pemmican. Rosehips, juniper, sweet grass and rat root were some of the most widely used medicinal plants. Other medicinal plants include gooseberry, raspberry, chokecherry, saskatoon, nettles, green frog plant and seneca root. Sweet grass, and the inner bark of the red willow (red osier dogwood) are important ceremonial plants as well. Kinnikinik (bearberry)

Table F3.2-1 Traditional Resource Use

Species [a]	Type of Use							Use Ranking [b]
	Food	Medicine	Spiritual	Hunting	Trapping	Fishing	Other	
Vegetation								
blueberry [a]	X							High
cranberry (lowbush) [a]	X							High
cranberry (bog)	X							High
dewberry	X	X						Low
saskatoon [a]	X	X					Wood	High
pincherry [a]	X	X						Medium
chokecherry [a]	X	X					Hard Wood	Medium
cloudberry	X	X						Low
raspberry [a]	X	X						Medium
huckleberry [a]	X							Low
dwarf raspberry	X							Medium
trailing raspberry	X							Medium
red currant [a]	X	X						Low
black currant [a]	X	X						Medium
snowberry		X						Low
strawberry [a]	X	X						High
gooseberry [a]	X	X						Medium
rose hip [a]	X	X						High
twisted stalk [a]	X							Low
red osier dogwood [a]		X	X				dye/tobacco	Medium
kinnikinik (bearberry) [a]	X	X	X				dye/tobacco	High
dogwood (bunchberry) [a]	X							Medium
common juniper [a]	X	X						Medium
common yarrow [a]		X						Low
common plantain [a]		X						Low
buffaloberry	X	X						Low
hazelnut [a]	X						dye/arrows	Medium
balsam fir [a]		X					construction	High
lodgepole pine [a]		X						Low
jack pine [a]		X						Low
green alder [a]		X					utensil/dye	Medium
river alder		X						Medium
trembling aspen [a]		X					utensil	Low
tamarack [a]		X					construction/ dye	High
birch - white [a]	X	X	X				construction /fire starter/ dye	High
birch - red (bog birch)		X						Medium
willow [a]		X	X				utensil	Medium
stiff club moss			X					Low
chamomile		X						Low
white or black spruce [a]		X		X			construction	High
black poplar		X					construction	High
harebell		X						Low
frying pan plant		X						Medium
green frog plant (pitcher plant)		X						Medium
fly honeysuckle		X						Low
twining honeysuckle		X						Low
bracketed honeysuckle		X						Low
labrador tea	X	X						Medium
rat root (sweet flag) [a]		X						High
wild mint [a]	X	X						High
common pink wintergreen		X						Low
white wintergreen		X						Low

Species [a]	Type of Use							Use Ranking [b]
	Food	Medicine	Spiritual	Hunting	Trapping	Fishing	Other	
muskeg (Labrador tea) [a]		X						High
moss [a]		X					chinking,smudges, diapers, dressing	High
horsetail [a]		X					utensil	Low
bulrush [a]	X							Low
nettles [a]	X	X						Medium
northern bedstraw							dye	Low
sweet scented bedstraw			X				utensil	Medium
fungi - dry dead wood							fire starter/insect repellent	High
ground fungus - puffball		X						High
bracket fungus	X							Low
tuckahoe	X							Low
red touchwood fungus	X							Low
rock tripe	X							Low
seneca root		X						Medium
wild sarsaparilla		X						Low
western dock							dye	Low
willow fungus		X						Medium
showy aster		X	X					Low
sweet grass		X	X					High
common tansey [a]	X							Low
common cattail [a]	X							Low
Fish								
pickerel	X					X		High
northern pike [a]	X					X		High
whitefish [a]	X					X	dog food	High
lake trout	X					X		High
grayling [a]	X					X	localized use	Medium
perch [a]	X					X	localized use	Medium
ling cod [a]	X					X		Medium
sucker [a]	X					X		Medium
goldeye [a]	X					X	localized use	Medium
walleye [a]	X							Medium
chub [a]	X					X		Medium
minnows [a]	X							Low
Mammals								
moose [a]	X			X			multiple	High
caribou - woodland [a]	X			X			localized use	Low
bison	X			X			localized use	Low
white-tailed deer [a]	X			X				High
mule deer [a]	X			X				Low
elk	X			X				Low
lynx [a]	X				X		fur	High
hare	X				X			High
wolf [a]					X		fur	High
coyote [a]					X		fur	Medium
marten [a]					X		fur	Medium
fisher [a]					X		fur	High
red fox [a]					X		fur	High
wolverine [a]					X		fur	Rare-Med.
beaver [a]	X	X			X		fur	High
muskrat [a]					X		fur	High
river otter [a]					X		fur	High
skunk		X	X		X			High
mink [a]					X		fur	High
red squirrel					X			High
tree (flying) squirrel					X			High
least weasel [a]					X		fur	High
short-tailed weasel [a]					X		fur	High
long-tailed weasel [a]					X		fur	High

Species [a]	Type of Use							Use Ranking [b]
	Food	Medicine	Spiritual	Hunting	Trapping	Fishing	Other	
black bear [a]	X		X	X	X			High
grizzly bear	X		X	X				Low
Birds								
Canada goose [a]	X						insulation/ stuffing/ wing duster	High
Ross' goose	X						insulation/ stuffing/ wing duster	Medium
snow goose/blue goose [a]	X						insulation/ stuffing/ wing duster	Medium
white-fronted goose	X						insulation/ stuffing/ wing duster	Medium
canvasback [a]	X							High
mallard [a]	X							High
pintail [a]	X							Low
redhead [a]	X							High
teal	X							High
greater scaup	X							High
lesser scaup	X							High
goldeneye	X							High
scoter	X							Low
ruddy duck	X							High
merganser	X							High
grebe [a]	X							High
loon [a]	X						waterproof bag (pouch)	High
pelican [a]							waterproof bag (pouch)	Low
cormorant								Low
ravens [a]								
crows [a]								
magpies [a]								
swan [a]								Low
seagull [a]								Medium
owl [a]	X						wing duster	High
sandhill crane [a]	X							High
whooping crane [a]	X							Low
hawks [a]							decoration	Low
eagle [a]							decoration	High
great blue heron [a]								Low
sharptail grouse [a]	X						fan/decoration	High
spruce grouse [a]	X						fan/decoration	High
ruffed grouse [a]	X						fan/decoration	High
ptarmigan [a]	X						fan/decoration	Low

(a) Indicates the species is noted as occurring within the Steepbank/Millennium LSA (Fort McKay 1996d, Fort McKay and AGRA 1998).

(b) Refers to the number of times a species name was referred to and the number of times a species was indicated on traditional land use maps.

leaves and the inner bark of red osier dogwood have also been used to extend expensive tobacco for smoking. Fungi found on dead logs and moss are often used in smudges and as insect repellents. Other berry bushes and aquatic plants are also part of the traditional environmental knowledge of the Fort McKay First Nations people, although they are not used as often.

Trees and herbaceous plants are harvested on a year-round basis, with the Athabasca River corridor and all major tributary creeks and rivers being the major sources. Berries and flowering plants are harvested in-season, with collection locales varying throughout the region, and inland locations having as much importance as riparian habitat.

Fauna

Animals are a critical aspect of traditional land use practices (Fort McKay First Nations 1994, Fort McKay 1997a). Large game animals in the region include moose, bison, caribou, white-tailed and mule deer. Elk (wapiti) were formerly present in the Athabasca region, although they currently have been extirpated from this portion of their range. An unusual migration of woodland caribou along the east side of the Athabasca River is reported to have occurred in 1948 (Fort McKay First Nations 1994). Presently, however, caribou is obtained through relationships with people living in the NWT (Fort McKay and AGRA 1998). White-tailed deer are likely recent arrivals into the region. Bison, once a major resource, are only encountered in the vicinity of Wood Buffalo Park and rarely in the Birch Mountains.

White-tailed deer and moose exist in relative abundance in the Project area because of its inaccessibility (Fort McKay 1996d). However this is changing because of the improving access situation. Until the Peter Lougheed Bridge was built, access to the east side of the Athabasca River was limited to those with water transport or to winter time, a situation that reduced the amount of hunting in this area. Although trails exist south of this bridge, the Muskeg and Steepbank rivers present formidable barriers and protect the Project area from casual hunters. Access to the recently built Suncor bridge is controlled by Suncor and is not available to the general public.

Other large game animals that were hunted in the region include black bear. These animals were traditionally hunted using traps made of several large logs. Bear meat was eaten, the fur used for clothing and the grease for cooking and making soap. Black bear was also listed by some of the Fort McKay Elders as an important spiritual animal (Fort McKay First Nations 1994). Grizzly bear are also spiritual animals, although they were never as plentiful as the black bear, and are now not found in the area.

Aboriginal people use all portions of these large animals. The meat and fat is used for food and the hides are used as clothing, blankets, mattresses, robes and containers. Bones and antlers are used to make tools, such as leather punches, knife handles, hide fleshers and billets, and sinew is used a binding material. Sites where these animals were killed or processed differ in size and location depending on whether the animal was normally solitary (e.g., moose, bear) or traveled in herds (e.g., bison, caribou), and where the animal was typically found.

Some of the smaller furbearers are also important to the people of the region. Beaver, muskrat and snowshoe hare are hunted for their meat and pelts (Fort McKay 1996a). The beaver is still regarded as a staple in the diet of some area residents. Wolverine is reported to be in short supply but most other species can still be obtained throughout the region (Fort McKay and AGRA 1998). Populations of most of the carnivorous furbearers vary according to fluctuations in prey species.

Beaver castor is also used as a medicine. Skunk were also trapped and used for spiritual and medicinal purposes. Skunk oil was (and occasionally still is) used for warding off and curing colds (Fort McKay First Nations 1994). River otter, mink, lynx, wolf, fisher, fox, weasels and muskrat were also traditionally trapped by the people of the region. Trapping of fur bearing animals for trade has been an important cash supplement to the proceeds of the "bush economy" for the people of the region since the advent of the fur trade in the 1700's.

The Athabasca River valley is an important migratory route for several types of birds including ducks, geese, cranes, loons, grebes and gulls. Both Shipyard and Saline lakes are mentioned as important staging areas for waterfowl and the latter is mentioned as area traditionally used to harvest duck and coot eggs (Fort McKay 1996d). Waterfowl were traditionally hunted by the people of the region during the spring and fall migrations. Harvesting eggs was also done during the spring. The spring is the best time for hunting migratory birds as their feathers and meat are in the best condition. The feathers are often used for clothing and bedding. The wings from owls and geese are also used for dusters and brooms. Tail feathers from grouse and ptarmigan were often used as a fan or decoration. The pouch from pelicans and loon skins were often used as waterproof bags. Large owls, such as the great horned and great gray owls, were also hunted for food. Upland game birds including ptarmigan, spruce, sharptail and ruffed grouse were hunted easily and harvested opportunistically. Long bones were traditionally made into beads and small whistles.

Fish in the region were used for food for both people and their dogs. Large numbers of fish were taken annually from the Athabasca River, but in recent times, concern for the amount of pollution in the river has significantly reduced the use of this once important source (Fort McKay 1996d, 1997a; Fort McKay and AGRA 1998). It is reported that a fall fishery was traditionally exploited at Tar Island, where large numbers of fish were caught and processed before oil sands operations developed this location (Fort McKay 1996d). Major tributaries and lakes in the Birch Mountains are now more frequently mentioned (Fort McKay First Nations 1994). Both the Steepbank River and Leggett Creek are mentioned as small scale sources of grayling (Fort McKay 1996d).

Whitefish were caught in the autumn and hung to dry for winter dog food. Thousands of fish may be needed to feed dogs through the winter depending on the number of dogs. Up to 2,000 fish could be caught and hung in a week. Grayling were caught on a much smaller scale. Whitefish, pickerel, northern pike, chub, lake trout, ling (burbot), goldeye, suckers, perch and grayling are all used by people in the area. Fish eggs were occasionally used as an ingredient in bannock (Fort McKay and AGRA 1998). Some fish such as the goldeye, grayling and perch are not available throughout the entire region and, therefore, had only localized importance. Fish bones were also boiled to extract grease. Fish scale was sometimes coloured and used as decoration on clothing (Fort McKay and AGRA 1998).

F3.2.3.2 Non-Consumptive Use

The above discussion relates to consumptive traditional resource use. A number of non-consumptive traditional land uses take place throughout the region. Both spiritual and recreational uses occur within the Regional Study Area. Spiritual and ceremonial special uses are personal and family matters which have not been the subject of systematic study in any of the reports prepared on traditional land uses but which, no doubt, are highly significant to local communities. The absence of this information represents a knowledge gap that can be addressed by continued consultation with local communities. Recreational use such as use of cabins and snowmobiling occur in conjunction with trapping and hunting activities (Fort McKay 1996a).

F3.2.4 Previous Study Within the Project Millennium Area

In conjunction with the recently approved Steepbank Mine, and as part of their on-going Aboriginal consultation program, Suncor commissioned a series of studies by Fort McKay Environment Services to provide a basis for understanding the traditional use of lands and resources (Fort McKay 1996b, 1996d, 1996f). The Steepbank Mine study area encompassed the Project Millennium development area. Consequently, the results of those studies are directly applicable to this EIA. In addition Suncor commissioned a traditional land use study specifically dedicated to Project Millennium (Fort McKay and AGRA 1998).

The study entitled "A Fort McKay Community Document Traditional Uses of the Renewable Resources on the Suncor Steepbank Mine Site" (Fort McKay 1996f) presents the results of a Community survey conducted with the objective of finding out how much the people of Fort McKay used fish, wildlife and vegetation from the Suncor Steepbank Mine area over time.

This survey was preceded by a review of relevant information including literature, maps and air photos. A questionnaire was developed and approved by the Fort McKay First Nations Council. Community members organized and conducted the interviews. People interviewed included elders who had spent many years practicing a traditional lifestyle, trappers with direct experience in the project area, and other community members, including school children. Participation in the interviews was near 100%.

In addition to the survey, a quantitative assessment of the types and abundance of wildlife associated with riparian habitats within the Steepbank LSA was conducted by Fort McKay Environment Services Ltd. (1996b). The area examined corresponds with the Project Millennium LSA. Trappers Julian Powder and Willie Boucher were interviewed and their harvest records as well as others available for the region were examined. An aerial survey was conducted, during which systematic observations were made along water bodies throughout the study area, according to recognized methods. In addition, Bobby Powder and Julian Powder, both from Fort McKay, assisted in the aircraft, providing additional traditional knowledge and identifying active and inactive beaver lodges. All information obtained was recorded on 1:50,000 scale maps or 1:40,000 scale air photos.

A major component of the study involved ground surveys conducted under snow covered conditions with observations of wildlife tracks tabulated, according to recognized sampling techniques. This information was supplemented by traditional knowledge provided by Julian Powder and Willie Boucher. In all, three transects 500 m in length by 20 m wide were walked. Only one of which lies outside the Project Millennium LSA. Data were recorded for animal species present as reflected by an "observed wildlife abundance index" was calculated for each transect.

The results of this study can be summarized as follows:

- Eighty-two active beaver lodges with associated food caches were recorded within the study area. These were predominantly located on small tributary drainages and upper basins of major rivers, with lake and ponds of secondary preference. No muskrat houses or pushups were recorded.
- Many different species were covered in the 100 tracks recorded during the ground survey (Fort McKay 1996b). Most abundant were furbearers, including fox, the most abundant, followed by weasel, mink, fisher, river otter, wolf, coyote, ruffed grouse and mouse or shrew.

The results of both of the studies conducted for the Steepbank project are summarized in a document entitled "The Community of Fort McKay Traditional Uses of the Renewable Resources on the Proposed Suncor Steepbank Mine (Fort McKay 1996b). The study area for this program corresponds with the Project Millennium LSA and its results are directly applicable.

The stated methods employed combined those cited above by the earlier two studies undertaken for the Steepbank Mine Project and encompassed both the community survey and the wildlife ground survey.

The map provided with the report illustrates the sites and resources traditionally used on the Project Millennium LSA. It has been reproduced here as Figure F3.2-4.

Within the Project Millennium development area, no cabins, graves or historic sites have been noted in community based interviews. Traditional trails are reported to traverse the project area: along the north bank of Wood Creek; the south bank of Leggett Creek; across the northern part of the development area between the Steepbank River and Shipyard Lake; and along the north bank of an unnamed creek. Numbers of active beaver dams with caches have also been recorded and several plant collection locales have been noted. However, the majority of these faunal resources are associated with drainage systems that lie outside proposed development zones.

The community survey portion of this study provided a listing of floral and faunal species that are used within the study area and surrounding regions. These were combined with the species noted as being used in other regional level studies and are included in the tabular display provided previously as Table 3.2-1 and its accompanying text descriptions of use patterns.

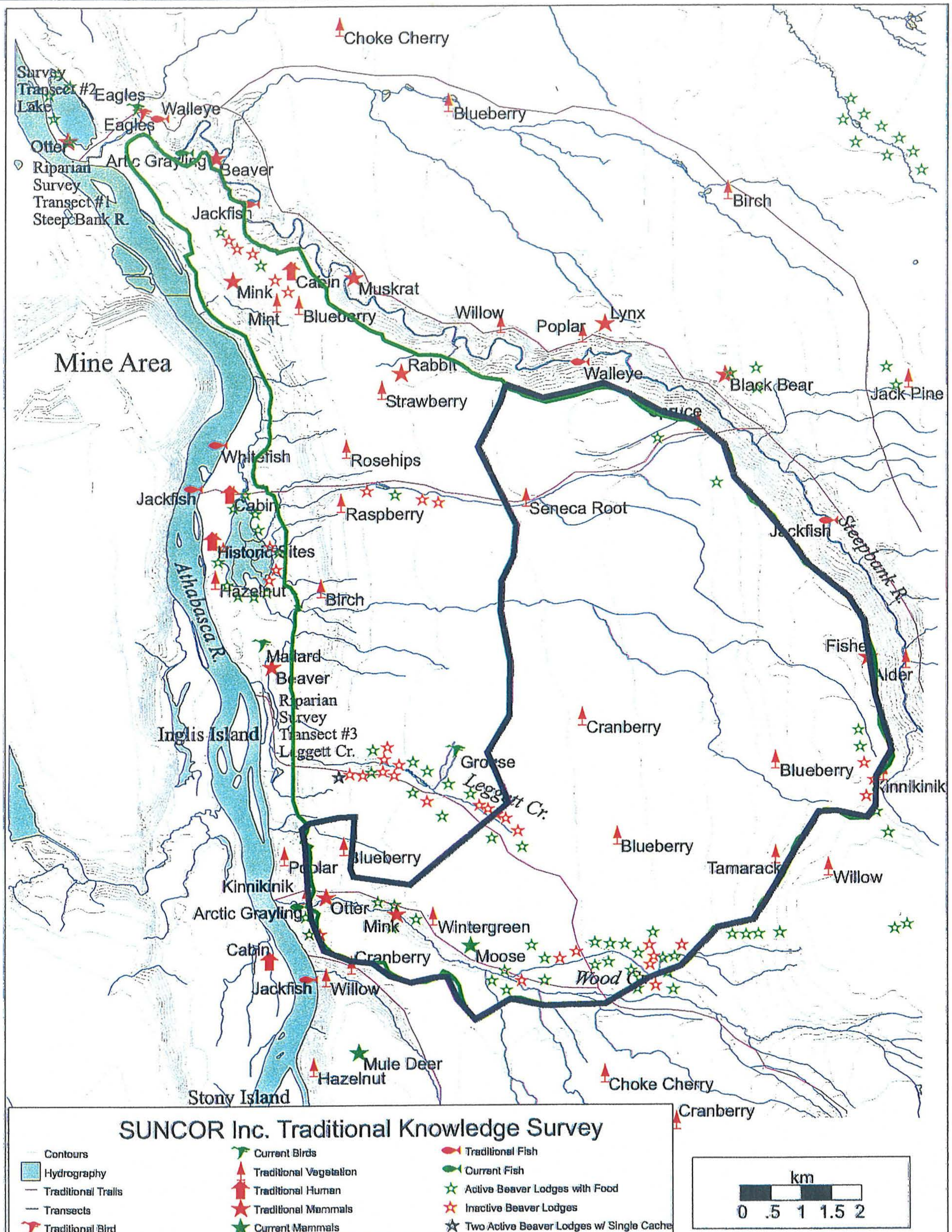
In summary, studies conducted by Fort McKay provide a firm basis for appreciating the traditional uses of the Steepbank/Millennium LSA. However, it should be noted that certain practices were not revealed during these studies. For example, during the survey, "the elders were hesitant to discuss culturally-sensitive traditional practices that occur and which reflect spiritual connectedness to the land" (Fort McKay 1996b). In addition specific locations of plants used for medicinal purposes, and their specific uses are no longer shared with the general public (ibid:22).

F3.2.5 Previous Study Elsewhere in the Regional Study Area

A similar series of traditional land use studies were conducted recently in conjunction with planning for the Syncrude Aurora Mine (Fort McKay 1996c, 1996e) and Shell Canada Muskeg River Mine Project (Fort McKay 1997b). Although both of these projects are north of the Project Millennium area, their results are reviewed because they have regional implications.

The first of these studies is entitled "The Community of Fort McKay Traditional Uses of the Renewable Resources on the Proposed Syncrude Aurora Mine Site Local Study Area" (Fort McKay 1996e). The objectives and methods of this study are the same as employed for the Suncor Steepbank studies.

Results of interviews with the area trappers provides valuable anecdotal information about the state of the traditional resource base in the Aurora



LEGEND

EAST BANK MINING AREA
PROJECT MILLENNIUM

REFERENCE

DIGITAL SURVEY FILE SUPPLIED BY CLIENT
FORT McKAY FIRST NATIONS (1994)

SUNCOR ENERGY | Project Millennium Taking Suncor into the 21st Century

TRADITIONAL KNOWLEDGE SURVEY

07 Apr. 1998	Figure F3.2–4	DRAWN BY: TM

project area and about concerns for increasing levels of development and non-traditional use in the region.

The results of the community survey portion of the this study provided a listing of floral and faunal species that are used within the Aurora Mine study area and surrounding regions, and have been incorporated in the summary of regional traditional resource uses provided in section F3.2.3 of this EIA.

The second study associated with Syncrude Canada's Aurora Mine project is entitled "Survey of Wildlife, Including Aquatic Mammals, Associated with Riparian Habitat on the Proposed Syncrude Canada Ltd. Aurora Mine Environmental Impact Assessment local study area" (Fort McKay 1996c). The objectives of this study and the methods employed were the same as the comparable Suncor Steepbank study.

One of the results of the in-field investigations indicated that active and inactive beaver lodges exist in modest numbers throughout the area. During the wildlife transect portion of the study, 248 tracks were observed, representing 22 different species of furbearing mammals, big game and birds. Each transect produced varying results. The one situated within the area cleared in 1979 for the Alsands Project exhibited far more productivity than the others. Wildlife activity here exceeds other comparable areas by between 4 and 30 times.

The outcome of the Steepbank Mine studies can be compared to the results obtained in the evaluation of wildlife for the Syncrude Aurora North Project (Fort McKay 1996c). For that study, four transects were completed in comparable areas, including the former Alsands Plant site area, which had been cleared of trees in 1979, and has had continuous drainage since that time. The transect completed in that area produced the highest abundance index of any site examined, with a wildlife activity index between 4 and 8 times greater than any of the Steepbank sites. This was surprising because the Alsands location is well inland of any major river system and would not be considered riparian habitat without the presence of drainage ditches. This demonstrates that human altered landscapes, if managed appropriately, can have positive effects on wildlife abundance and diversity in this region of the province, and can enhance opportunities for on-going traditional land use practices.

The results of the study completed for the Aurora project have been recently confirmed and expanded upon by a more systematic investigation of the productivity of the cleared area of the former Alsands Project area, sponsored by Shell Canada Ltd. (Fort McKay 1997b).

The objectives of this study were to delineate habitat types and successional trends in the cleared former Alsands lease area, to determine the variety of animals that currently inhabit this area, to compare these patterns with the former vegetation and wildlife communities in this area, and finally, to determine any health hazards that might be present in the plants and animals of the area. The results of this study indicate that regeneration of this area has produced a suite of plant and animal resources highly sought after as traditional resources. Certain prey species, such as beaver, sharp-tailed grouse and snowshoe hare have readily exploited the new drainage regime and the regenerated vegetation in this area. Larger game have also been attracted by the new food sources present in the new vegetation. However, for big game, the lack of cover has made individuals extremely susceptible to hunting.

F3.2.6 Relevant Studies Near the Regional Study Area

In 1995, Suncor commissioned a study by the Fort Chipewyan community as part of their Aboriginal consultation program. The objectives of this study were: "development of a comprehensive socio-economic Community Profile of Fort Chipewyan"; and, "determining and identifying the prevailing attitudes and perceptions of the of the indigenous people wherein it concerns Suncor Inc." (Fort Chipewyan 1996). Because the main focus of the study was the Fort Chipewyan Community north of the Project Millennium RSA, the traditional land use issues raised apply in a regional rather than a development-specific sense. Nevertheless the results of this study convey the views toward existing and proposed development, especially the operations of Suncor.

Within this community, the attitudes and perceptions toward Suncor's development were sought by conducting a survey, the objectives of which were to: ensure the views of indigenous people in the Community were voiced; that concerns for traditional life in the community's traditional lands were taken into account; and that the input of elders was included. Responses to a wide ranging questionnaire were received from 120 households, reflecting a representative range of the three indigenous groups and age categories within these.

Traditional land use issues addressed in the study responses are divided into several areas. A summary of these areas and the responses obtained follows:

Cultural and Traditional: There are a wide range of cultural sites situated in the community's traditional lands, most of which are located on the shores of rivers and lakes. Under half the respondents feel that these sites have been negatively affected by oil sands industry pollution. Respondents indicate that there were traditional sites in the area of Suncor's developments and indicate that these are still used. While a large majority of respondents believe that traditional lifestyles have been negatively affected by oil sands development, other causes identified, ranged from environmental pollution to loss of traditional lifestyle and competing non-traditional use of the area.

Social Impacts: Respondents believe that traditional settlement patterns have changed since the oil sands development began and that air and water pollution have been responsible for a loss of traditional lifestyle forcing them to move to Fort Chipewyan from more dispersed traditional settlement areas. However, in response to a specific question about reasons for the move to Fort Chipewyan, respondents indicated that education, jobs, goods and services were the principle attractions. It is interesting to note that, prior to oil sands development, almost all of respondents indicate that the knowledge and skills necessary for self sufficiency were learned by traditional education.

Environmental Impacts: Respondents believe that the distribution and productivity of traditional fauna and floral resources have been affected negatively by air and water pollution from oil sands developments. Lower water levels as a result of changes in the flows in the Peace River are also cited as an important negative effect on traditional lifestyles.

In summary, the study concludes that the presence of oil sands and other industrial developments, along with agricultural and municipal development in both the Peace and Athabasca River basins, have important negative effects on the traditional life of the Fort Chipewyan Community and on the environment that supported that lifestyle. Air, land and water pollution are considered the major causes of these effects. Recommendations arising from this study include: reinforcement of Suncor's support for the principles embodied in the (June 1995) Memorandum of Agreement with the community of Fort Chipewyan, which establishes a basis for on-going mutual cooperation and open consultation; and increased effort on Suncor's part to ensure the community of Fort Chipewyan's long term participation in the Suncor oil sands operations.

Archival Sampling

The archival sampling program conducted for the Project Millennium EIA (Golder 1998q) was completed in recognition of the potential benefits of this type of study for establishing and quantifying patterns of natural resource use over the course of nearly two hundred years. The objective of this research was to obtain a longer term and more detailed impression of use against which the combined effects of regional industrial development can be measured. Such information can aid in demonstrating the value and longevity of certain traditional lifestyles and serve, along with oral history information, as a basis for planning for the preservation of fundamentally important aspects of local culture.

Sampling was undertaken at the Hudson's Bay Company's archives, where records are maintained for the fur trade posts distributed along the Peace and Athabasca rivers beginning in 1783 and extending to the modern era. The emphasis of the program was identification of records dealing with natural resources such as furbearing animals, game, fowl, fish, timber, berries and herbs. These records were examined with the objective of determining the degree to which harvest of these resources could be quantified over time. Additionally, they were assessed for their utility in identifying traditional places such as campsites, hay meadows, portages, wood sources, natural springs, pitch sources, trails, trap-lines, salt licks, burial sites and so forth.

Of the many records housed in the archives, three types were considered to be of particular importance for this study:

- Account books, which comprise annual records of inventories and all transactions with the company;
- Reports on Districts, which provide narrative comments on social and economic conditions in the region; and
- Post Journals, which are the daily records maintained by clerk/traders and provide information on weather conditions, activities, events, visitors, but also include some account information.

The sampling program focused on Account Books first, as they contained the most useful and detailed information, with Reports of Districts and Post Journals examined in less detail.

These records were sampled at three levels, moving outward from the Project Millennium development area. Examination began with the records available from Fort McKay and Fort McMurray and proceeded through the extensive series available for Fort Chipweyan, to a series of smaller peripheral posts in the district, such as Fort Vermilion, Lac La Biche, Trout Lake and Whitefish Lake. In reviewing the utility of these records, it is important to appreciate the hierarchy of posts in the Athabasca District. All trade in the region was controlled from Fort Chipweyan. This has resulted in a exceedingly lengthy and detailed series of documents relating to that post, while others have shorter time spans represented and include far less detail.

The results of the archival sampling indicate that both Fort McKay (1891-1911) and Fort McMurray (1870-1900) records are too limited in temporal span and too inconsistent in format to permit rigorous analysis of resource use over time. Nevertheless, data was found on the range of species used during these periods, with some information on quantities used. In addition, inconsistent references to fluctuating resource populations are made in District Reports and Post Journals.

The records for Fort Chipweyan (1802-1927) include those of Nottingham House and Fort Wedderburn, and have good temporal depth and detail. As they apply to the entire Municipality of Wood Buffalo, they make it possible to track natural resource harvests by species over nearly a century and a half, and to link those harvests, in many cases, with specific outposts within a triangular area between Fort McMurray, Fort Vermilion and Fort Chipweyan. Their importance for historical interpretation of long-term traditional land use patterns cannot be overstated.

Records from Fort Vermilion (1802-1906) provide supplemental data, principally relating to products such as buffalo, hay, dried meat, salt and other items, obtained as supply for other posts in the region. In addition these records provide species lists that complement those of other posts in the region and make it possible to reconstruct a pattern of land use for the entire Athabasca District. The records for Portage La Loche (1834-1932), Lac LaBiche (1799-1895), Trout Lake (1899-1895) and Whitefish Lake (1889-1896) provide information that is variable with respect to temporal span and detail, but in some cases, would be considered important supplemental information with potential to assist in developing a regional traditional land use pattern.

F3.3 TRADITIONAL LAND USE PROJECT IMPACT ASSESSMENT

F3.3.1 Introduction

Traditional land use issues that may have bearing on the development of Project Millennium are important to both the aboriginal people and to Suncor. These issues will be addressed throughout the life of the project through Suncor's commitment to on-going consultation with aboriginal communities in the region. Programs have been established to address some of the immediate concerns while others will develop as planning proceeds. However, on the basis of currently available information, it is possible to identify both general and specific, traditional use practices that have occurred within the immediate Project area in the past and that continue to take place today. This information can serve as a basis for determining the specific impacts of the project and can be incorporated with regional level information to obtain an indication of the combined effects of developments planned throughout the region.

F3.3.2 Key Question TLU-1: What Impacts Will Development and Closure of Project Millennium Have on Traditional Land Use Practices?

Project Millennium will change traditional land use patterns within the area scheduled for development. The information presented in this regard is based on a review of documentation relating to traditional land use in the region, with a focus on the area proposed for Project development.

F3.3.3 Background Information

To obtain an impression of the types of resources that were incorporated in the traditional "bush economy" of First Nations peoples of the area, a review was conducted of the regional level traditional land use investigations completed by the Fort McKay First Nations (1994). This information was supplemented by data accumulated in specific and general traditional land use studies completed for Project Millennium (Fort McKay and AGRA 1998), Suncor's Steepbank Project (Fort McKay 1996b, 1996d, 1996f), the Syncrude Aurora Project (Fort McKay 1996a, 1996c, 1996e, 1997a) and Shell Canada's Muskeg River Mine Project (Fort McKay 1997b). This information, as presented in section F3.2, was consolidated into a table and accompanying text to summarize regional traditional land use practices.

F3.3.4 Recorded Land Use

As part of the interview process completed for the regional Traditional Land Use and Occupancy Study conducted by the Fort McKay First Nations

(1994), elders and other traditional people of the region were asked to place symbols indicating use of specific resources on maps of the area. These maps serve as an indication of remembrance of use of a specific area and resource, but do not preclude other resources and uses that may have taken place in earlier times, by other aboriginal people, or those that were not particularly memorable. Nevertheless, the mapped information provides concrete data for specific areas.

The study described above produced ten clear overlays for a 1:250,000 scale topographic map for the region, displaying information for: trails and cabins, spiritual and historical sites, fur bearing animals, big game, fish, birds, berries, trees and plants, and traplines. A composite of these maps was examined to determine specific uses that had been recorded for the Project Millennium development area.

A second regional level study has been completed in conjunction with the Syncrude Aurora project (Fort McKay 1997a). The area under consideration for this study overlaps considerably with the Project Millennium development area and can provide additional information relating to specific uses of this area. During the interviews and the questionnaire completed for this project participants were asked to indicate locations from which traditional resources were harvested. These locations were then transferred to maps by the project personnel. Seven maps were produced showing harvest locations for faunal species including: caribou, moose, mule deer, white tailed deer muskrat and beaver. These locations were displayed on a base maps showing trail and cabin locations.

While the information provided by the above studies is regional in nature and deals only in a limited degree with the Project Millennium development area, a third study provides a direct basis of determining specific traditional uses within the study area (Fort McKay 1996d). A trapper interview and community questionnaire program conducted prior to approval of the Suncor Steepbank Mine Project concerns itself with a study area that corresponds directly with the Project Millennium development area. Its results are detailed, specific and directly applicable to this EIA.

F3.3.5 Project Area

In the two regional level studies, for the Project Millennium development area itself, relatively limited use is indicated when compared to other nearby areas such as the Athabasca River corridor. Nevertheless, the maps produced for "There is Still Survival Out There" (Fort McKay First Nations 1994) shows a cabin on the lower reaches of the Steepbank River just north of the Project Millennium development area and a trail linking the east side of the Steepbank River with the Shipyard Lake area (Figure F3.2-4). Although archaeological sites may be associated with this trail, the portions of it that traverse the development area is situated in low lying, water saturated terrain and would be considered to have low potential in this regard. In-field examination of the area through which the western portion of this trail passes failed to identify intact sections of a pre-industrial trail, although a relatively modern cabin was identified north of this general area.

Examination of the remaining maps produced the following information. No graves were identified anywhere near the Project Millennium development area. Single harvest location symbols have been provided for white tailed deer, grayling, duck and grouse along the Steepbank River adjacent to but outside the Project Millennium development area. Within the Project Millennium development area two harvest locations each for blueberries and raspberries have been identified. The locations of these were too imprecise to warrant investigation. In terms of trees and plants, the Project Millennium development area encompasses reported harvest locations for black spruce, balsam fir and birch (one symbol each). No specific place names have been identified within the Project Millennium development area.

In the second regional level study (Fort McKay 1997a), the maps showing harvest locations for consumable resources provided the following information for the Project Millennium development area. Two cabin locations are identified along the Athabasca River near Shipyard Lake outside the development area. The above described trail is, again, indicated and another is shown along the north banks of Wood Creek. This latter trail is well developed on the ground and has been used by many of the vehicles that have been involved in exploration and recreational activities in this area. During the archaeological portion of the studies conducted for this project, portions of this trail were traversed (Golder 1998f). The attributes of this trail have been altered such that its pre-industrial development characteristics cannot be determined.

Two recent cabins were identified and recorded, but no other physical remains of traditional land use were recognized, despite detailed examination and intense shovel testing throughout the Project area.

Light harvesting of moose is shown throughout the Project Millennium development area, with heavy harvesting indicated for the Athabasca River valley outside the development area. No caribou, mule deer or white-tailed deer harvest areas are indicated for the Project Millennium development area, but the latter two are harvested within the Athabasca River corridor outside the development area. Snowshoe hare are harvested throughout the development area. Muskrat harvest areas all lie outside the Project Millennium development area, but beaver harvest takes place throughout the development zone and adjacent areas.

A third study on Traditional Land Use practices relates specifically to the Project Millennium development area, as its defined focus was the proposed Steepbank Mine LSA, which overlaps with the current Project LSA (Fort McKay 1996d). This study provides a specific indication of the traditional land use practices of the Fort McKay communities within the Project Millennium study area.

The detail relating to the types of resources utilized and their associated harvest locations are summarized for both the LSA and the Project Millennium development area in Table F3.3-1 which follows and in Figure F3.2-4 presented previously. It is apparent that traditional land use practices and resource harvesting occur most commonly in the Athabasca River valley and along the river and creek drainages that feed into it. Traditional land use practices occur less frequently in the interior of the development area. With the exception of trails, the structural features relating to those practices (those which would have recognizable physical remains), such as cabins and historical sites, all lie outside the proposed Project Millennium development area. The trails themselves have been used for transport of vehicles and heavy equipment during exploration and forestry activities in recent years and have had their traditional attributes significantly modified.

It might be expected that the current sites of beaver dams may have been useful in this regard over long periods of time and that archaeological or surficial historic period remains relating to traditional use of these animals may be present in these locations. During the Historical Resources Impact Assessment conducted for the Project Millennium development area (Golder 1998f), several of these features were inspected by the archaeologists. Three dams were subjected to shovel testing, on the side of the dam where well drained, level terrace landforms suggested processing or other types of activities could have been conducted. None of these investigations produced evidence of archaeological or traditional land use practices.

The balance of the resource harvest locales identified were not investigated in any detail, as they are too imprecisely defined to be able to be certain, for example, which berry patch would have been harvested in particular area. Additionally, finding such locales is difficult because many of the resources harvested are mobile in nature (e.g., animals may move to another area), and because it is believed that any identifiable physical evidence of their exploitation would have been removed or obscured by subsequent natural processes.

The data presented in Table F3.3-1 shows that only a small portion of the traditional land use practices undertaken by members of the Fort McKay community within the Project Millennium LSA would be affected by planned Project development. No previously reported cabin or historic sites would be affected, although two newly recorded cabins lie within proposed development zones. These latter sites are discussed in detail in section F4.3 of this EIA and in the Historical Resources Impact Assessment (Golder 1998f). The significant number of beaver lodges present within the Project Millennium development area suggest a potential for on-going trapping,

Table F3.3-1 Reported Traditional Resource Harvest Locations Within the Project Millennium Local Study and Development Areas (including beaver lodges recorded during aerial survey)

Resource Harvest Locales	Local Study Area	Project Development Area
active beaver lodges	82	28
inactive beaver lodges	37	11
trails	6	3
cabins	4	0
moose	1	1
deer	1	0
black bear	1	0
lynx	1	0
beaver	2	0
otter	2	1
mink	2	1
rabbit	1	0
fisher	1	1
muskrat	1	0
grouse	1	0
mallard	1	0
eagle	2	0
cranberry	3	2
choke cherry	2	0
hazelnut	2	0
blueberry	5	2
raspberry	1	0
strawberry	1	0
rosehip	1	0
wintergreen	1	1
kinnikinik	2	2
seneca root	1	1
mint	1	0
willow	3	0
poplar	2	0
tamarack	1	1
birch	2	0
spruce	1	1
alder	1	0
jack pine	1	0
walleye	2	0
grayling	2	0
jackfish	4	0
whitefish	1	0

along with the other traditional uses of beaver, would be directly affected by project development. These potential losses have been offset by the compensation measures instituted by Suncor in consultation with the registered trapline owners in the area (see below). Otherwise the effect of the development of Project Millennium on the reported traditional land use practices within the LSA would be relatively minor.

Finally a traditional land use study has been completed specifically for the Project Millennium development area (Fort McKay and AGRA 1998). This study provides a summary of available traditional land use information for both the region and the Project Millennium development area. The regional level information is based on the results of previous studies (Fort McKay First Nations 1994, Fort McKay 1996a, 1997a). This information has been summarized and incorporated in the discussion of regional traditional resource use provided in Section F3.2.2 of this EIA.

The information presented relating to specific traditional uses of the Project Millennium development area is summarized from the results of traditional land use studies undertaken for the Steepbank project (Fort McKay 1996d, 1996f). The map that accompanies the latter is reproduced to depict the recorded harvest locations of traditional resources in the LSA and the Project Millennium development area. This information is, similarly, summarized in this EIA in Figure 3.2-4 and Table F3.3-1 (above) as well as in the discussion that accompanies it.

The study concludes with statements identifying the negative influence of the East Bank mining developments on certain members of the Fort McKay community, notably trap line owners; and the general negative effects of cumulative regional developments as result of improved access to traditional lands for non-traditional uses. Recommendations to Suncor arising from this study include: ensuring that trap line owners are fairly compensated through consideration of the Community's Trapper Compensation Policy Proposal; employment of the two affected owners to monitor changes to the environment and their trap lines, and co-operative sponsorship, along with other adjacent lease holders, of a study into the cumulative effects of nearby developments on the community of Fort McKay.

F3.3.5.1 Traplines

Traplines in Project LSA have been registered with two members of the Fort McKay aboriginal communities. The historic harvest records for these harvest areas are presented in Tables F3.3-2 and F3.3-3. Willie Boucher (deceased) harvested the resources from the area north of the Township 91/92 boundary line (registry # 2297) and Julie Lindstrom (deceased) and Julian Powder harvested the resources south of this line (registry #2453). Suncor has purchased the rights for both of these traplines.

F3.3.6 Mitigation

It can be assumed that the data available for the eight year use of the registered traplines in the area reveal only a small portion of the traditional use of the area. The information above, both in terms of regional use patterns and the specific species currently or formerly present within the Project area, suggest that development of Project Millennium will have a

Table F3.3-2 Furbearing Species Trapped Within Registered Fur Management Area 2297 (Willie Boucher) From 1988 to 1996

Year	Timber wolf	Red fox	Coyote	Canada lynx	Wolverine	Fisher	Marten	Weasel	Mink	River otter	Beaver	Muskrat	Squirrel
1988		2		1		1					17	7	37
1989		8	2	1		2	1	8	1		22		80
1990		2		10		5					27		
1991		1	2			4		2			14		50
1992		1	2	4		5		1			31		50
1993		3				1	2			2	25		25
1994											14		
1995											0		
1996											22		
Total	**0**	**17**	**6**	**16**	**0**	**18**	**3**	**11**	**1**	**2**	**162**	**7**	**231**

Table F3.3-3 Furbearing Species Trapped Within Registered Fur Management Area 2453 (Julian Powder) From 1988 to 1997

Year	Timber wolf	Red fox	Coyote	Canada lynx	Wolverine	Fisher	Marten	Weasel	Mink	River otter	Beaver	Muskrat	Squirrel
1988						3					22	22	
1989						1					19		
1990		7		2		1					18	7	2
1991													
1992			1	1							7		
1993											17		
1994						3							
1995													
1996													
1997						1	2	4	2		9		52
Total	**0**	**7**	**1**	**3**	**0**	**9**	**2**	**4**	**2**	**0**	**92**	**29**	**54**

moderate to low impact on traditional land use practices in the area because the area has not been used extensively. Mitigation plans, intended to compensate for some of the specific impacts of the Project Millennium development area, are currently in place between Suncor and the registered trapline owners of the Project area.

In a more general sense, Suncor has established protocols for discussion of concerns and interests of local aboriginal communities by entering into memoranda of understanding (MOUs) with both the Communities of Fort McKay and Fort Chipweyan. These agreements acknowledge that Suncor's operations take place in areas considered to be traditional lands. They further establish the intent of Suncor to assist these communities in achieving their objectives of self reliance, to ensure they benefit from industrial development, and to identify and resolve issues created by the company's operations to the mutual satisfaction of both parties. While not limited to issues relating to traditional land use, these agreements provide the framework for on-going identification and resolution of traditional land use concerns relating to development and operation of Project Millennium, as well as other Suncor operations, through development of long term cooperative relationships.

Perhaps one of the most frequently raised concerns in the traditional land use studies completed to-date relates to the type of landscape that will remain when the oil sands operations in the region close. Concerns have been raised about whether these landscapes will be sufficiently clean and productive to ensure the sustainability of traditional land use practices. Later stages of Project Millennium development, including mine closure, will require detailed planning and consultation. Suncor will ensure that closure planning considers the on-going sustainability of traditional land uses by providing opportunities for direct involvement of aboriginal peoples in the closure planning process.

F3.3.7 Summary

Although Project Millennium represents a small portion of the area that is currently considered to be the traditional lands of the resident aboriginal communities, the above discussions indicate that it is currently used for a range of traditional land use practices. Project development will impact these practices over a 50 year period from the initiation of development through to project closure. Mitigative procedures, which include direct compensation to trappers, staged development to provide a transition period and closure planning that will incorporate traditional land use needs, will effectively offset many of these effects. Consequently, the residual impacts to traditional land use are considered to be low and possibly reversible, at least partially, by appropriate closure planning.

F3.4 RESOURCE USE BASELINE/ENVIRONMENTAL SETTING

F3.4.1 Methodology

In this section resource use refers to "non-traditional" resource or land use. "Non-Traditional" refers to the general non-aboriginal population within the LSA and RSA.

Information sources used to evaluate resource use in the LSA and RSA include:

- the non-traditional land use study completed by BOVAR (1996c);
- a resource use telephone survey;
- personal communications with various government and non-government agencies;
- several businesses based in Fort McMurray;
- various government reports and databases; and
- industry management plans.

A comprehensive resource use telephone survey, conducted by BOVAR Environmental Ltd. (BOVAR 1996c), involved representatives from a variety of recreational organizations and other local resource sources. The potential users interviewed by BOVAR were not re-interviewed as part of this assessment.

F3.4.2 Land Use Zoning

The local study area (LSA) and a large part of the regional study area (RSA) are located within the Fort McMurray-Athabasca Oil Sands Subregional Integrated Resource Plan (IRP) area (AEP 1996a). This IRP provides direction for the management of public land and resources through future actions of both the provincial government and the private sector. The IRP ensures development activities are compatible within each Resource Management Area (RMA). There are four RMAs in the RSA: Fort McMurray Fringe, Athabasca-Clearwater, Mildred-Kearl Lakes and Stoney-Birch (Figure F3.4-1). The LSA is within the Athabasca-Clearwater and Mildred-Kearl Lakes RMAs.

The IRP has listed specific objectives and guidelines for each RMA (AEP 1996a). The management intents for the RMAs within the LSA are to:

- manage public land and resources in recognition of the multiple uses required to service and enhance development of the urban service area of Fort McMurray in the Fort McMurray Fringe RMA;
- protect the natural landscape, which encompasses water, wildlife habitat, ecological and geological features, and to ensure aesthetic, recreational, traditional and environmental values in the Athabasca-Clearwater RMA;
- promote the orderly planning, exploration and development of resources with emphasis on the area's oil sands reserves in the Mildred-Kearl Lakes RMA; and
- manage the exploration, extraction and/or development of a range of resources while recognizing opportunities associated with the wildlife, fisheries and other valued ecological components in the Stoney-Birch RMA.

To ensure development activities are compatible within each RMA, IRP guidelines range from expressing a concern to limiting how or where an activity is conducted (Table F3.4-1). Guidelines were developed for mineral and surface material resources, forest resources, access and infrastructure, agriculture, recreation and tourism, ecological reserves, wildlife resources, fisheries and historical resources.

F3.4.3 Natural Areas (Protected Areas)

Natural Areas, Ecological Reserves, Wilderness Reserves and Provincial Parks are legislatively protected under the authority of the Wilderness, Ecological Reserves and Natural Areas Act. The primary objective of this act is to maintain the natural features of the areas while allowing for appropriate public use. Alberta Environmental Protection was contacted regarding these areas within the LSA and RSA. No protected areas were reported in the LSA. Within the RSA, four areas are reported:

- a park near Gregoire Lake;
- an area at Twp. 89, R1 near the Clearwater River;
- an Ecological Reserve at the border of Twp. 105-106, R6; and
- an area along the Athabasca River at Twp. 93, R10.

F3.4.4 Environmentally Significant Areas

Environmentally significant areas (ESAs) are areas that contain unique or representative landforms, rare or endangered vegetation, or significant or important wildlife habitat. Often ESAs contribute to biodiversity because they represent a unique combination of landscape features, vegetation communities, habitats (i.e., forest types), species populations and genetic

F3-37

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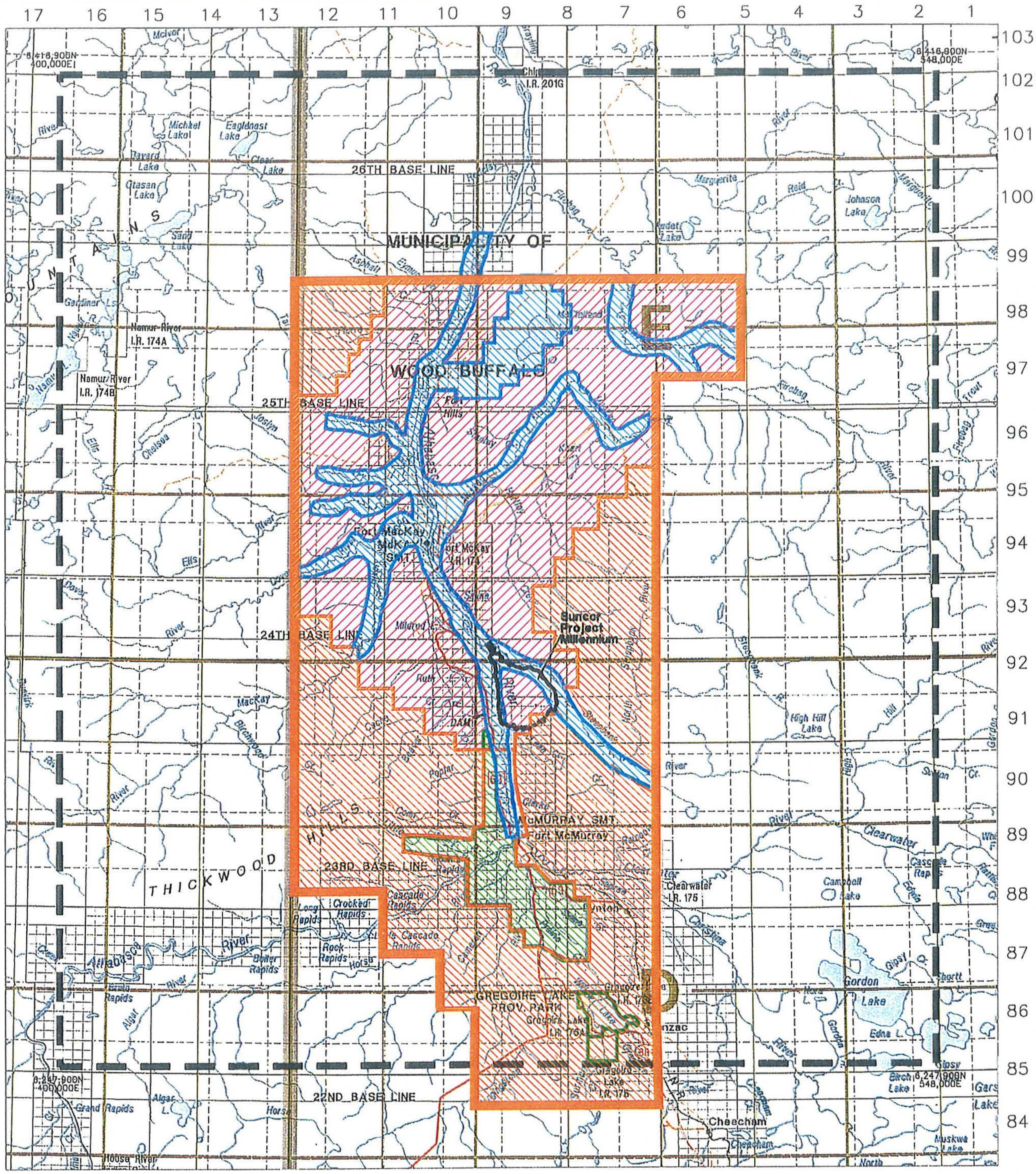

LEGEND

- REGIONAL STUDY AREA
- FORT McMURRAY– ATHABASCA OIL SANDS SUBREGIONAL INTEGRATED RESOURCE PLAN BOUNDARY
- ATHABASCA–CLEARWATER RMA
- STONY–BIRCH RMA
- FORT McMURRAY FRINGE RMA
- MILDRED–KEARL LAKES RMA

REFERENCE

SCANNED IMAGE OF ALBERTA ENVIRONMENTAL PROTECTION PROVINCIAL BASE MAP 1997, ORIGINAL SCALE 1:1,000,000

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Project Millennium
Taking Suncor Into the 21st Century

INTEGRATED RESOURCE PLAN
RESOURCE MANAGEMENT AREAS (RMAs)
FOR THE RSA

08 Apr. 1998	Figure 3.4–1	DRAWN BY: RFM

Table F3.4-1 Integrated Resource Plan Guidelines (AEP 1996a)

Activity	Broad Guidelines	Fort McMurray Fringe RMA	Athabasca-Clearwater RMA	Mildred-Kearl Lakes	Stoney-Birch
Mineral and Surface Material Resources	• Impacts on the environment and other resource values should be minimized. • Mineral exploration and development is subject to current regulatory review and approval processes. • Surface disturbances must be progressively reclaimed or alternative reclamation approaches may be considered. • The location of aggregated deposits must be reported to Alberta Land and Forest Service.	• Surface mining is not permitted. • In-situ oil sands development will be permitted where conflict with other land uses can be mitigated. • Impacts on aesthetics and wildlife values must be minimized by limiting line-of-sight; retaining vegetation buffers between development and public roads; and clearing the site in an irregular shape.	• Oil sands development is not permitted in the Clearwater River valley, McClelland Lake wetlands and the MacKay River tributary. • Surface mining in other areas must mitigate impacts in highly sensitive areas. • Oil sands recovery will be considered within the Athabasca and Clearwater River valleys, associated tributaries and the upland drainage of the McClelland Lake wetlands. • Seismic and other mineral exploration within the Athabasca and Clearwater River valleys should maximize use of existing access. • Extraction of oil sands must be conducted such that impacts on watershed, wildlife, fisheries, vegetation, aesthetic and recreation values are minimized. • Instream gravel production is not permitted. Sand and gravel operations require a minimum 50 m buffer from rivers. • Surface mineable areas in the Athabasca River valley have a separate set of guidelines.	• Mineral exploration activities are subject to site-specific operating conditions.	• Within the Thickwood Hills, Birch Mountain and Stoney Mountain Upland areas, the development must be designed to minimize impacts on wildland recreational resources.

Activity	Broad Guidelines	Fort McMurray Fringe RMA	Athabasca-Clearwater RMA	Mildred-Kearl Lakes	Stoney-Birch
Forestry	• Harvesting and reforestation methods must be in accordance with the Forests Act, Timber Management Regulations, Timber Harvest Planning and Operating Ground Rules and other policies. • Timber salvage cutting should occur wherever possible. • Alberta Land and Forest Service will identify forestry lands (e.g., intensive forest management, future timber development, miscellaneous timber use areas).	• Recreation activities and aesthetics must be maintained.	• Impacts on watershed must be reduced through special conditions (e.g., cutblock size and configuration). • Buffers around sinkholes may be required in sensitive areas (e.g., McClelland Lake wetlands). • Timber harvesting should occur in accordance with the "Forest Landscape Management Strategies of Alberta" guidelines.	• Where loss of the forest land base occurs, reforestation is required.	• Alberta Land and Forest Service will select and manage sites for improved wood quality and timber productivity, with considerations for watershed integrity. • On the Stoney Mountain Upland, timber harvesting must use techniques defined in the "Forest Landscape Management Strategies for Alberta" and the "Timber Harvest Cutblock Design."
Agriculture	• Agriculture activity is limited to the Fort McMurray Fringe RMA and reclaimed areas as identified in the Landscape Reclamation Strategy.	• Future market gardening on Class 3 soils only; a 100 m undisturbed buffer along river edges. • Grazing is permitted on Class 4 soils or better. • Permanent residences are not allowed on agricultural leases. • Horse-holding areas will be considered in public land areas with road access.	• Agricultural activity is not compatible with the intent of this RMA.	• Agricultural activity in this RMA will be considered on a site-specific basis.	• Agricultural activity will be considered on a site-specific basis.
Recreation and Tourism	• Private sector and non- profit organizations should take an active role in identifying and encouraging recreational activities. • Alberta Tourism and Recreation will review proposals.	• Private sector and non-profit organizations should take an active role in identifying and encouraging recreational activities. • Alberta Economic Development and Tourism and Recreation and Protected Areas will review proposals.	• Development of support services (e.g., parking) must adhere to the Settlement Guidelines. • Surface access will not be permitted within 200 m of the river shoreline or lands identified for the proposed provincial recreation area within the Fort Hills.	• Alberta Economic Development and Tourism should be included in referral systems for proposals that affect river or stream crossings, significant wildlife habitats and viewing areas of special interest.	• Potential impacts from increased access or development in the Thickwood Hills, or the Birch Mountain and Stoney Mountain Uplands were addressed in the mineral resources, forest resources, and access guidelines section above.

Activity	Broad Guidelines	Fort McMurray Fringe RMA	Athabasca-Clearwater RMA	Mildred-Kearl Lakes	Stoney-Birch
Water Resources	• Water resources will be managed on a drainage-basin basis reflecting local, regional and provincial needs. • Water quantity and quality will be managed together. • The public should participate in water management planning programs. • Consultation between provincial agencies will continue. • Development conditions may be imposed to ensure protection of the water resource. • Re-routing of rivers and streams in the planning area is discouraged. • Water quality and quantity monitoring programs should be maintained. • The domestic water supply of Fort McMurray, Fort McKay and other settlements will be recognized.	• Where there is a risk of flooding, operating guidelines must be adhered to. • Buffers may be established in proximity to Fort McMurray and along river flood plains.	• The domestic water supply must be recognized in any planning scenario.	• Guidelines were not defined in the IRP.	• Special protective measures to preserve water quality in Surmount Creek (the primary source for Gregoire Lake) must occur for activities located in the creek's watershed.
Access and Infrastructure	• Linear developments will be encouraged to use existing or planned access routes or corridors. • Where possible, linear development will not occur parallel to rivers within valleys or within 100 m of the top of valley breaks. • Public access to recreation opportunities is a priority. • Off-highway vehicle use will be restricted in areas of industrial activity, reclamation sites, and environmentally sensitive areas.	• Guidelines were not defined in the IRP.	• River crossings must be constructed so as to meet all objectives in the IRP. • Riverbank disturbances must be mitigated. • Linear developments crossing the McClelland Lake wetlands should use the existing corridor. • New roads should be developed with recreation and tourism values in mind. • Resource development facilities should be screened from the river.	• Proponents of oil sands developments on the east side of the Athabasca River should use the Athabasca Oil Sands Multiple Use Corridor, proposed by AEP. • Surface access leading to disposition in areas designated as provincial recreational areas (e.g., Fort Hills) must maintain recreational potential.	• Access to recreational activities should be maintained. • In the Thickwood Hills, Birch Mountain or Stoney Mountain Uplands, route selections must avoid or minimize impacts on wildland recreational resources.

Activity	Broad Guidelines	Fort McMurray Fringe RMA	Athabasca-Clearwater RMA	Mildred-Kearl Lakes	Stoney-Birch
Fisheries	• The limited fisheries resource will be allocated to meet the demand of high priority user groups. • Fisheries habitat protection guidelines shall be applied to local plans and developments. • Fisheries production will continue to rely on naturally reproducing populations. • Stream and lake fisheries will be managed to maintain naturally reproducing fish populations. • Unrestricted legal public access to waterbodies containing fishery resources will be maintained.	• Guidelines were not defined in the IRP.	• Emphasis on site selection and erosion control measures should be made to maintain riparian habitats and shoreline vegetation, to protect water quality, and to protect fish-spawning and fish-rearing habitat.	• Guidelines were not defined in the IRP.	• Guidelines were not defined in the IRP.
Wildlife	• Hunting is managed under existing guidelines to achieve equitable use among subsistence users, recreational users and commercial users. • Wildlife habitat protection guidelines will be applied. In important wildlife areas, techniques to minimize habitat loss, wildlife disruption and lost recreational/commercial opportunities will be used. • Conflicts between trappers and other users will be reduced through consultation with trapping area holders. • Priority is management of the habitats and populations of rare and endangered species. • In important wildlife areas and for wildlife management purposes, techniques may be applied in situations of new industrial access. • Wildlife-viewing opportunities will be encouraged.	• Guidelines were not defined in the IRP.	• Developments will not be permitted in significant waterfowl nesting habitat (e.g., Horseshoe Lake, Saline Lake, McClelland Lake and Little McClelland Lake). • Critical habitat for moose must be maintained, especially in river valleys (e.g., Clearwater, Hangingstone, Lower Muskeg, Lower Steepbank and Athabasca).	• Where development activities affect moose habitat, off-site enhancement or special protective measures may be required. • For lakes (e.g., Kearl, Calumet), backshore buffers should be maintained to protect waterfowl nesting and staging and fish spawning sites.	• Developments are not allowed adjacent to Anzac Lake, which provides important waterfowl habitat. • Special protective measures (e.g., timing constraints) are required to maintain moose populations and moose habitat in the Christina and Clearwater rivers, lands between the Horse and Athabasca rivers, and various other locations.

Activity	Broad Guidelines	Fort McMurray Fringe RMA	Athabasca-Clearwater RMA	Mildred-Kearl Lakes	Stoney-Birch
Ecological Resources	• Ecological resources will be identified by government agencies and individual groups. Public land reservations will be established and maintained.	• Guidelines were not defined in the IRP.	• Development activity must not disturb the La Saline Natural Area. • Adverse impacts must be mitigated within significant areas (e.g., Athabasca River Tar Sands Reach, McClelland Lake Patterned Fen, Eymundson Sinkholes on Pierre River, Ells River, Firebag River and Clearwater River).	• Activity adjacent to the La Saline Natural Area must not disturb or adversely affect this resource.	• Guidelines were not defined in the IRP.
Historical Resources	• Before development, a Historical Resources Impact Assessment should be conducted.	• Guidelines were not defined in the IRP.	• Activity must not disturb the Beaver River Quarry Archeological Site or the Bitumount Historic Site.	• Before development, a Historical Resources Impact Assessment should be conducted.	• Guidelines were not defined in the IRP.

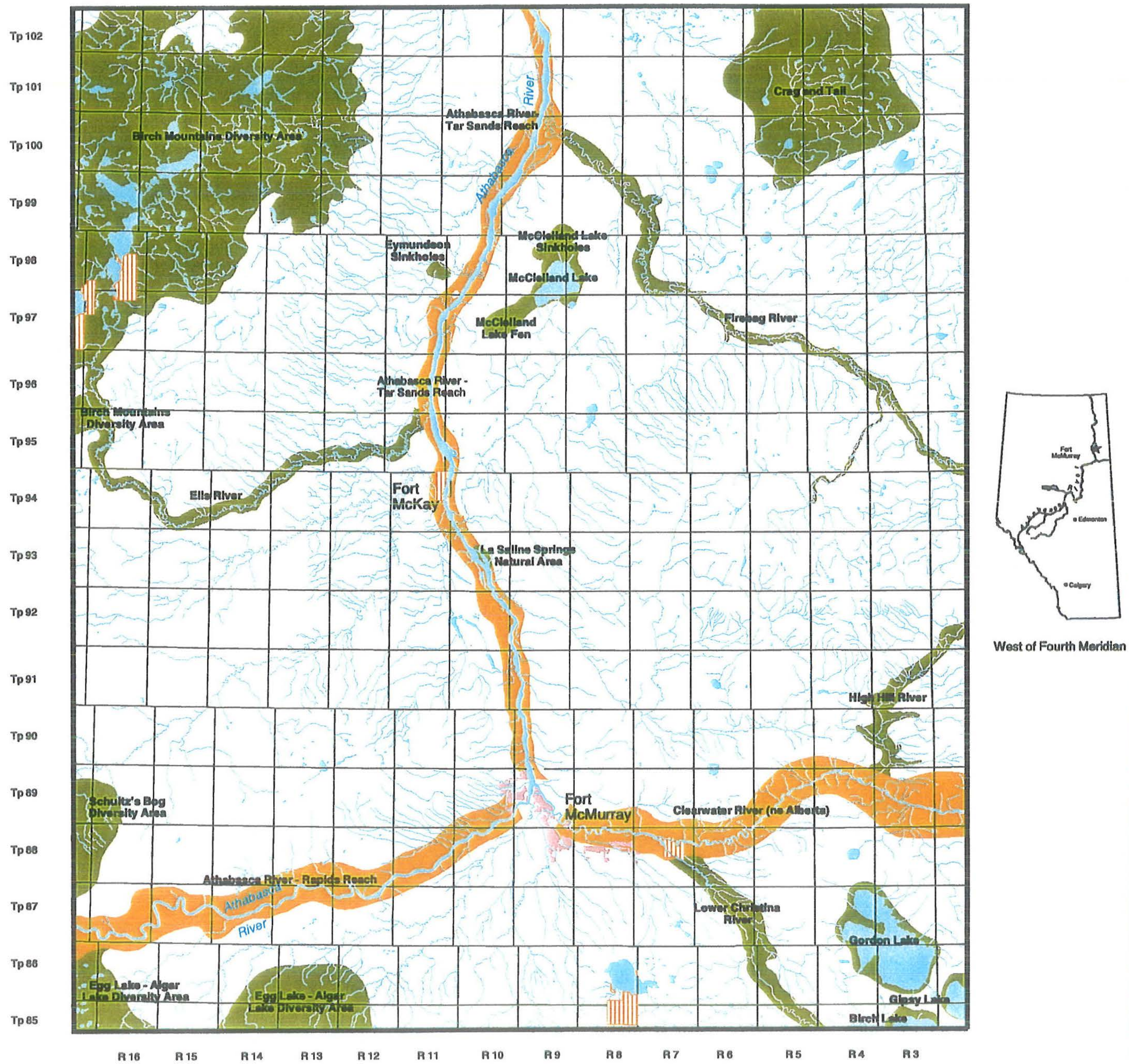
resources that are otherwise uncommon in the region. One ESA was identified in the LSA, the Athabasca - Tar Sands reach. The Fort McMurray-Athabasca Oil Sands Subregional Integrated Resource Management Plan (AEP 1996a) addresses the importance of protecting ESAs. A number of ESAs were identified in the RSA (Figure F3.4-2) and are listed below in Table F3.4.2. This list is compiled from a database provided by AEP and was based on work completed by Westworth (1990). Table F3.4-2 details the ESA hectares and percentages of the area in the RSA. The area of the RSA is 2,428,645 ha and ESAs represent approximately 23% of the area.

Table F3.4-2 Environmentally Significant Areas in the RSA

ESA	Hectares (ha)	Percent of the RSA
Athabasca River - Tar Sands Reach	52,690	2.2
Birch Mountains Diversity Area	195,704	8.1
Crag and Tail	63,351	2.6
Firebag River	21,474	0.9
McClelland Lake	6,403	0.3
McClelland Lake Fen	3,070	0.1
McClelland Lake Sinkholes	2,052	0.1
Eymundson Sinkholes	841	<0.1
Ells River	18,364	0.8
La Saline Springs Natural Area	733	<0.1
High Hill River	9,571	0.4
Clearwater River (NE Alberta)	49,495	2.0
Schultz's Bog Diversity Area	10,972	0.5
Athabasca River - Rapids Reach	46,790	1.9
Lower Christina River	13,156	0.5
Gordon Lake	19,179	0.8
Egg Lake - Algar Lake Diversity Area	10,161	0.4
Egg Lake - Algar Lake Diversity Area	22,037	0.9
Gipsy Lake	2,696	0.1
Birch Lake	2,486	0.1
TOTAL	**551,225**	**22.7**

Athabasca River - Tar Sands Reach

The Athabasca River, which is one of the largest and longest rivers in the Mixedwood Boreal Forest of Canada, is classified a nationally significant area. It is described as one of the most diverse and productive river valley systems. The Tar Sands reach, which is not as incised as other sections of the Athabasca River, has extensive riparian forest, including areas of old growth stands along its shores. The Athabasca supports an important sport fishery with several important species: walleye, lake whitefish, Arctic grayling, northern pike and goldeye. The Athabasca River is also considered important hydrologically. The Tar Sands Reach contains important landforms like bitumen outcrops and point bars. The area is important moose habitat and waterfowl staging.



SOURCES: Golder, Alberta Natural Heritage Information Centre

Scale 1:1,000,000

10 0 10 20 30 40

Kilometres

Map Projection: UTM 12
Datum: NAD 83

LEGEND

- Regional Study Area
- Linear Disturbances
- Open Water
- Municipalities
- Indian Reserves

ENVIRONMENTAL SIGNIFICANCE

- International
- National
- Provincial

N

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Project Millennium

ENVIRONMENTALLY SIGNIFICANT AREAS OF THE REGIONAL STUDY AREA

09 Apr. 1998	Figure F3.4-2	PRODUCED BY: K.K.Q. REVIEWED BY:

Birch Mountains

The Birch Mountains is classified as a provincially significant area. It is one of the most diverse intact major hill systems in the Boreal Forest of Alberta. The area is also provincially significant because of a California Gull colony. The Birch Mountains have a high landform diversity (one of the best examples of glacial flutings in Alberta).

The Birch Mountains are a large plateau supporting boreal, sub-arctic and foothills species. They have high vegetation and wildlife diversity. Big Island Lake is an important nesting area for bald eagles, ospreys and American white pelicans. The Birch Mountains support sport, commercial/domestic and trophy fishing. Important fish species are lake trout, lake whitefish, cisco, arctic grayling, northern pike, walleye and yellow perch.

Crag and Tail

The Crag and Tail is a provincially significant ESA. The area is described as craggy knolls of Precambrian Shield bedrock and "tails" of glacial till deposited on the lee sides of the knolls during a glacial advance. The area includes the only significant area of crag and tail topography in Alberta. The area is primarily an outcrop of the Precambrian Shield with rugged granite crags rising abruptly and grading gently into till on their lee sides. Individual crag and tail features are separated by black spruce bogs. Open jack pine woods with sparse understories occur only on exposed granite outcrops. The area is inhabited by disjunct Precambrian Shield plant species.

Firebag River

The Firebag River and its tributaries are provincially significant Arctic grayling habitat. The river is considered hydrologically important and has a high landform diversity (meanders and delta). The area has old growth alluvial white spruce forest (623 hectares, 170 to 190 years old) The Firebag River is also considered key moose range. The river is describe as key fisheries habitat (spawning, feeding and over-wintering) for walleye, lake whitefish, northern pike, yellow perch and burbot. The area support a sport fishery of northern pike, Arctic grayling and walleye.

McClelland Lake

McClelland Lake is a provincially significant duck staging habitat. The lake is considered important hydrologically. The area is also important for bald eagle nesting.

McClelland Lake Fen

The McClelland Lake Fen is provincially significant. The fen is one of the largest, most significant patterned fens in Alberta. It supports rare vegetation species and is a sandhill crane nesting area.

McClelland Lake Sinkholes

The McClelland Lake Sinkholes are a rare feature in Alberta's boreal forest. The provincially significant sinkhole features are a string of 12 karst lakes in mixedwood forest. McClelland Lake is considered a hydrologically important lake.

Eymundson Sinkholes

The Eymundson Sinkholes are provincially significant sinkhole lakes that are considered a rare feature in Alberta. The area is also recognized for its karst topography.

Ells River

The Ells River is a provincially significant ESA because it is one of the best examples of incised oxbows and meanders in Alberta. The river supports an outstanding sport fishery with the following species: walleye, lake whitefish, Arctic grayling, mountain whitefish, northern pike, yellow perch, goldeye and burbot. The area has high vegetation diversity and is a major wildlife corridor.

La Saline Springs Natural Area

The La Saline Springs are provincially significant, unique saline spring system in the boreal forest of Alberta. It is a large travertine cone and mineralized (saline) springs flowing into an oxbow lake. The area supports rare vegetation species and is an important waterfowl area (breeding and staging).

High Hill River

The High Hill River Valley is a provincially significant ESA. It is one of the most diverse valleys in the mixedwood area of Alberta. The river supports an important sport fishery with the following species: Arctic grayling, mountain whitefish (NE-most range) and northern pike. The valley is an important wildlife movement corridor. It is considered a hydrologically important river with diverse landforms including canyon and outcrops.

Clearwater River

The Clearwater River is nationally significant and an inter-provincial waterway that connects to Canadian Heritage River in Saskatchewan. It supports an important sportfishery (over 20 fish species recorded) and is site of northern pike and burbot spawning. The area is important moose habitat and has a wildlife mineral lick. There are rare vegetation species in the Clearwater Springs. The area has high landform diversity (including the outstanding Whitemud Falls), and a saline spring on Devonian limestone.

Schultz's Bog

Schultz's Bog is provincially significant. It is one of the most diverse wetlands complexes in the Central Mixedwood. It is important woodland caribou habitat and has a diverse peatland/wetlands vegetation community (palsa bog and patterned fen). The area has high landform diversity.

Athabasca River - Rapids Reach

The Athabasca River is nationally significant. It is an interprovincial waterway and one of the largest and longest rivers in the Mixedwood Boreal Forest of Canada. It is considered one of the most diverse and productive river valley systems within that region. It is a scenic river with many rapids, bedrock outcrops and a deeply incised valley. The area supports spawning lake whitefish and other important fish species: walleye, Arctic grayling, mountain whitefish, northern pike and goldeye. The area is important moose habitat and furbearer (lynx) habitat.

Lower Christina River

The Lower Christina River is provincially significant. It is one of the most diverse and intact river valleys in the Central Mixedwood of Alberta. It supports an important sport fishery, is a walleye spawning area and is inhabited by other important fish species, including: lake whitefish, Arctic grayling, mountain whitefish, northern pike, yellow perch, goldeye and burbot. The area is important moose over-wintering habitat and important raptor nesting area. The area has diverse landforms including canyons and slumps.

Gordon Lake

Gordon Lake is one of the most important waterfowl breeding, molting and staging areas in the mixedwood area of Alberta. The lake is also considered to be hydrologically important.

Egg Lake

Egg Lake one of the most diverse and relatively intact Boreal Forest landscapes in Alberta. It is a significant patterned fen, important woodland caribou habitat and has a high vegetation diversity.

Gipsy Lake

Gipsy Lake is a provincially significant as both an American white pelican non-breeding habitat and also as an area supporting an American white pelican colony.

Birch Lake

Birch Lake is an important American white pelican and double-crested cormorant nesting area. It is considered hydrologically important, with a diverse wetlands, habitat with large seepage area on north side of lake.

F3.4.5 Special Places 2000

Special Places 2000 is an Alberta Government initiative to protect the natural variety of Alberta's species and spaces within a system of protected areas. Initially the government of Alberta invited nomination of special places to be considered. These places were designated "nominated site" and were forwarded to the Provincial Coordinating Committee for review. The committee upgraded sites promising sites to "candidate sites" that were forwarded to a local committed for review. If approved by the local committee the "candidate site" was sent to the Minister of Environment and Provincial Coordinating Committee for final approval. An approved site would then be designated and protected as wilderness areas, provincial parks or ecological reserves and be protected under the appropriate legislation.

There are no nominated sites within the LSA; however, there are eleven nominated sites within the RSA. The areas are described below using information provided by the Strategic and Regional Support Division of Alberta Environmental Protection. The sites within the RSA are being considered for upgrading to "candidate" sites. Many of the Special Places 2000 sites are included within ESAs.

Richardson River-Paxton Lake

The nominated site is located approximately 50 km south of Lake Athabasca just north of the RSA. The area is managed for preservation and includes the Athabasca Dune Ecological Area.

Six Lakes

Six Lakes is considered a valuable recreation area for the residence of Fort McMurray. It is an important fishing area and has possible canoe routes.

Marguerite River

The Marguerite River is valued for its unique geology, crag and tail terrain and vegetation that includes some rare species.

Fort Hills - McClelland Lake

The Fort Hills a "dissected kame" glacial landform, which means that it is a mound-shaped hill or ridge cut into two or more pieces. The Fort Hills supports high landform and bird diversity. As well, the area provides important habitat for moose and Canada lynx (BOVAR 1996c).

This area is further described above in the under the Fort Hills, McClelland Lake, McClelland Lake Fen and McClelland Lake Sinkholes.

Cree Burn Lake Prehistoric Regions

This area is valued for several reasons, including because it contains archaeological sites (2,000 to 8,000 years old) and fossils (375 million years old). The area encompasses part of the Athabasca River - Tar Sands Reach ESA and is valued for its boating (Canoe loop), fishing (21 species) and tourism potential. The area is reported to have a high animal and plant diversity, with rare plants.

La Saline Natural Area Addition

The area is describe as being very sensitive to outside interference. It is suggested, by the nominee, that the area be managed as an ecological reserve.

Clearwater River

The Clearwater River is a provincially significant ESA. It was described in the ESA section.

Gregroire Lake National Area Expansion

The area nominated is a low lying wetlands, that is described as being important to the health of Gregoire Lake. It is valued as a staging and nesting area for waterfowl and other birds.

Athabasca River Valley

The Athabasca River Valley was described in the ESA section.

Maqua Lake

The area is reported to support six species of rare plants. It is suggested that the area also has high value for non-consumptive outdoor recreation because of the variety of wildlife present.

Stoney Mountain

This area is south of Gregoire Lake, which is just south of the RSA. The area is valued because it contains the Chain Lakes watershed, Cheecham escarpment, woodland caribou habitat, permafrost sites, old growth forest and a biological diversity area.

F3.4.6 Access

The principal access corridors to the LSA is through the existing Suncor operations. Because access is restricted by Suncor, there are limitations on resource use in the LSA and on nearby Suncor properties. Some of Suncor's policy that restrict activity are:

- no one is permitted on site without proper authorization;
- no firearms are allowed on Suncor's sites; and
- no unauthorized vehicles are permitted on Suncor's sites.

One company accesses the LSA using ice bridges and winter roads:

- Northlands Forestry Products harvest timber on the east side of Athabasca River.

The ice bridges are located at the south end of the LSA. Northlands uses the seasonal roads for the removal of timber from the area. Other companies have applied for Surface Material Lease access (gravel) in the area. The ice bridge and winter road may be affected by Project Millennium.

F3.4.7 Use of Resources

The LSA and RSA are located within the Green Zone and are composed primarily of public lands owned by the Government of Alberta (Alberta Agriculture, Food and Rural Development 1995). Forested lands in this area are managed mainly for forest production, watershed protection, recreation, fish and wildlife and industrial development. The RSA covers approximately 300 townships or 2,428,645 hectares in the Regional Municipality of Wood Buffalo.

Mineral and Surface Materials

Mineral and surface materials within the LSA and RSA include oil sands, petroleum and natural gas, and other surface and subsurface minerals (AEP 96a).

Oil Sands and Mining

The main mining and surface material extraction operations currently within the RSA include:

- Suncor Lease 86/17, and Steepbank Mine (oil sands mining, extraction and upgrading);
- Syncrude Mildred Lake and Aurora Mine (oil sands mining, extraction and upgrading);
- SOLV-EX Lease 5 oil sands mining and bitumen and mineral extraction (operations currently suspended);
- Northstar Energy steam assisted gravity drainage bitumen extraction;
- Birch Mountain Resources Ltd. hold Metallic and Industrial Mineral rights in area; and
- some other pilot in-situ operations.

Granular Resources

Alberta Environmental Protection and Alberta Agriculture, Food and Rural Development (AFRD) administer and manage sand and gravel resources on public lands (AEP, Alberta Land and Forest Services and AFRD n.d.). Gravel is relatively scarce in the IRP area and in the RSA (AEP 1996a). In attempt to assess the sand and gravel resource in the study areas several sources were reviewed, including government databases, existing reports and discussions with government employees.

The Land Status Automated System (LSAS), a database operated by Crown Resources Data and Services (Alberta Energy), was searched for the LSA and RSA. The LSAS provides the official record of all surface interests on Crown Land. The Commercial Sand and Gravel Division of AEP was contacted to determine appropriate activity codes that would indicate potential gravel reserves. BOVAR (1996c) was reviewed to determine other activity codes that could potentially impact development. All surface interests for the LSA and RSA were reviewed. The activity codes are describe below:

- Consultative Notations (CNT), which require contact with the disposition holder before conducting an activity and indicate potential gravel resources;
- Surface Material Lease (SML), may indicate gravel reserves;
- Surface Material License (SMC), may indicate gravel reserves;
- Protective Notations (PNT), which place restrictions on the types of activities that may occur; and
- Disposition Reservations (DRS), which are held by the provincial government for the protection of a facility.

The results of the surface interest search, for the LSA, are summarized in Table F3.4-3. The search of the LSA did not provide information suggesting there were any gravel pits on the LSA. However, several companies have applied for SMLs on the LSA.

Table F3.4-3 Summary of Surface Dispositions Within the LSA

Surface Disposition	Location	Area (ha)	Client	Status/Type Comments
CNT-870307	Twp 91 R9	1,787	Alberta Energy and Utility	industrial/commercial site
CNT-900353	Twp 92 R9	6,410	Environmental Protection	potential timber disposal
CNT-900353	Twp 91/92 R9	1,733	Environmental Protection	approved, potential timber disposal
CNT-940088	Twp 86-90 R9	5,180	Environmental Protection	multiple resource concerns
CNT-960110	Twp 89-92 R9	3,894	Environmental Protection	special places (Athabasca River Valley)
DRS-780004	Twp 90 R9	0.4	Environmental Protection	other miscellaneous site protected area
DRS-860252	Twp 92 R9	4	Environmental Protection	research or sample plot/expiry
PNT-660001	Twp 90 R9	76	Environmental Protection	approved silviculture plot
PNT-742922	Twp 91 R9	185	Environmental Protection	approved silviculture plot
PNT-860186	Twp 91 R9	442	Agricultural, Food and Rural Development	potential subdivision
SML-960038	Twp 92 R9	34	Suncor Energy	letter of author
SML-970027	Twp 91 R8	8	TBG Contracting Ltd.	application
SML-970028	Twp 91 R8	8	TBAT	application
SML-970029	Twp 91 R8	16	Sil Silca Ltd.	application
SML-970030	Twp 91 R8	8	Wells Construction Ltd.	application
SML-970032	Twp 91 R8	8	Transportation Systems Management	application

Public Lands division of AEP in Edmonton indicated that the two main gravel pits used in the Fort McMurray area are located at Twp 91, R 10, W4M and Twp 95, R10, W4M.

AEP, Lands and Forestry in Fort McMurray was contacted regarding gravel pits in the Fort McMurray area. The pit located at Twp. 95, R10 is nearly exhausted. A second pit, located near Susan Lake, will be run by a contractor and should be open in early 1998. Another gravel pit has been applied for and approved for operation at Twp 92, R8. There is also a public gravel pit located at Twp 83, R6. AEP report that there are two private pits at Twp. 91, R8 that have been approved for development. The LSAS database was checked for confirmation of the gravel pits.

Granular resources for the LSA are described in the "Sand and Gravel Resources of the Athabasca Oil Sands Region, Northeast Alberta" (Fox 1980). The reserves on the LSA are indicated on Figure F3.4-3 (Fox 1980).

The LSA sand and gravel units are described as infilled channels that occur near the Athabasca River (indicated as 2A on Figure F3.4-3). The area was calculated to be 823 hectares. The granular material is fine to coarse grained with minor lenses or layers of gravel. Silt clay and minor boulders are also present near the base of the deposits. Typically, the deposits are less than 6 m thick. The deposit is considered fair with fewer uses than sand and gravel deposits (Fox 1980). Figure F3.4-3 indicates a point sources, rated fair, along Wood Creek in the southeast portion of the LSA.

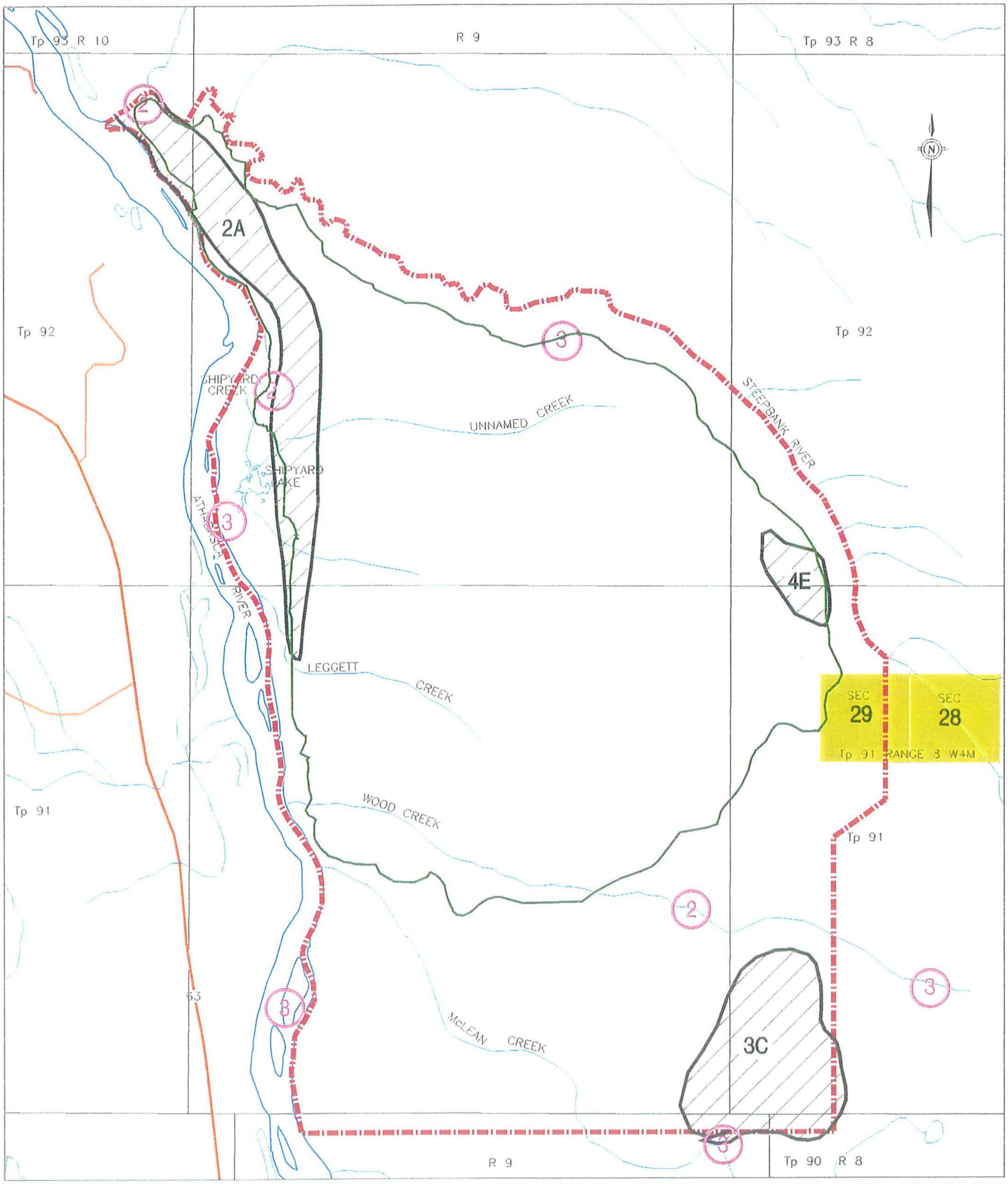
The LSA has deposits rated as poor, Site 3C and point information (circled 3). Site 3C as an estimated area of 753 hectares. Typically these deposits have few uses and are localized with small volume and incorporated with silt and clay. The LSA also has known aeolian deposits, Site 4E, of sand in dune of sheet forms (Fox 1980). Site 4E has an estimated area of 132 hectares. These deposit would probably have very limited use.

A geological investigation was conducted on the LSA in 1997 and 1998. The program located granular deposits on the LSA. The volume and quality of the granular material could not accurately be measured.

The database covering the RSA was searched for activities that might indicate gravel and aggregate reserves. Several sites indicating gravel or surface resource were found within the RSA and are summarized in Table F3.4-4. The RSA information did not include the volume or quality of the sand and gravel.

Fox (1980) was reviewed for information regarding sand and gravel resource within the RSA. Areas that are ranked as good sand and gravel potential are located in the areas below:

- West 1/2 of Twp 97, R10, W4M. A large sand and gravel deposit near Susan Lake. The area is estimated to be 625 hectares;
- Twp 92 to 93, R10, W4M. Mostly a sand deposits with gravel and sand occurring as bars and outwash remnants. This site is on the west side of



LEGEND

- AREA INFORMATION
- (3) POINT INFORMATION
- LOCAL STUDY AREA
- EAST BANK MINING AREA
- SURFACE MINERAL LEASE

REFERENCE

Sand and Gravel Deposit Information from Mollard, 1978.
Sand and Gravel Resources of the Athabasca Oil Sands Area
DIGITAL DATA SETS 74D AND 74E RESOURCE DATA DIVISION, ALBERTA ENVIRONMENTAL PROTECTION, 1997.
MINE PLAN SUPPLIED BY SUNCOR ENERGY, MAR 1998.
DATUM IS IN NAD83 UTM

0 1 2 3km
SCALE 1:100,000

SUNCOR ENERGY

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GRANULAR RESOURCES ON PROJECT MILLENNIUM LSA

08 Apr. 1998	Figure F3.4-3	DRAWN BY: RFM/DC

the Athabasca River near Mildred Lake. The area is estimated to be 3,689 hectares;

- Twp 89 to 90, R8 to 9, W4M. An area of thin sand and gravel occurs within the listed area. The area is estimated to be 9,751 hectares;
- Twp 88, R7 to 9, W4M. A large area of meltwater channel deposits southeast of Fort McMurray. Serves as a source of aggregate in the Fort McMurray area. The area is estimated to be 750 hectares;
- Twp 96 to 97, R10 to 11, W4M. A major deposit near the Bitumont airstrip. The deposit medium to coarse sand with gravel up 10 cm. The area is estimated to be 4,500 hectares;
- Twp 95, R10, W4M. Three small deposits of sand and gravel. The area is estimated to be 749 hectares;
- Twp 96, R9, W4M. A deposit of sand and gravel. The area is estimated to be 250 hectares;
- Twp 92, R12, W4M. A series of terraces along the MacKay River with a layer of silt and clay on top of a layer of sand and gravel. A total volume of sand and gravel is potentially eight million m^3 of low quality aggregate. The area is estimated to be 1,750 hectares; and
- Twp 87, R15, W4M. Rate as a good prospect for sand and gravel. Probably small terraces of sand and gravel of unknown depth. An area could not be estimated.

Agriculture

Agriculture in the LSA and RSA is limited, due to unfavourable climate in the region and generally low-quality soils (AEP 1996a). There are some small-scale market gardening ventures in the Clearwater River valley, located in the Fort McMurray Fringe RMA. There is little demand for cattle grazing. There are small horse-holding (grazing) areas, averaging 5 ha in size in the vicinity of the Thickwood Tower and the Clearwater Lighthorse and Rodeo areas. Reclamation strategies in the IRP include other potential agricultural activities (e.g., livestock grazing, wild rice and berry production) (BOVAR 1996c).

Forestry

The Project Millennium LSA occurs within Forestry Management Unit (FMU) A5 (Figure F3.4-4) of the Athabasca Forest. The RSA covers portions of the A2, A3, A4, A5, A6, A7, A8, A10 and A11 FMUs. Timber rights have been granted to Alberta-Pacific Industries Inc. (Al-Pac) under a Forest Management Agreement. Additionally, a timber quota disposition has been granted to Northlands Forest Products Ltd. (BOVAR 1996c).

Al-Pac (1995) in BOVAR (1996c), developed a forest management plan for the purpose of identifying sustainable allowable cut and projected timber harvesting levels. This plan also includes projected harvest levels by

Table F3.4-4 Surface Dispositions Indicating Potential Sand and Gravel Resources in the RSA

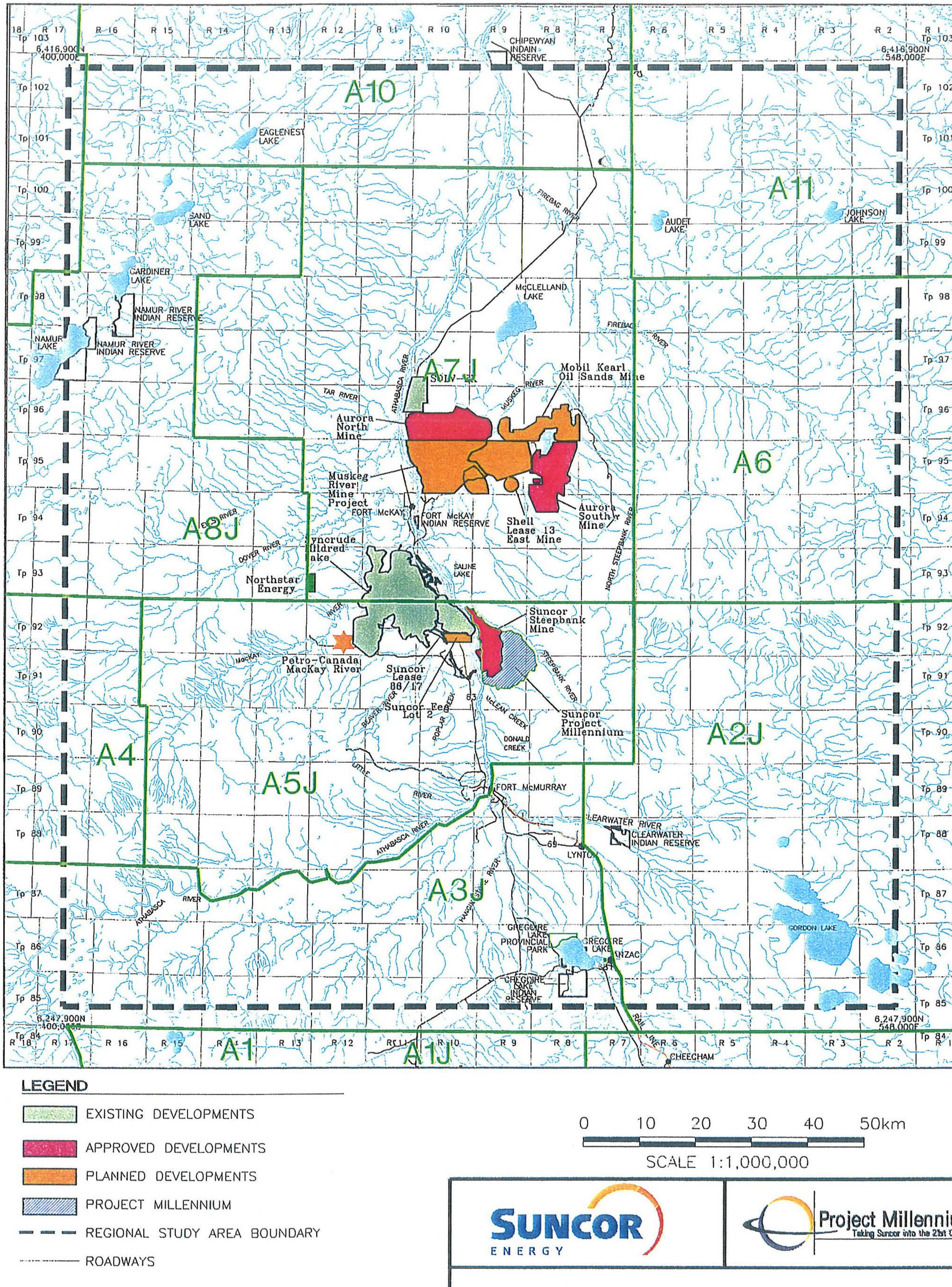
Surface Disposition	Location	Area (ha)	Client	Status/Type Comments
CNT-740007	R10, TWP 95	1,813	Environmental Protection	Surface Materials Potential
CNT-770026	R10, TWP 92	393	Environmental Protection	Surface Materials Potential
CNT-780072	R7, TWP 89	647	Alberta Transportation and Utilities	Surface Materials Exploration
CNT-780073	R11, TWP 95	--	Alberta Transportation and Utilities	Surface Materials Exploration
CNT-790068	R11, TWP 97	--	Alberta Transportation and Utilities	Surface Materials Exploration
CNT-820114	R7, TWP 88	--	Alberta Transportation and Utilities	Surface Materials Exploration
CNT-820380	R8, TWP 88	122	Alberta Transportation and Utilities	Surface Materials Exploration
CNT-900275	R11, TWP 94	--	Department of Energy	Quarrible Minerals
CNT-900276	R10, TWP 94	--	Department of Energy	Quarrible Minerals
CNT-900277	R10, TWP 94	--	Department of Energy	Quarrible Minerals
CNT-900278	R10, TWP 94	--	Department of Energy	Quarrible Minerals
CNT-900279	R10, TWP 94	--	Department of Energy	Quarrible Minerals
CNT-920327	R10, TWP 94	--	Environmental Protection	Surface Materials Potential
CNT-950028	R7, TWP 88	--	Environmental Protection	Surface Materials Exploration
DRS-911	R10, TWP 91	1,536	Environmental Protection	Pubic Pit (Domestic Use)
DRS-1641	R8, TWP 86	2	Environmental Protection	Sand & Gravel Removal
DRS-780100	R11, TWP 97	27	Alberta Transportation and Utilities	Sand and Gravel Removal
DRS-930015	R10, TWP 95	8	Alberta Transportation and Utilities	Surface Materials Stockpile Site
DRS-940031	R8, TWP 88	12	Environmental Protection	Sand and Gravel Removal
PNT-870326	R10, TWP 95 R11, TWP 96	65 7,157	Environmental Protection	Sand & Gravel Removal
PNT-890583	R7, TWP 95	188	Environmental Protection	Surface Materials Potential

Northlands Forest Products Ltd. The projected timber harvesting yields are presented in Table F3.4-5. Al-Pac's harvest projections indicated that 6,957,200 ha of deciduous and 5,533,600 ha of coniferous timber will be harvested by 2016. In 1998, Al-Pac expects to harvest approximately 11,400 hectares (Al-Pac 1997).

Table F3.4-5 Twenty Year Harvest Schedule for Deciduous and Coniferous Timber in RSA Forest Management Units (1,000 m^3/five year period) (BOVAR 1996c)

5 Year Harvest Period	Deciduous (ha)	Coniferous (ha)
1996-2001	355	1,218
2001-2006	1,620	1,260
2006-2011	4,949	1,730
2011-2016	33	1,326
ALL YEARS	**6,957**	**5,534**

In Al-Pac's 1998 annual operating plan identifies the north side of the Steepbank River is identified as planning unit 092084, and is planned to be harvested in 1998 (Al-Pac 1997).



REFERENCE
DIGITAL DATA SETS 74D, 74E, 74I
84A AND 84H FROM RESOURCE DATA DIVISION
ALBERTA ENVIRONMENTAL PROTECTION, 1997.
DATUM IS IN NAD83 UTM PROJECTION

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FOREST MANAGEMENT UNIT BOUNDARY

08 Apr. 1998	Figure F3.4-4	DRAWN BY: RFM/CG

Al-Pac calculated the total coniferous and deciduous merchantable timber within their Forest Management Agreement (FMA). The coniferous volume of timber within the FMA is 154,145,000 m^3/ha and the deciduous volume is 243,228,000 m^3/ha (BOVAR 1996c). In the LSA, forest productivity for both deciduous and coniferous timber is highly variable. Productive stands in the LSA comprise 61% of the LSA (Table F3.4-6). Detailed information on Forestry Resources is provided in the Forestry Resource Report (Golder 1998e).

Table F3.4-6 Timber Productivity Rating for the Local Study Area

	TPR	Area (ha)	% Area
1	Good	2,298	14.2
2	Moderate	5,923	36.6
3	Fair	1,714	10.6
4	Unproductive	6,247	38.6
TOTAL		**16,181**	**100.0**

In 1996, BOVAR distributed a resource use questionnaire (RUQ) to local residents. The results of the RUQ indicated that apart from large-scale commercial forestry, only 29% of the respondents harvested trees in the area. The primary resource uses of the timber were for firewood, construction material (e.g., log cabins), and small-scale timber harvest and sales (BOVAR 1996c).

Berry Harvesting

From their telephone survey, BOVAR (1996c) were able to report on plant-gathering activities in the RSA. They found that wild berries were harvested to some degree by approximately 80% of the respondents. Blueberries were the most commonly harvested. Other berries in the order of preference were cranberries, raspberries, saskatoons, chokecherries, rosehips and strawberries. One respondent also picked mushrooms. Locations at which berries were picked included: the Clearwater River valley, Thickwood Hills, Peter Lougheed Bridge, Highway 963 to the OSLO site, Kearl Lake, MacKay River, Mildred Lake, Muskeg River and east of the Athabasca River.

Potential areas for berry harvesting have been calculated for the LSA and RSA. In Table F3.4-7 the species of berry, area within the LSA, percent of the LSA are presented. A further description of the vegetation within the study area is in the vegetation baseline document.

Table F3.4-7 Species of Berries in the LSA

Berry	LSA (Adjusted) Area (ha)	% LSA
Bog Cranberry	12,622	78
Choke cherry	941	6
Common blueberry	991	6
Dwarf blueberry	12,269	76
Dwarf raspberry	11,143	69
Low-bush cranberry	5,216	32
Prickly rose	13,549	84
Saskatoon	4,148	26
Velvet-leaved blueberry	5,153	32
Wild strawberry	13,537	84

Hunting

Big game animals with open seasons in the boreal region include white-tailed deer, mule deer, moose, black bears, wolves and coyotes (AEP 1997d, Smith 1993). Important upland game birds with open seasons in the boreal region include ruffed grouse, spruce grouse, sharp-tailed grouse and ptarmigan (AEP 1997d; Semenchuk 1992). Important waterfowl species include mallards, northern pintails, northern shovelers, blue-winged teals, green-winged teals, scaups, redheads and canvasbacks. White-fronted geese, Canada geese, snow geese and Ross' geese may also be hunted (AEP 1997d).

In the RSA, hunting is regulated within Wildlife Management Units (WMUs) 518, 519, 529, 530 and 531 (AEP 1997c). The LSA is located in WMU 530 (AEP 1997c). Information on the harvest and hunting efforts by big game hunters in Alberta for the 1990 to 1995 hunting seasons for WMU 530 (encompasses the LSA) is summarized in Table F3.4-8. More recent data for harvest and effort by big game hunters will be available in March 1998. These values do not include hunting activities by aboriginal hunters.

In general, hunting is not permitted in wildlife sanctuaries, natural areas, ecological reserves, provincial parks or national parks. Gamebird hunting is not permitted at Richardson Lake in WMU 530 (AEP 1997d).

A telephone survey conducted by BOVAR (1996c) indicated that approximately 70% of their respondents hunted. The most common purpose for hunting was to gather food. Other reasons cited for hunting were enjoyment, occupational reasons (e.g., professional guide/outfitting services) and as a source of food for dog teams. Most respondents preferred to hunt moose and deer. Other common game species included ruffed grouse, black bear, ducks, partridge, geese, spruce grouse and ptarmigan.

Non-residents and foreign hunters prefer hunting for bear and moose over other game species. According to the telephone survey, hunters spent an average of 14 days hunting per year, with a range of 4 to 30 days per year. The respondents all hunted with partners and most camped in the area in which they hunted. Hunting locations included: the Clearwater River valley, Athabasca River valley, Bitumount Tower, Kearl Lake, MacKay River, Highway 963 Extension, Alsands lease area and the Peter Lougheed Bridge area (BOVAR 1996c).

Table F3.4-8 Big Game Harvest for Wildlife Management Unit 530

		Animals Harvested		Number of Hunter Days	
Species	Year	Estimated Number	Percentage of Provincial Harvest	Estimated Number	Percentage of Provincial Total
Moose	1990	47	0.4	1,326	0.4
	1991	66	0.6	2,721	1.0
	1992	42	0.5	1,285	0.6
	1993	53	0.01	937	0.01
	1994	33	0.01	569	0.00
	1995	61	0.02	1,324	0.02
	Average	**50**	**0.3**	**1,360**	**0.34**
White-tailed deer	1990	6	0.1	410	0.1
	1991	10	0.1	806	0.2
	1992	12	0.1	516	0.1
	1993	12	0.00	599	0.00
	1994	9	0.00	479	0.00
	1995	4	0.00	854	0.00
	Average	**9**	**0.05**	**611**	**0.07**
Black Bear	1990	9	1.0	82	0.2
	1991	3	0.3	189	0.5
	1992	27	3.9	124	0.9
	1993	11	0.01	183	0.01
	1994	6	0.01	155	0.01
	1995	8	0.01	567	0.02
	Average	**11**	**0.97**	**217**	**0.27**

Source: BOVAR (1996c); AEP (1997c); AEP (1997d).

Trapping

Trapping in the LSA is discussed in Section F3.2 under Traditional Land Use. The registered fur management areas for the RSA are shown in Figure F3.4-5.

Fishing

The LSA and RSA occur within Fish Management Area (FMA) 8 (AEP 1997a). This FMA encompasses the watersheds of the Athabasca, Birch, Clearwater and Slave rivers and their tributaries. Common game fish in FMA 8 include goldeye, burbot, lake and mountain whitefish, northern pike, Arctic grayling, walleye, lake trout and yellow perch (Nelson and Paetz 1992). The Northern River Basins Study Project (R.L.&L. 1994) provided a baseline fish/fish habitat inventory for various reaches and site locations. This study determined that fish species diversity and abundance were generally greater in the lower reaches of the Athabasca River.

In FMA 8, sport fishing is allowed on flowing waters only from June 1 to October 31. Lakes, ponds and reservoirs are open to fishing all year. Exceptions to these regulations are described in AEP (1997a).

The Steepbank River provides habitat for walleye, lake whitefish, grayling and northern pike (Westworth 1990). In a 1996 study, Golder (1996a) found that the Steepbank River is a key watercourse in the Athabasca River watershed and supports an abundant and diverse fish fauna. Twenty-five species of fish have been recorded from the Steepbank River, of which ten (Arctic grayling, northern pike, longnose sucker, white sucker, lake chub, pearl dace, longnose dace, trout-perch, brook stickleback and slimy sculpin) are common and widespread (Sekerak and Walder 1980). A more detailed description of the fish community within the LSA is provide in section C4.1 of the EIA.

Fisheries Management Division of AEP was asked for information about fishing in the LSA. They reported that fishing was low due to limited access. In addition to sport fishing, commercial fishing also occurs on the Athabasca River, especially in the vicinity of Fort McKay (L. Rhude, pers. comm., November 1997).

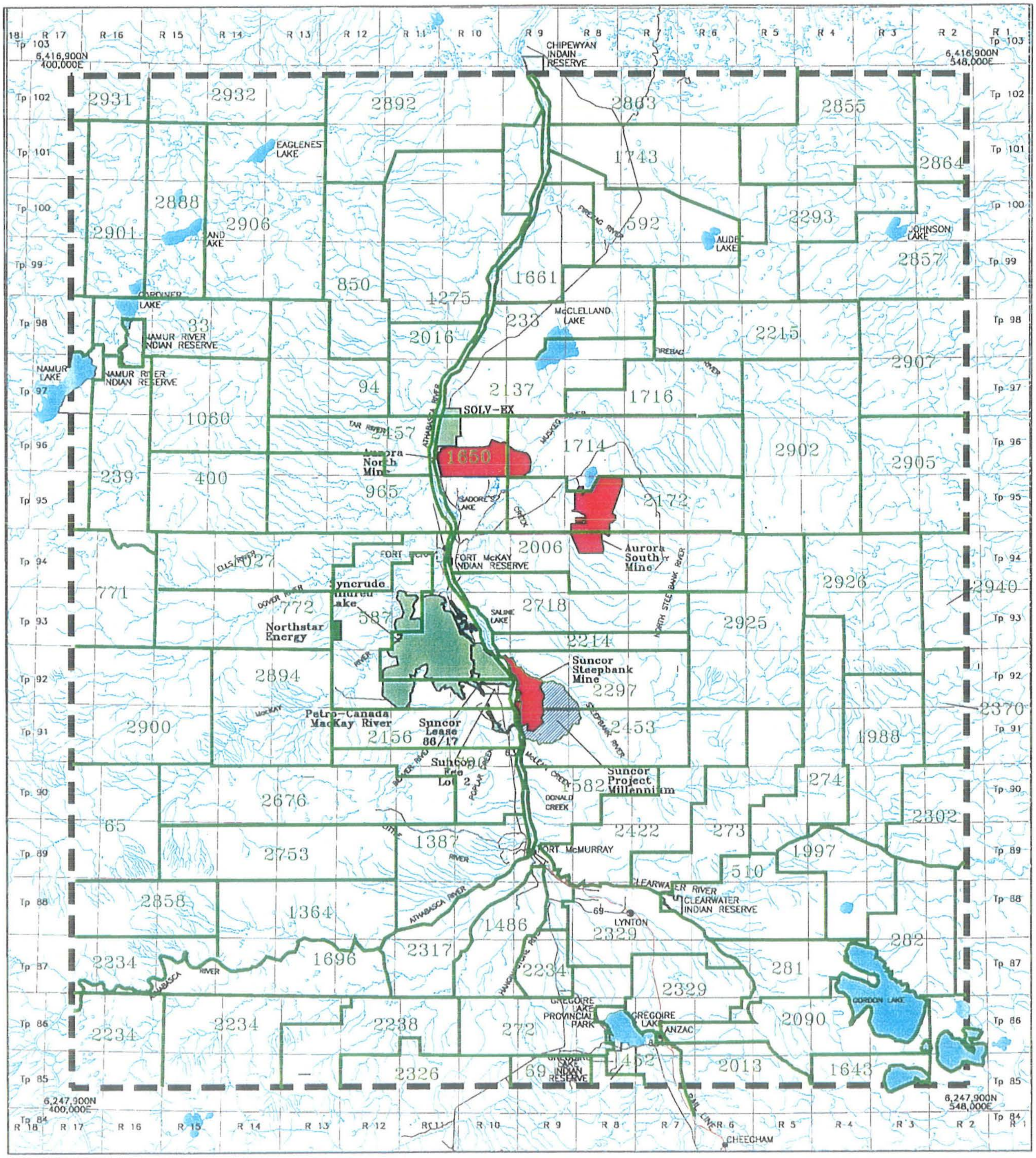
A summary of fish habitats occur within the RSA are listed in Table F3.4-9 (Westworth 1990).

Most of the respondents to the BOVAR (1996c) telephone survey participated in fishing activities (16 of 17). Most fishing activity occurred in the summer season, although 19% of the respondents fished all year. The preferred location for fishing was the Clearwater River, followed by the Athabasca River. Other identified fishing locations were the Muskeg, Horse, Hangingstone, MacKay and Firebag rivers. The preferred sport fish. species were northern pike and walleye, followed by pickerel, grayling, perch, whitefish, lake trout and rainbow trout.

Recreation (Non-Consumptive)

Non-consumptive resource use includes activities such as camping, hiking, boating, photography, birdwatching, kayaking and snowmobiling. Significant recreation activity include tours of the operating oil sands developments. The Fort McMurray Visitor's Bureau organizes tours from May to October for Syncrude Canada Ltd. and from June to September for Suncor Energy (Ref. Jan Bourassa, Visitor's Bureau pers. comm., Dec. 1997).

The oil sands companies have also developed several facilities that cater to non-consumptive recreation. These activities and their locations include:



LEGEND

EXISTING DEVELOPMENTS

APPROVED DEVELOPMENTS

PROJECT MILLENNIUM

REGIONAL STUDY AREA BOUNDARY

ROADWAYS

REGISTERED FUR MANAGEMENT AREA

0 10 20 30 40 50km

SCALE 1:1,000,000

REFERENCE

DIGITAL DATA SETS 74D, 74E, 74I
84A AND 84H FROM RESOURCE DATA DIVISION
ALBERTA ENVIRONMENTAL PROTECTION, 1997.
DATUM IS IN NAD83 UTM PROJECTION

SUNCOR ENERGY

Project Millennium
Taking Suncor into the 21st Century

PROJECT MILLENNIUM
REGISTERED FUR MANAGEMENT AREAS FOR RSA

07 Apr. 1998	Figure F3.4-5	DRAWN BY: DC/TM

Table F3.4-9 Summary of Fish Habitat in the Regional Study Area[a]

Location	Important Fish Species								
	Walleye	Lake White-fish	Arctic Grayling	Mountain White-fish	Pike	Yellow Perch	Rainbow Trout	Goldeye	Burbot
Athabasca River	X	X	X		X			X	
Christina River: Lower Reach	X	X	X	X	X	X		X	X
Clarke Creek			X						
Clearwater River	X	X	X	X	X			X	X
Dover River				X	X				
Ells River	X	X	X	X	X	X		X	X
Hangingstone River	X		X	X	X				
Horse River	X		X		X	X		X	
Horseshoe Lake							X		
Jackpine Creek			X	X	X				
MacKay River	X		X	X	X	X			X
Muskeg River	X	X	X	X	X				X
Saline Creek		X							
Steepbank River	X	X	X		X				
High Hill River			X	X	X				
Pierre River	X		X		X				

(a) Source: Westworth 1990.

- wildlife viewing area and nature trail at Suncor's Crane Lake;
- wildlife viewing area, temporary Boy Scout camp and canoeing at Poplar Creek Reservoir;
- wildlife viewing area at Wood Bison Gateway and Wood Bison Trail (where Highway 63 enters the Syncrude Mildred Lake Mine);
- hiking trails at Matcheetawin Discovery Trails;
- wildlife viewing area at Wood Bison Viewpoint (Syncrude Mildred Lake);
- canoeing at Ruth Lake; and
- canoeing at Beaver Creek Reservoir.

BOVAR (1996c) determined that the most common non-consumptive activity, as noted by 71% of the respondents to the telephone survey, was camping. Other activities were hiking, canoeing, snowmobiling, river boating, cross-country skiing, driving quads (all-terrain recreational vehicles), kayaking, sightseeing, plant studies, birdwatching, photography, water-skiing, dog mushing, swimming, picnics and snowshoeing. Individuals often engaged in more than one recreational activity during any given outing. Potential non-consumptive resource users are outlined in Table F3.4-10.

Table F3.4-10 Potential Resource Users in the LSA and RSA

Alberta Forestry Conservation Community Committee
Alberta Snowmobile Association
Alberta Trapper's Association
All Terrain Vehicle (ATV) Association
Canadian Institute of Mining
Clearwater River Committee
Equestrian Group
Federation of Alberta Naturalists
Fort McMurray Field Naturalists Society
Fort McMurray Fish and Game Association
Fort McMurray Musher's Association
Fort McMurray Snow-Drifters
Fort McMurray Visitor's Bureau
Jetboaters and Large Motorized Watercraft Group
Lodges, Guides and Outfitter's Group
Muffaloose Trail Blazers
Northeast Alberta Off-Highway Vehicle (OHV) Association
Northern Alberta Native Plant Council
Professional Outfitters Association of Alberta
Ptarmigan Nordic Ski Club
Tarsands Canoe and Kayak Club

According to BOVAR (1996c), the main locations for recreational activities were:

- the Clearwater River valley (boating, camping and dog-mushing);
- he Athabasca River valley (camping, boating and snowmobiling);
- Thickwood Tower Road (camping, hiking and plant studies);
- Muskeg River (canoeing, kayaking and camping);
- Hangingstone River (canoeing and kayaking);
- Saline Lake (wildlife viewing, rare plants and photography);
- McClelland Lake (birdwatching);
- Birch Mountain (camping and hiking); and
- along the Fort Chipewyan Road (camping and snowmobiling).

The Tourist Information Centre was contacted to determine businesses in the Fort McMurray area that may be offering non-consumptive recreation services. Many of these business offer hunting and fishing opportunities, but many are offering activities like birdwatching, river tours and hiking. Several businesses operating in the LSA and RSA that potentially offer non-consumptive recreation activities are:

- Northern Sport Fishing;

- Namur Lake Lodge;
- Northern Lights;
- Snowy Lane Sled Dogs;
- Majic Country Wilderness Adventures;
- Clearwater River Lodge;
- Points North Adventure;
- Island Lake Lodge;
- Lloyd Lake Lodge;
- Grist Haven Lodge (Winefred Lake);
- Bear Paw Tours;
- Sky Wander Tours;
- Gypsy Lake Lodge;
- Island Lake Lodge;
- MacKenzie Brothers Outfitting;
- Poplar Ridge Outfitter; and
- Steepbank Wilderness Lodge.

Mr. Blair Jean the owner of Clearwater River Lodge was contacted. His lodge is approximately 60 km up the Clearwater River to the east of Fort McMurray. He indicated that business has increased in recent years. This is potentially due to the growth of Fort McMurray leading to increased day-trips. He also indicated that guests from areas other than Fort McMurray are common.

While conducting winter field work in 1997, Golder employees observed two snowmobilers on the Steepbank River. Based on the number of tracks, the Steepbank River appeared to be used regularly by snowmobilers.

A recreational opportunity associated with oil sands is the Fort McMurray Oil Sands Discovery Centre. The Oil Sands Discovery Centre has recently launched a multi-million dollar campaign to redevelop the exhibition hall. In 1997 the Visitor's Bureau reported 8,145 visitors.

In addition, a lake is planned for the Syncrude Mildred Lake mine pit west of Wood Bison Trail (BOVAR 1996c). It is expected this lake will be 2,000 ha in size and will offer boating, fishing and general recreation opportunities.

F3.5 RESOURCE USE IMPACT ASSESSMENT

F3.5.1 Introduction

Evaluation of the impact of Project Millennium on resource use by non-traditional users included consideration of:

- linkages among Project initiated environmental changes and changes in resource use potentials; and
- Project activities and resource use in a local study area.

F3.5.2 Potential Linkages and Key Questions

The approach for the evaluation of impacts for resource use as well as other EIA components was described in detail in Section A2 of the EIA.

The purpose of this assessment is to determine the potential impacts of construction and operations on resource use, develop appropriate mitigation measures and evaluate residual impacts.

A number of resource uses could potentially be affected to differing degrees by Project Millennium. Important resource uses in the vicinity of the Project were identified in Section F3.4. These resource uses include surface and mineral extraction, forestry, hunting, trapping, fishing and non-consumptive recreation.

The assessment involved identifying and discussing possible interactions between resource use and the proposed development. Key Questions and linkage diagrams were developed to detail potential impacts of the Project on resource use (Figure F3.1-1). The Key Questions were developed to help describe the potential impacts of the Project on the various resource uses.

RU-1: What impacts will development and closure of Project Millennium have on potential development mineral extraction activities, agricultural developments and forestry operations?

Mineral and surface materials within the LSA include oil sands and surface materials (AEP 1996a). These activities are compatible with the intent of the RMAs if all guidelines are met (see Section F3.4). The Project has the potential to affect three surface dispositions, one of which is a gravel deposit. Mineral and surface material extraction may be affected by changes in the amount of area available for extraction and by changes in access.

Forestry is one of the main resource uses in the vicinity of the Project, and harvest levels are essential for sustaining the economic health and vitality of the forest industry in the region (AEP 1996a). This question focuses on whether gain, loss or alteration of vegetation or soils will lead to a change in forest productivity and timber harvest potential.

RU-2: What impacts will development and closure of Project Millennium have on environmentally significant areas?

Environmentally Significant Areas (ESAs) contain unique or representative landforms, rare or endangered vegetation, or significant or important wildlife habitat. In this assessment both ESAs, as well as, areas that are Special Places 2000 nominated sites were considered.

RU-3: What impacts will development and closure of Project Millennium have on consumptive resource use, including berry-picking, hunting, fishing and trapping?

Many local residents regularly engage in berry-picking (BOVAR 1996c). Within the LSA, the valley of the Athabasca River was identified as an area where berry-picking occurs.

RU-4: What impacts will development and closure of Project Millennium have on non-consumptive recreational use?

Many of the local residents engage in non-consumptive recreational activities (e.g., canoeing, camping, hiking, snowmobiling). The Athabasca and Steepbank rivers are two of the main locations for this resource use. Construction and operation activities may result in changes in aesthetics, plus some minor changes in opportunities for these recreational uses and restricted access.

F3.5.3 Methods

Linkages between project activities and environmental changes that affect each of the Key Questions were developed and then assessed as to their validity. In general, assessments were based on the literature and professional judgment. Project construction and operation details were evaluated to determine potential impacts. Following the assessment of the impacts, mitigation strategies were developed for each valid linkage. Residual impacts were then assessed with regard to direction, magnitude, geographic extent, duration, reversibility and frequency.

F3.5.4 Key Question RU-1: What Impacts will Development and Closure of Project Millennium Have on Potential Development Mineral Extraction Activities, Agricultural Developments and Forestry Operations?

F3.5.4.1 Analysis of Potential Linkages

Linkage Between Change in Access and Change in Mineral Extraction

Currently there are five surface material lease applications (Table F3.4-3) on the LSA. These dispositions may be affected by Project Millennium activities. The areas may be directly impacted by the mine or access (via winter road) to the areas may be altered.

The linkage is valid.

Linkage Between Loss or Alteration of Soils and Terrain and Change in Agriculture

Loss or alteration of terrain or soils may make an area unusable for other agricultural use. However, agriculture activity in the LSA does not exist and the conditions are considered unfavorable for such development (Section F3.3).

The linkage is not valid.

Linkage Between Alteration or Loss of Vegetation and Change in Forestry

Vegetation, including standing timber and understory that would become merchantable on maturation, will be lost due to site clearing for Project Millennium. As well, site clearing will affect timber harvesting to some extent. Timber will be harvested and salvaged out of the scheduled forest management sequence. Following site clearing, the area will be removed from forest production during construction and operations for 40 to 50 years.

This linkage is valid.

Linkage Between Change in Access and Change in Forestry

Timber rights within the LSA have been granted to Alberta-Pacific Industries Inc. (Al-Pac), and a timber quota disposition has been granted to Northlands Forest Products Ltd. Access to merchantable timber stands outside of the project may be affected.

This linkage is valid.

F3.5.4.2 Analysis of Key Question

No granular resources will be lost because of the Project development. Currently, five surface material lease applications occur within the LSA. Three surface mineral lease applications contact the development footprint and may be directly impacted by mining activity. The area included in the development footprint is approximately 16 ha. The final two are in the LSA but not in contact with the development footprint. The area in the LSA but not in the development footprint is 180 ha. The known granular resources found in the LSA are considered of fair or poor quality (Section F3.4.4.1). Access to the surface mineral lease areas may be impacted by the Project. Mitigation for this impact involves salvaging materials prior to oil sands mining.

Birch Mountain Resources Ltd. holds the metallic and industrial mineral rights in the LSA. Project Millennium will impact the ability of Birch Mountain Resources to exploit metallic and mineral resources (limestone, gold, platinum) in the area during the lifetime of Project Millennium. Because the distribution of metallic resources and plans to exploit them are unknown at this time, it is impossible to predict the specific effects of Project Millennium on this enterprise.

Vegetation will be lost due to site clearing during the construction and operation phases. Merchantable timber will be salvaged during site clearing. Thirty-nine percent of the stands in the LSA are considered unproductive (Table F3.4-6). Fourteen percent of the LSA is considered good forest productivity. Reclamation of the development area is expected to return the area to equivalent or greater capability. Forest regeneration to commercial standards will require 50 years for aspen, and 80 to 100 years for coniferous species (BOVAR 1996c). The Forest Management Area and quota holders have been consulted regarding reclamation and closure planning. It is expected that the majority of reforested land will be planted to mixedwood forests using species that have proven most effective in past reclamation efforts. For the east bank mining area productive forest will increase from 2,753 ha (Predevelopment) to 7,246 ha (Post disturbance). This will lead to an improved forestry resource in the area. Details on reclamation and closure plans are provided in Section E of Volume 1.

Mitigation measures will reduce the impact of site clearing. For example, merchantable timber will be salvaged. As well, site clearing will be kept to the smallest practical area. Finally, the development area will be reclaimed to equivalent or greater forest capability following closure. This will result in the potential for a net increase in forest productivity.

Northlands Forestry Products currently accesses the east side of the Athabasca using an ice bridge. Project Millennium may impact the current road location used for timber harvesting. The issue can be mitigated by relocating access.

Residual Impacts

There will be a decrease in timber production during the construction and operation phases for the duration of Project Millennium. This decrease is considered minor for the LSA as the productivity of the area is low and all merchantable timber will be salvaged, where possible. As well, within the Project development area, timber will be harvested, and disturbed sites will be reclaimed to equivalent or better forestry capability. The result of closure of the site is that an increase in areas of merchantible timber are predicted. Therefore, the overall residual impact for forestry is positive.

Monitoring

A monitoring program will be designed to document the re-establishment of plant species and community types on reclaimed sites (see the Reclamation and Closure Plan Section (E) of Volume 1 of the Application). Plots will be established to examine species composition and community structure, forest growth and shrub productivity. This program will ensure the re-establishment of a productive forest.

F3.5.5 Key Question RU-2: What Impacts Will Development and Closure of Project Millennium Have on Environmentally Significant Areas?

F3.5.5.1 Analysis of Potential Linkages

Linkage Between Site Clearing and Change in ESAs

The one nationally Environmentally Significant Areas (ESA), the Athabasca River - Tar Sands Reach, is in the LSA (Section F3.2.2.3), Figure 3.5-1. Project Millennium development will follow the guidelines outlined in the IRP (AEP 1996a). No sites nominated for Special Places 2000 status are within the LSA.

The Athabasca River - Tar Sands Reach is addressed in the IRP guidelines, which will be followed by Suncor. Suncor will maintain a minimum 300 m setback between the Project developments and the Athabasca River. No Special Places 2000 nominated site will be impacted.

The linkage is not valid.

F3.5.6 RU-3 What Impacts Will Development and Closure of Project Millennium Have on Consumptive Resource Use, Including Berry-picking, Hunting, Fishing and Trapping?

F3.5.6.1 Analysis of Potential Linkages

Linkage Between Change in Vegetation and Wildlife Abundance and Berry-Picking, Hunting, Fishing and Trapping?

Change in berry-picking, hunting, fishing and trapping potential is directly related to changes in the vegetation, numbers of hunted species, numbers of fish angled or numbers of wildlife trapped. These impacted are discussed in detail in the vegetation section, wildlife section and aquatic resource section.

The linkage is valid.

Linkage Between Change in Access and Change in Berry-Picking, Nunting, Fish and Trapping

For the berry, wildlife and fisheries resources to be used and consumed access for the resource users must be available. Potential access to the LSA is generally poor. It is available via boat during the river ice-free periods or snowshoe, ski, or snowmobile during the winter.

The linkage is valid.

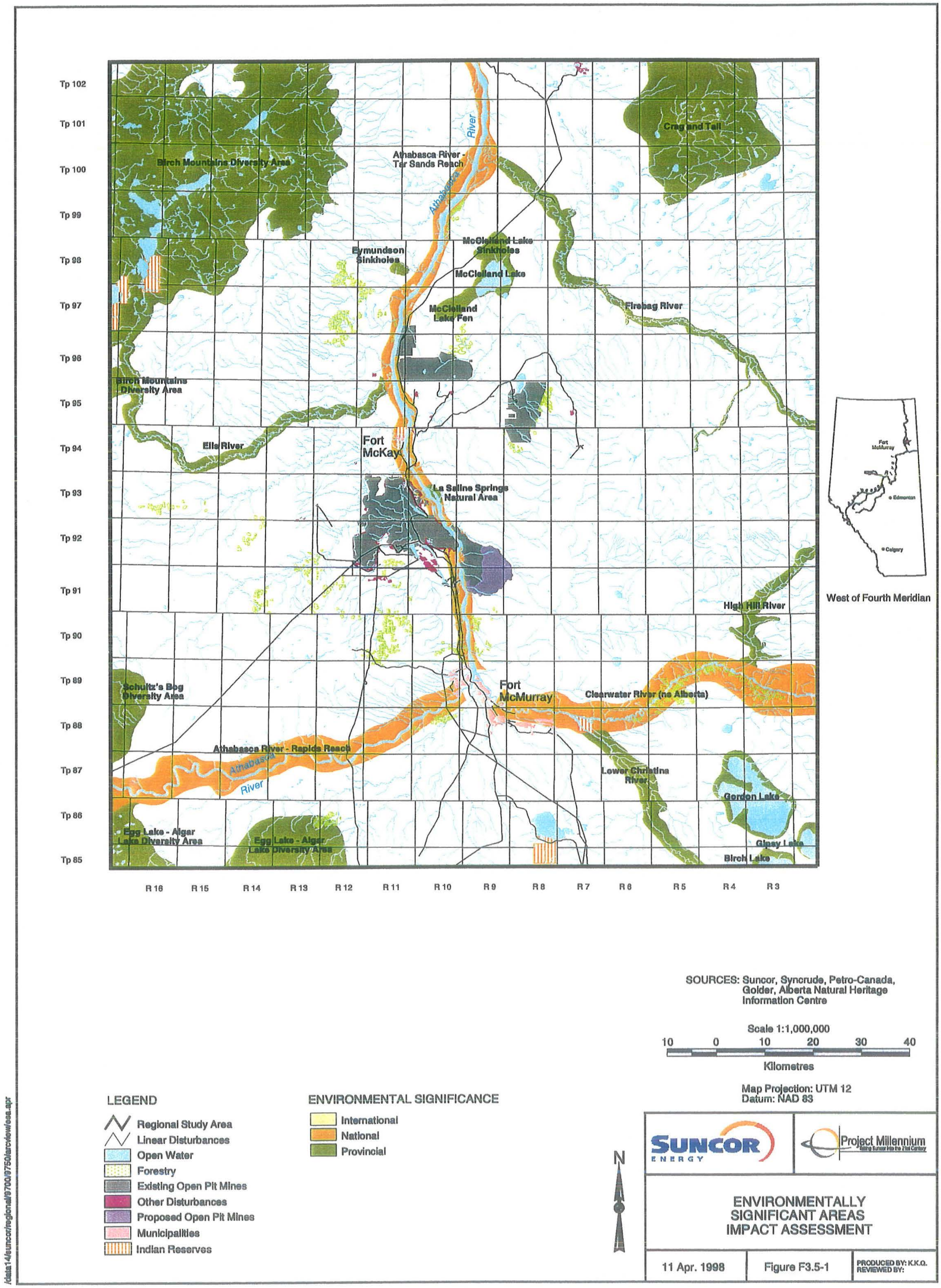
F3.5.6.2 Analysis of Key Question

The principle access to the LSA is via the Athabasca River. This limits berry-picking, hunting, fishing and trapping on the LSA. Access may increase post closure because of potential bridge and road access.

Loss or alteration of vegetation, wildlife and aquatic habitat in the LSA will impact resources in the LSA. This impacts are discussed in detail in:

- Fisheries and Fish Habitat (Section C4);
- Terrestrial Vegetation and Wetlands (Section D3); and
- Wildlife (Section D5).

Berry-producing plants will be removed through clearing and replaced through reclamation. All berry types common to the LSA will be affected. However, access to the area for berry-picking activities will continue to be limited in LSA during construction and operation phases because access will remain restricted through the Suncor operation. This impact is expected to be minimal as berry-picking activity rarely occurred in the LSA prior to the Project.



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R 5
R 4
R 3
Birch Mountains Diversity Area
Athabasca River - Tar Sands Reach
Athabasca River
Crag and Tail
Eymundson Sinkholes
McClelland Lake Sinkholes
McClelland Lake
McClelland Lake Fen
Firebag River
Birch Mountains Diversity Area
Ells River
Fort McKay
La Saline Springs Natural Area
High Hill River
West of Fourth Meridian
Fort McMurray
Edmonton
Calgary
Schultz's Bog Diversity Area
Fort McMurray
Clearwater River (ne Alberta)
Athabasca River - Rapids Reach
Athabasca River
Lower Christina River
Gordon Lake
Egg Lake - Algar Lake Diversity Area
Egg Lake - Algar Lake Diversity Area
Gipsy Lake
Birch Lake
SOURCES: Suncor, Syncrude, Petro-Canada, Golder, Alberta Natural Heritage Information Centre
Scale 1:1,000,000
10 0 10 20 30 40
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Map Projection: UTM 12
Datum: NAD 83
LEGEND
Regional Study Area
Linear Disturbances
Open Water
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Existing Open Pit Mines
Other Disturbances
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Project Millennium
ENVIRONMENTALLY SIGNIFICANT AREAS IMPACT ASSESSMENT
11 Apr. 1998
Figure F3.5-1
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Berry-picking in the area may increase following Project closure because access may be improved. Where possible, areas will be revegetated to create a mosaic of vegetation communities, similar to those found before disturbance. Berry-producing shrubs will be included in the revegetation scheme.

Project Millennium will occur within two Wildlife Management Units (WMUs), and these areas are actively used by resident and non-resident hunters. Wildlife species may be affected by project activities, especially loss of habitat. Access to the area will change because of Project Millennium. Thus, hunting opportunities will be restricted within the LSA during construction and operations, and for some time after closure.

Hunting may increase following Project Millennium closure because access may improve, for example, existing access corridors used during the construction and operation phases may become available to hunters. In addition, specified roads in the development area may remain open to allow public access to recreational locations, including potential hunting areas.

Reclamation activities are expected to return the site to equivalent or greater vegetation capability. Once revegetation has occurred, wildlife will return to the area. Species such as moose, bear, ruffed grouse and snowshoe hare are expected to return to reclaimed areas fairly quickly (i.e., 20 years). Species such as fisher will take much longer to return to the area (i.e., 60 years or more), due to specific habitat requirements.

Project Millennium will not directly affect the Athabasca and Steepbank rivers. Sport fish abundance will not be reduced as a result of the construction and operation of Project Millennium.

Access to fishing sites may improve after reclamation and closure if existing access corridors remain in place. Some roads in the development area may allow public access to recreational locations, involving fishing locations. The improvement of access could result in additional sport and subsistence fishing opportunities.

All trapping within the area has been undertaken by registered trapline holders. This was discussed earlier in Section F3.3.

Trapping potential will be reduced during construction and operations due to access restrictions and habitat disruption. Suncor has purchased the rights to the traplines in the LSA. After closure the potential for viable traplines exists.

F3.5.7 Key Question RU-4: What Impacts will Development and Closure of Project Millennium Have on Non-Consumptive Recreational Use?

F3.5.7.1 Analysis of Potential Linkages

Linkage Between Change in Access and Change in Non-Consumptive Recreational Use

Recreational activities include camping, canoeing, boating, kayaking and snowmobiling. These activities are generally undertaken because of an enjoyment of the outdoors. It is expected that access will continue to be the same for these activities in the area. Most activities are concentrated along the rivers and access to the Athabasca and Steepbank rivers will not be altered by Project Millennium development. Access on the development footprint will be restricted.

The linkage is valid.

F3.5.7.2 Analysis of Key Question

The Athabasca and Steepbank rivers will not be altered by the proposed mine. Thus, these rivers will continue to provide opportunities for kayakers, canoeists, boaters and snowmobilers.

Although restricted access to the Project Millennium development area will preclude land based recreational activities, during construction and operations phases, these uses were never substantial. The negative effects on these activities will be negligible. However, the opportunities for land based recreation may improve after closure.

Access to non-consumptive recreation sites could improve following Project Millennium closure depending on decisions regarding the Suncor Steepbank bridge. Access corridors established during the construction and operation phase may remain in place. Specified roads in the development area may be opened to allow public access to recreational sites.

F3.5.8 Resource Use Impact Summary

The assessment of the Project's effects on resource use included consideration of changes in:

- surface and subsurface minerals;
- environmentally significant areas;
- forestry;

- berry-picking;
- hunting;
- trapping;
- fishing; and
- non-consumptive recreational use.

Mitigation strategies to minimize the potential impacts to non-traditional resource use will include:

- salvage of surface resource materials (e.g., gravel) during operations;
- avoiding alteration of Athabasca and Steepbank rivers;
- salvaging of merchantable timber during site clearing;
- planning reclamation to return forestry potential to equivalent or better capability;
- minimize site clearing areas;
- including berry producing shrubs in reclamation species prescriptions;
- completing revegetation to improve protective cover and browse for wildlife species; and
- compensating trapline holders for loss of revenues.

Monitoring identified for resource uses in Project Millennium area include annual conservation and reclamation (C&R) monitoring for plant species and community type re-establishment. Plots will be established to examine species composition, community structure, forest growth and shrub productivity. Water quality monitoring programs will provide information to assess potential adverse impacts to fish habitat and thus fishing capability.

Sport fish species will not be affected by the construction and operation of the Project and access to potential sport fishing sites will be improved after closure.

It is concluded that Project Millennium will not cause significant impacts to surface or mineral materials. Timber resources will be adequately salvaged and forest capability will be equivalent or better than pre-disturbance levels. Loss of berry-picking areas will be minimized and access to the reclamation area berry-picking sites will be increased after Project closure. Non-consumptive resource use patterns will be changed, and closure plans may enhance future non-consumptive recreational use.

Hunting and trapping potential will be reduced during construction and operations due to access restrictions and habitat disruption. Potential increase of access to the area after closure could increase the opportunities for hunting and trapping in the area.

Overall impacts to the current land use in the Project area will be minimal during the construction and operational phases of Project Millennium. Reclamation and closure plans will mitigate any adverse impacts and in some cases improve the land use capability.

F3.6 TRADITIONAL LAND USE AND RESOURCE USE CUMULATIVE EFFECTS ASSESSMENT

F3.6.1 Introduction

This cumulative effects assessment (CEA) predicts the effects of Project Millennium in combination with other developments on traditional land use and resource use by non-traditional users in the Regional Study Area (RSA). Three scenarios are considered in this analysis as outlined in Table A2-11, including:

- existing + approved developments;
- existing + approved developments + Project Millennium; and
- existing + approved developments + Project Millennium + planned developments.

Descriptions of the developments involved in these scenarios and the assumptions for this CEA are detailed in Section A2.

F3.6.2 Potential Linkages and Key Questions

One key question has been established in relation to the cumulative effects of regional developments on resource use.

CRU-1: What impacts will result from changes to traditional land use and non-traditional resource use associated with Project Millennium and the combined developments?

In consideration of the issues surrounding this question, discussion of the effects on traditional land use will precede those on resource utilization.

F3.6.3 Approach and Methods

The principal basis for assessment of this question in relation to traditional land use is a quantitative approach. This analysis compares the area included within the stated traditional territory of the Fort McKay communities with the areas that would be lost either temporarily or permanently to existing, approved and planned developments within the RSA of the Project. This comparison is expressed as a simple percentage of the traditional lands to be affected.

The assessment of non-traditional land use is a combination of quantitative and qualitative information. Quantitative information from Soils and Terrain, Vegetation, Wildlife and Aquatic resources are used in the assessment. Qualitative information from telephone conversations, expert opinion and other data sources is combined with the quantitative data to assess the potential impact of developments in the RSA. A comprehensive listing of contacts and information sources is used in the assessment are reviewed in baseline and impact assessment sections. Detailed technical information on cumulative effects is found in the following sections:

- Aquatics, Section C5; and
- Soils and Terrain, Vegetation and Wildlife, Section D6.

F3.6.4 Key Question CRU-1: What Impacts Will Result From Changes to Traditional Land Use and Non-traditional Resource Use Associated With Project Millennium and the Combined Developments?

F3.6.5 Analysis of Key Question

The people of the community of Fort McKay traditionally hunt, trap and conduct other traditional practices fundamental to the continuance of their traditional way of life over a large area, which encompasses Project Millennium and other regional developments. This area has been defined in a document entitled 'From Where We Stand' (Fort McKay Tribal Administration 1983). The area illustrated in Figure 2 of that document (Fort McKay Hunting and Trapping Territory) has been calculated and portions of its outline reproduced previously in Figure F3.2-1, (note that Fort McKay traditional lands extend somewhat west and north of the RSA).

The area included within these boundaries forms the basis of a quantitative assessment undertaken of the potential combined effects of existing, recently approved and planned developments on the traditional practices conducted by the Fort McKay Communities. These communities include the Treaty Indians, both Chipweyan and Cree, and the Metis and Non-Status Indians who live in Fort McKay (Fort McKay Tribal Administration 1983, Fort McKay First Nations 1994).

The area encompassed by these traditional lands has been compared with the areas represented by existing, approved and planned developments. These data, when compared with the area identified as traditional use lands (Table F3.6-1), show that: Project Millennium will affect less than 1% of the lands considered to be the Communities' traditional lands; 3% of the lands considered to be the Communities' traditional lands would be affected by existing and approved developments; 4% would be affected when Project Millennium is added to these; and that the Project in combination with existing, approved and planned developments would affect 12% of the aboriginal traditional lands.

Finally, it should also be noted that the areas listed in Table F3.6-1 represent maximum disturbance zones. Both forestry and oil sands developments will be phased such that only portions of each area will be disturbed at any one time. In addition, reclamation will be phased such that reclaimed land may be available for traditional land use during various stages of development closure.

The impacts of oil sands developments will depend on the lifespan of the developments involved and the character and the success of reclamation activities. Effective reclamation may enhance opportunities for traditional land use after closure. In this respect it can be assumed that final landscape productivity will compare favorably with pre-Project conditions. Depending on which types of traditional resources are preferable, conditions favoring these resources can be incorporated into reclamation designs.

Table F3.6-1 Areas of Existing and Approved Developments in the Regional Study Area in Relation to the Traditional Land Use Areas

Areas	Area (km^2)	Traditional Lands Affected
Fort McKay Communities Traditional Lands	20,669	
Project Millennium	56	<1%
Existing + Approved Developments	696	3%
Project Millennium + Existing + Approved	753	4%
Planned Developments	1810	9%
Project Millennium + Existing + Approved + Planned	2563	12%
- Total Oil Sands Developments	657	3%
- Total Forestry	1709	8%
- Other Developments	197	<1%

Use of Vegetation, Including Berry-Picking

Existing and new developments within the RSA have the potential to disturb vegetation through loss of habitat and/or contamination. Loss of important berry producing shrubs and changes in access may affect recreational berry-picking. Important berry-picking sites as identified by BOVAR (1996c) are the Clearwater River valley, Thickwood Hills, near the Peter Lougheed bridge, near Highway 963, Kearl Lake, MacKay River, Mildred Lake, Muskeg River and east of the Athabasca River. Berry picking sites may be completely or partially lost, however, they can be reclaimed following reclamation and closure of the developments. Revegetation during reclamation can be focused toward vegetation species which have medicinal, dietary, ritual, utensil and dye uses. As well, access to berry-picking sites should be restored during reclamation and closure and may even be enhanced.

Hunting and Trapping

In considering this comparison, it should be noted that the traditional hunting and trapping lands illustrated in "From Where We Stand" has a truncated northern boundary in the Lake Claire area. Traditional lands of the Fort McKay Communities may extend somewhat further north and encompass more area than shown in Table F3.6-1. Traditional activities that are conducted throughout this area are summarized in Section F3.2 of this EIA and are referred to in the context of discussions relating to specific terrestrial (Section D3.1 and 5.1) and aquatic (Section C4.1) resources.

Hunting and trapping opportunities within the RSA will be incrementally affected by the developments in the area. Typical effects are likely to be Negative during development and operation and Positive following closure. Important hunting locations within the RSA include the Athabasca River Valley, Bitumont Tower, Kearl Lake, MacKay River, the Highway 963 Extension, and the Alsands lease area and Peter Lougheed bridge (BOVAR 1996c). Hunting pressures in the area will increase with the increase in the regional population. This increase in hunting pressure will occur concurrent with reduction in hunting areas as wildlife habitat is altered by development. Hunting opportunities will improve during reclamation and closure as habitat areas are reestablished. In addition, improved access following site closure may also lead to increases in hunting and trapping opportunities.

Habitat loss due to existing and reasonably foreseeable developments is approximately 1% of black bear, moose, fisher, dabbling duck and ruffed grouse habitat within the RSA. Impacts are likely to be less due to the phasing of site clearing and reclamation activities. Following development closure, habitat conditions for moose, black bears, beavers and ruffed grouse should rapidly improve within the Project Millennium Area. Habitat for fishers and other late successional species will require more time for re-establishment to the pre-development state.

Cumulative, residual losses to game and furbearer species were considered to be low as no KIR will experience losses of more than 1.6% of habitat within the RSA due to existing, approved and proposed developments. While the direction of the impacts during development will be negative, the impacts are reversible, as reclamation of the sites is expected to replace habitat capability.

There are 83 registered fur management areas (RFMAs) within the RSA (Figure F3.6-1). Changes in wildlife abundance and diversity and changes in access may reduce trapping opportunities in the RSA. Forty-six may be directly impacted by developments considered in this CEA. Forty RFMAs are included in Al-Pac's forest management plans.

Fishing

Preferred fishing locations identified in the RSA which may be affected by various developments include the Clearwater, Athabasca, Muskeg, Horse, Hangingstone, MacKay and Firebag rivers. Fish habitat may be altered as part of development, which in turn, reduces fishing opportunities.

Reclamation of sites following closure may improve fishing opportunities, especially because of improved access.

Developments must comply with stringent water quality and fish habitat guidelines. As well, significant measures are typically undertaken by developers to minimize impact. Thus, sport fish abundance and distribution is not expected to change as a result of development activities. Following closure, sport fish habitat may be enhanced by the creation of reclamation lakes, ponds and drainages. As well, access to important sport fishing locations is expected to improve.

There are many businesses located in the RSA that rely on fishing as part of their core business (as well as hunting and non-consumptive use). With the increase in population in the area and in the number of visitors, many of the businesses may expect increased business.

Forestry

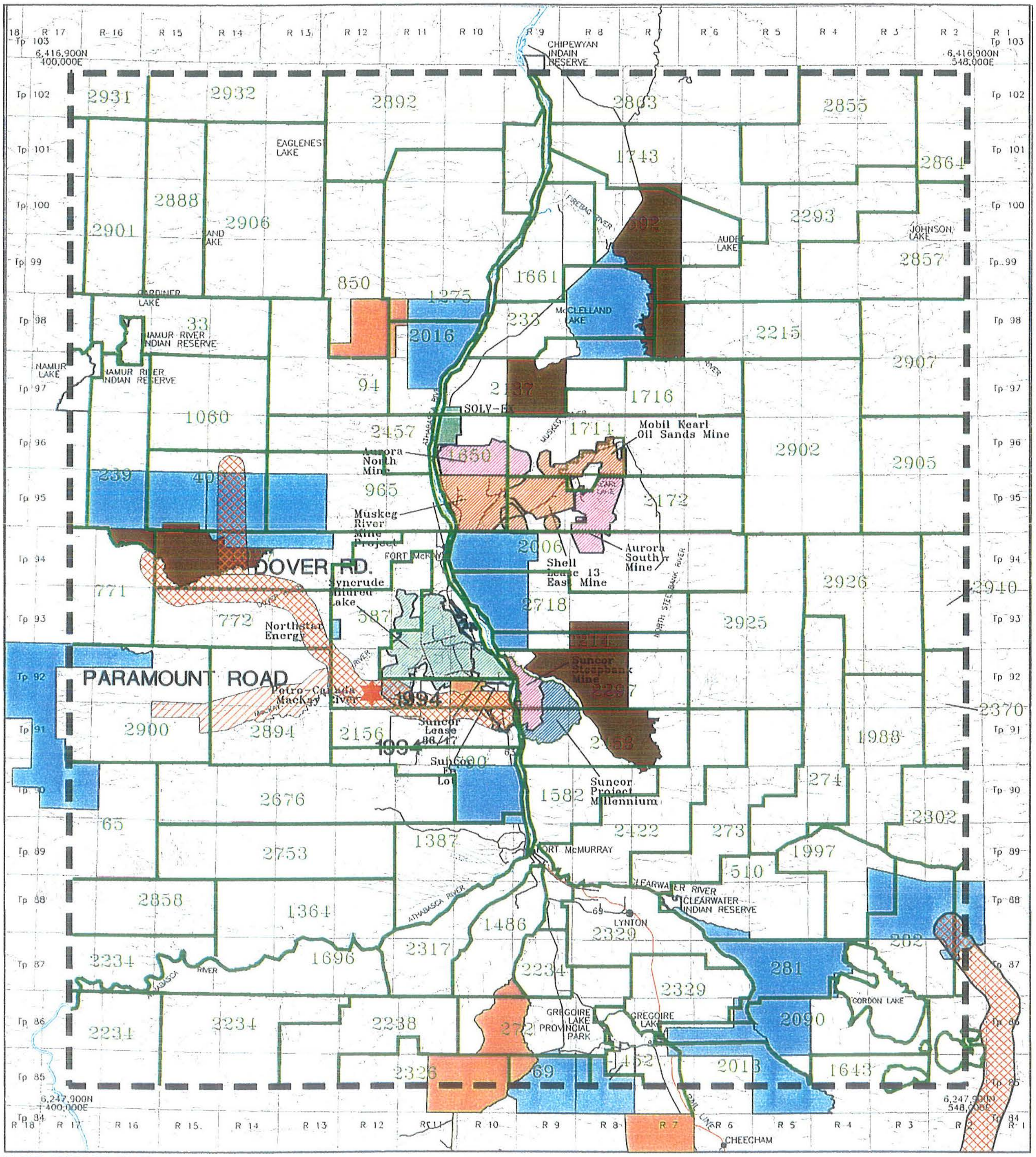
Forestry calculations reflect only the RSA for the Project. Considerably larger areas would be affected within the traditional lands outside the RSA.

The effects of forestry activities will occur over a longer time frame and will affect large areas within the region. The long-term effects of these activities will depend on the timing and character of vegetative regeneration. In many instances opportunities for continuing traditional land use practices may be enhanced by the revegetation procedures employed by the forestry industry. Existing, approved and planned forestry developments within the RSA will affect 8% of the Communities' traditional lands.

Activities that may affect merchantable forests include oil sands mining, municipalities and various other developments. These activities may result in the loss of merchantable timber and changes in access. Loss of timber may be minimized by salvaging timber during site clearing. However, once sites are developed, the footprint area is lost until reclamation. At that point, reforestation activities would occur.

The greatest impact to the area of forest will be from timber harvesting. Alberta Pacific Forest Industries (Al-Pac) and Northland Forest Products will harvest close to 71,000 ha of the RSA in the next 30 years (BOVAR 1996c).

The Annual Allowable Cut (AAC) for the Al-Pac Forest Management Agreement (FMA) is 3,091,000 m^3/year. The AAC for Northland Forest Products is 210,200 m^3/year (BOVAR 1996c). The combined total AAC volume is 3,301,200 m^3/year. It is expected that the annual salvage of timber from the various developments will vary, but should be less than 2% of the Al-Pac's FMA and Northland Forest Products combined wood



OIL SANDS DEVELOPMENTS

- EXISTING DEVELOPMENTS
- APPROVED DEVELOPMENTS
- PROPOSED DEVELOPMENTS
- PROJECT MILLENNIUM
- REGIONAL STUDY AREA BOUNDARY
- ROADWAYS
- REGISTERED FUR MANAGEMENT AREA

FORESTRY DEVELOPMENT

- SEPT 1, 1997 – AUGUST 31, 1999
- SEPT 1, 1999 – AUGUST 31, 2002
- PREVIOUSLY ENTERED TOWNSHIPS (1993 –1997)
- SELECTED ROAD CORRIDORS
- LOWER CLASS ROAD OPTIONS

REFERENCE

DIGITAL DATA SETS 74D, 74E, 74I, 84A AND 84H FROM RESOURCE DATA DIVISION, ALBERTA ENVIRONMENTAL PROTECTION, 1997. FORESTRY AREAS TAKEN FROM ALBERTA FORESTRY, LANDS AND WILDLIFE. PUBLISHED 1997. DATUM IS IN NAD83 UTM PROJECTION.

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REGISTERED FUR MANAGEMENT AREAS CUMULATIVE EFFECTS

11 Apr. 1998	Figure F3.6-1	DRAWN BY: RFM/TM

supply. Thus, timber salvage from the various developments in the area represent only a small percentage of the total AAC.

Some areas of merchantable timber will be lost due to project development. This impact cannot be mitigated. However, the magnitude of the impact is expected to be low, as these areas represent a very small portion of the total AAC. Duration of the impact will range from medium to long-term, based on the projected lifespan of each development. In the far future there will be an increase in productive forest lands. In summary, the impact on forests of the Project and combined developments is minimal. Therefore, the cumulative impact is defined as neutral in direction and negligible in magnitude.

Sand and Gravel

Sand and gravel resources will be affected by road and infrastucture construction. The RSA has some good quality sand and gravel, as detailed in Section F3.4; however, no volume estimates were available. The IRP describes the aggregate resources of the regional level as limited. It is possible that the inadequate supply of aggregate resources could be a constraint on the construction of buildings and infrastructure (AEP 1996a. The known granular resource deposits in the LSA are described as fair or poor (Section F3.4). In contrast, several areas within the RSA are known to be of good quality.

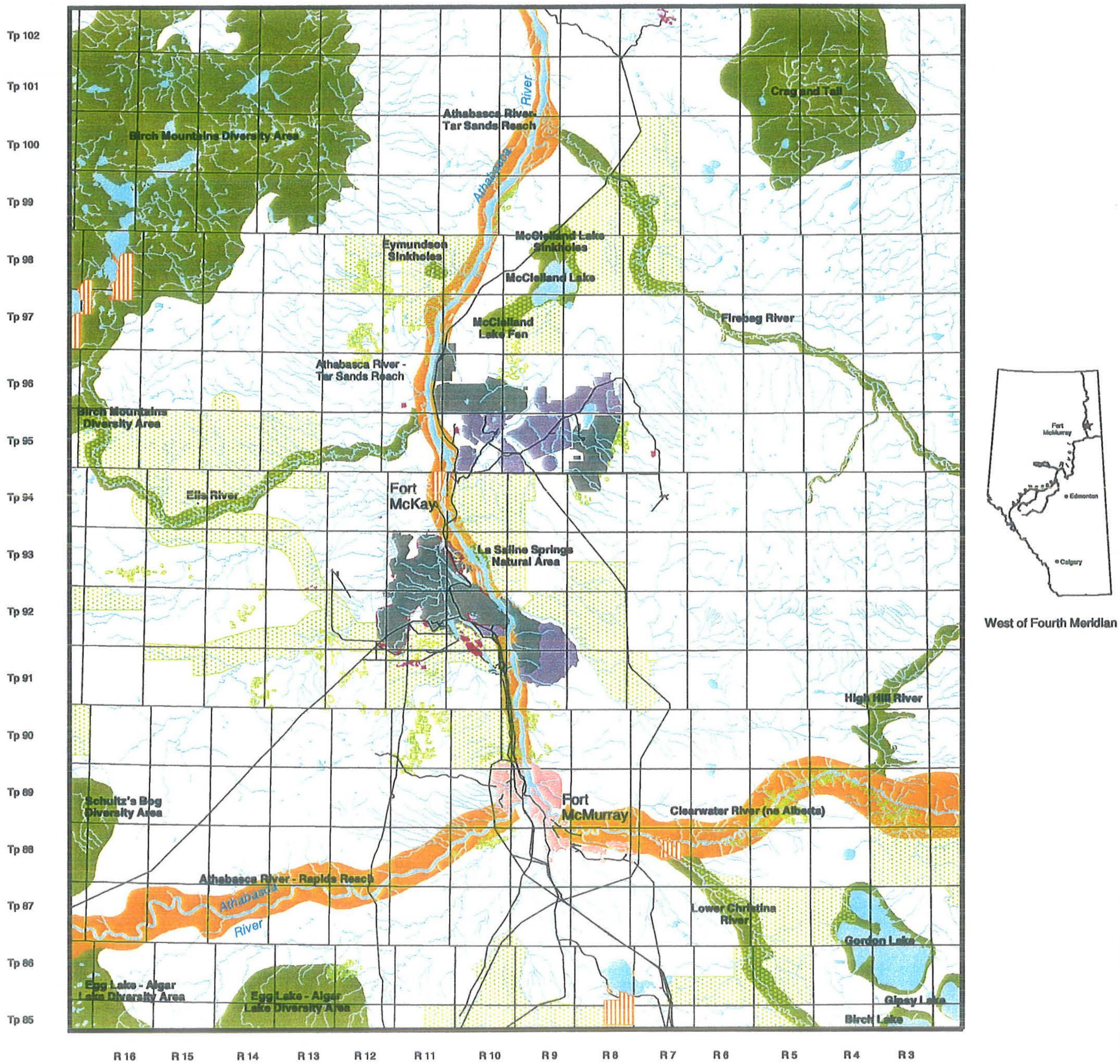
The impact for the RSA because of Project Millennium is negligible because sufficient resources exist on the Project area for the infrastructure needs of the Project.

Environmentally Significant Areas

The developments considered for the CEA were over-laid, using GIS, on the Environmentally Significant Areas (ESAs) found in the RSA (Figure F3.6-2). Potentially impacted ESAs include: Firebag River, McClelland Lake, McClelland Lake Fen, McClelland Lake Sinkholes, Eyumdson Sinkholes, Birch Mountain Diversity Area, Ells River, La Saline Springs Natural Area, Athabasca River, Clearwater River, Lower Christina River, Gordon Lake and Lower Christina River. The ESAs are described in Section F3.4.

The following Special Places 2000 nominated sites may also be impacted by activities in the regional study area: Cree Burn Lake, Fort Hills-McLelland Lake, La Saline Natural Area, Clearwater River, Maqua River, Stoney Mountain, Athabasca River Valley and Marguerite River.

Development along the Athabasca River is addressed in the IRP (AEP 1996a). Project Millennium will follow the criteria outlined in the IRP as summarized in Section F3.4.



SOURCES: Suncor, Syncrude, Petro-Canada, Mobil, Al-Pac, Golder, Alberta Natural Heritage Information Centre

Scale 1:1,000,000

10 0 10 20 30 40

Kilometres

Map Projection: UTM 12
Datum: NAD 83

LEGEND

- Regional Study Area
- Linear Disturbances
- Open Water
- Forestry
- Existing Open Pit Mines
- Other Disturbances
- In-Situ
- Proposed Open Pit Mines
- Municipalities
- Indian Reserves

ENVIRONMENTAL SIGNIFICANCE

- International
- National
- Provincial

N

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Project Millennium

ENVIRONMENTALLY SIGNIFICANT AREAS CUMULATIVE EFFECTS ASSESSMENT

11 Apr. 1998	Figure F3.6-2	PRODUCED BY: K.K.O. REVIEWED BY:

The ESAs and Special Places 2000 nominated sites may be affected by changes to terrain, vegetation, or wildlife or by changes in access. Provided that the areas are avoided to the extent possible and that appropriate mitigation measures are used to further minimize impacts, the cumulative impacts associated with the developments on these ESA will be minor.

To the extent possible, ESAs and Special Places 2000 nominated sites are expected to be considered during project development and attempts to minimize impacts, including avoiding these areas whenever possible will be implemented. As well, mitigation measures such as reducing the total area cleared, maintaining native vegetation for cover and maintaining adequate buffer zones around rivers, lakes and other sensitive areas, further reduces impacts to ESAs and Special Places 2000 nominated sites.

Non-consumptive Use

Non-consumptive recreational uses include camping, hiking, boating, wildlife viewing and snowmobiling. Important recreational areas for these activities are outlined in Section F3.4. Recreational areas may be affected by disturbances from of combined developments.

However, development may increase the level of non-consumptive resource use. For example, an increase in population will likely increase the number of persons partaking in non-consumptive activities. As well, the oil sands developments have themselves become visitor attractions. Over 8,000 persons visited the Oil Sands Discovery Centre in 1997. One lodge operator indicated that his business had increased since the oil sands had been developed (Section F3.4).

Changes in access and changes in terrain, vegetation and wildlife due to project development may reduce some recreational opportunities within the RSA. However, since recreational sites are numerous and scattered throughout the RSA, the cumulative effects of various developments is expected to be low.

F3.6.6 Summary

The quantitative analysis of the proportional effects of existing, approved and planned developments within the region indicates that 12% percent of the traditional lands of the Fort McKay Communities would be directly affected. These effects would be considered to be moderate. However, the indirect effects of increasing non-traditional land uses throughout the region, in combination with more extensive forestry operations than considered in this analysis, would result in additional effects that cannot be assessed effectively.

While this analysis provides a quantitative measure of the combined effects of regional developments, qualitative issues relating to landscape productivity over the short, medium and long term, and the significance of sustainable traditional land use practices to local communities, must be addressed by other means, as well as in conjunction with regional residents and other development stakeholders. Suncor is addressing these issues through on-going consultation at both local and regional levels.

Suncor actively participates in the recently established Cumulative Effects Assessment Working Group, which includes representation from a wide range of industries, local governments and local communities, including First Nations and Metis groups in the Regional Municipality of Wood Buffalo. The mandate of this multi-stakeholder group is to develop and implement a strategy on how the issue of CEA should be handled. This group provides a forum for input relating to traditional land use and resource utilization concerns, as well as a wide range of other interests.

In addition, Suncor actively participates in the Regional Infrastructure Working Group that includes representation from nine companies operating in the region and the Regional Municipality of Wood Buffalo. Suncor also participated in the multi-stakeholder End Land Use Committee established to consider land use options and other issues related to end land use on a regional basis. Open invitations to participate in the operations of this committee were made to local communities in the region.

Suncor's participation in these regional committees flow from the company's commitment to consult with regional aboriginal peoples and other regional stakeholders. It is Suncor's intent that regional development proceeds in a manner that is sensitive to, and accommodates the concerns of those regional communities. Amongst these concerns is the desire to ensure the sustainablity of traditional land use and other resource utilization practices within the region in conjunction with oil sands development.

Residual Impact Classification

Impacts on the traditional land use practices of the aboriginal people as a result of Project Millennium in combination with existing and approved developments in the region would occur if opportunities to conduct these practices are permanently precluded. Based on proposed reclamation plans and regional consultation efforts, this concern will be offset effectively and the long-term effects of these projects are classified as low.

F3.6.7 Summary of Impact

Table F3.6-2 summarizes the impact on traditional land use and resource utilization under the CEA.

Table F3.6-2 Summary of Impacts on Traditional Land Use and Resource Utilization

Key Question	CEA Results
CRU-1: What impacts will result from changes to traditional land use and non-traditional resource use associated with Project Millennium and the combined developments	• Oil sands developments and their auxiliary activities will result in negative effects on the traditional land use practices of the Fort McKay communities and other aboriginal people. These effects will be moderate considering the proportion of the established traditional lands effected. Given the potential for reversibility of these effects, the environmental concern is **Low.** • Forestry developments will have Negative effects on traditional land use practices. These effects would be considered to be Moderate in magnitude considering the proportions of the traditional lands that would be affected. They would be Regional in extent over the Long-Term but localized to specific cut blocks and staging areas in the Short-Term. These effects would be Reversible. The environmental consequence is **Low.** • Forestry will have Negative effects on resource utilization. Forestry activities may affect ESAs, berry-picking areas, hunting areas, fishing areas, trapping areas and non-consumptive recreational activities. These affects would be considered Moderate in magnitude. They would be Regional in extent over the Long-Term, but localized to specific cut blocks and staging areas in the Short-Term. These effects are considered Reversible. The environmental consequence is **Low.** • Oil sands development impacts on resource utilization under the CEA scenario will be Low in magnitude. The primary impact on resource use such as berry-picking, hunting, fishing, trapping and non-consumptive use will be an alteration of access and population. The effects will be Regional in extent and Long-Term. The effects will be Reversible with reductions in access during development, but possibly increased after project closures. The population in the area will likely increase during development and decrease after closure. The environmental consequence is **Low.**

F3.7 TRADITIONAL LAND USE AND RESOURCE USE CONCLUSION

F3.7.1 Introduction

This section provides concluding remarks on the Traditional Land Use and Resource Use components of the Project Millennium EIA. It reviews the impacts of the Project on Traditional Land Use and Resource Use both locally and regionally. It also comments on the anticipated effects of the Project in combination with existing, approved and planned developments in the region.

F3.7.2 Traditional Land Use

The objectives of this component of the EIA were to address two key questions: "What impacts will development and closure of Project Millennium have on traditional land use practices?" and "What impacts will result from changes to traditional land use associated with Project Millennium and the combined developments?".

With respect to traditional land use, methods adopted to consider these issues included:

- Review and consolidation of the extensive background information to establish a detailed understanding of traditional land use in the Project local and regional study areas.
- Preparation of a report by the Fort McKay communities to provide specific information on resource and site distributions, harvest locations and traditional land use practices in both the local and regional study areas.
- Archival investigations to determine the potential of materials maintained at the Hudson Bay Company archives in defining a pattern of regional traditional land use over a much broader time frame than currently available.
- Quantitative analysis comparing the area identified by the Fort McKay communities as traditional lands with those that would be affected by existing, approved and planned developments in combination with Project Millennium.

The information obtained in these studies provided a firm basis for concluding that the Aboriginal communities surrounding the development area continue to actively and extensively rely on land uses to maintain their traditional way of life. These practices involve, hunting, trapping, fishing, plant collection (for food, medicinal and other purposes) and a variety of social, ceremonial and recreational activities.

Many of these activities focus on highly productive riparian habitat in the vicinity of watercourses and in upland areas such as the Birch Mountains. By comparison, use of the level interior plains, such as those where Project Millennium is situated, is relatively modest. Several resource harvest areas that reflect traditional use of the area associated with traplines will be affected. In these areas, a wide variety of traditional practices were conducted (see Section F3.2). Although two traditional trails occur in the Project Millennium development area, these have been heavily modified by modern activities. No graves, cabins, or special places were reported to be present within the project area. However, two relatively recent cabins were identified during historical resources investigations. Suncor has already compensated trapline owners for the loss of their resource harvest areas in the local study area (LSA) as part of the Steepbank Mine Project. The effects of the Project on traditional land use practices in the LSA will be low, considering reported use patterns and the limited area to be affected by the project in comparison to the total traditional territory of the aboriginal communities. However, limited population increases associated with the project may result in indirect effects on traditional land use patterns.

The effects of the project will be addressed through involvement of the aboriginal communities in closure and end land use planning. This will ensure that the reclaimed landscape will provide potential for traditional land uses.

Project Millennium, in combination with existing, approved and planned developments in the region, would affect 12% of the traditional lands of the Fort McKay community.

In a quantitative sense, the direct effects of regional development on traditional land use practices would be considered to be moderate, considering the portion of the traditional land use base that would be directly affected. Cumulatively, indirect effects on traditional land use patterns due to limited population increases are difficult to evaluate. These indirect effects may also be reversible over the long term as developments cease operation and regional populations decrease.

The concern for loss of the traditional lifestyle in regional aboriginal communities has been reported in studies conducted for projects in the region and other more general studies. On-going consultation with each community will further the understanding of this issue. Suncor also supports the multistakeholder efforts currently underway and is committed to active participation in efforts to establish a regional strategy that balances development objectives with the concerns of resident communities.

F3.7.3 Resource Use

The impact of Project Millennium on the non-traditional resource use was assessed through four key questions for the EIA. The questions addressed the impacts of Project Millennium on surface and mineral material extraction, agriculture, forestry and Environmentally Significant Areas (ESAs), including Special Places 2000 nominated sites. Two questions were used to assess impacts on consumptive and non-consumptive resource utilization.

Project Millennium will impact sand and gravel resources due to of the need for roads and infrastructure. Suncor will use or stockpile available material within the mine development area to minimize the impact on regional gravel resources. The agricultural potential for the LSA is very limited and, therefore, will not be impacted by the development. Forestry will be impacted on the LSA during the life of Project Millennium, but forestry potential will be regained after closure. Trees will be salvaged from areas impacted by development to ensure this resource is not wasted. The Project impact on berry-picking, trapping, hunting and fishing is negligible because there will be no change in current access to, or use of the area. After closure, access to the area may improve because of the remaining mine infrastructure.

The Athabasca River-Tar Sands Reach ESA will be affected by Project development. However, this area has been recognized in the Fort McMurray-Athabasca Oil Sands Subregional Integrated Resource Plan (AEP 1996a). As with the Steepbank Mine Project, the resource plan guidelines will be followed during the development and operation of Project Millennium. Therefore, no new impacts are predicted.

Non-consumptive resource use will not be negatively impacted by Project Millennium. As with berry-picking, hunting, fishing and trapping, access to the area will not change. After closure the opportunity for non-consumptive resource use may improve due to improved access. Project Millennium may increase the potential for non-consumptive use because of population increases and a higher number of visitors due to the growing profile of the oil sands region.

Cumulative effects were addressed through analysis of Key Question CRU-1. Cumulative effects were evaluated in a qualitative way. The results of the assessment of combined developments are predicted to have a low impact on land use in the RSA.

F4 HISTORICAL RESOURCES

F4.1 HISTORICAL RESOURCES SCOPE OF ASSESSMENT

This section of the EIA provides information on Historical Resources. Specifically, the following is addressed:

- Provide evidence of consultation with the Historical Sites and Archives Service, Alberta Community Development.
- Provide the Historical Resource Impact Assessment (HRIA) report as required by Alberta Community Development for the Project Area.
- Provide an overview of the results of any previous heritage resource studies that have been conducted in the Study Area.
- Summarize the results from the field program performed to assess archaeological, palaeontological and historical significance of the Project.
- Determine the impact of development on these resources and identify possible mitigation strategies.

The following subsections summarize the baseline information on the Historical Resources identified during the Project Millennium HRIA.

F4.2 HISTORICAL RESOURCES BASELINE/ENVIRONMENTAL SETTING

The purpose of this section is to review the historical resource status of the entire Project Millennium area. Historical resources are defined by the *Alberta Historical Resources Act* (1987) as:

"any work of nature or man that is primarily of value for its palaeontological, archaeological, prehistoric, historic, cultural, natural, scientific or aesthetic interest, including but not limited to, a palaeontological, archaeological, prehistoric, historic or natural site, structure or object."

Consequently, historical resources include, as well as the sites where events took place in the past, all of the objects that they contain and any of the contextual information that may be associated with them, and will aid in their interpretation, including natural specimens and documents or verbal accounts. They are generally divided into three types, prehistoric archaeological, historic period archaeological and structural, and palaeontological. Natural objects and features have also been occasionally managed under the provisions of the Historical Resources Act.

Prehistoric archaeological resources in northern North America are the archaeological sites, objects and affiliated materials that represent occupations by Aboriginal peoples before the arrival of European influence and the historic records that characterize their culture. In this region of the province these consist of the locations where activities took place and remains of these activities, usually stone artifacts and features such as hearths. Generally, associated animal bone and other organic artifacts have been removed by the acid soils of the area. These can span the entire 10,000 year period of recognized prehistory in this region of the province.

Historic archaeological and structural resources generally include the sites, artifacts, structures and documents that relate to the Euro-Canadian occupation of the region and date to the last 250 years. These include remains related to the early fur trade conducted in the region as well as those relating to later economic developments such as trapping, forestry and oil sands exploration and production. A key component of the historic period record are the sites, artifacts and affiliated resources relating to post-contact Aboriginal people's use of the landscape. These include both archaeological sites and objects such as standing and collapsed cabins, campsites, graves, and traditional sites and resources such as special places, hunting and plant collecting areas, trap lines and their associated remains, oral traditions and various documents. These latter resources are usually identified through consultation procedures such as "Traditional Land Use" studies.

Palaeontological resources consist of physical remains representing the evidence of extinct multicellular plants and animals, and related contextual information, that inhabited the region in prehistoric times. These can include fossils, bone deposits, shells and the impressions of these remains and can occur in both bedrock and unconsolidated glacial and postglacial sedimentary deposits.

F4.2.1 Historical Resources Background

Historical resources are non-renewable resources that may be located at or near ground level or may be deeply buried. Alteration of the landscape can result in the damage or complete destruction of significant historical resources. These alterations may involve the displacement of artifacts resulting in the loss of valuable contextual information, or the destruction of the artifacts and features themselves, resulting in the complete loss of important information. The loss of historical resources is permanent and irreversible.

Historical resources are managed under the provisions of the Alberta Historical Resources Act. If significant historical resources may be damaged by a proposed development, the Minister of Community Development may require the proponent to undertake an HRIA that will:

- determine the presence and value of any historical resource in the immediate development area;
- forecast the nature of proposed impacts; and
- recommend mitigation procedures that will offset potential negative effects.

F4.2.2 Previous Archaeological Study in the Local Study Area

Previous historical resource investigations, which have taken place in the RSA, have primarily centred on the assessment of development areas. Only a few key studies have been conducted in which the primary goal was research oriented. The studies have resulted in a basic understanding of the prehistoric record within the RSA. Knowledge of the prehistoric use of the specific Project area was, at best, incomplete.

Previous archaeological studies undertaken within the LSA have been limited. There have been no previous archaeological field studies conducted within the Project area itself. The only HRIA completed within the LSA was conducted on behalf of Suncor for the Steepbank Mine in 1995 (Golder 1996h). The Steepbank Mine HRIA study area is located directly adjacent to the mine expansion area for Project Millennium.

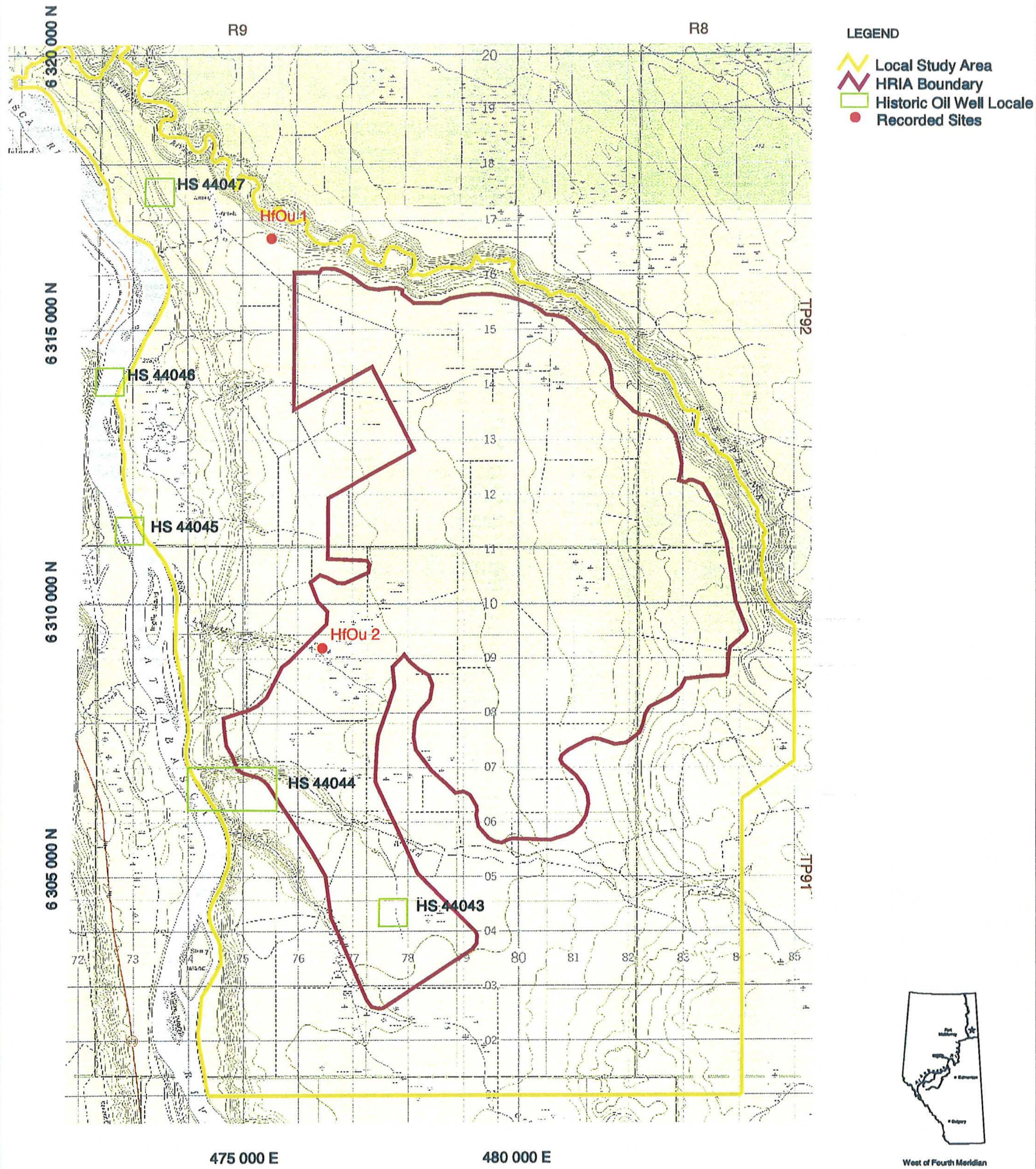
A total of seven historical resource sites have been previously recorded within the LSA (Table F4.2-1; Figure F4.2-1). These sites were identified during a site file search at the Provincial Museum of Alberta. Two are prehistoric historical resources, HfOu 1 and HfOu 2. These sites are small lithic find locations that were recorded during the HRIA of the Steepbank Mine (Golder 1996h).

Five historic period sites are also on record within the LSA including HS 44043, 44044, 44045, 44046 and 44047 (Table F4.2-1; Figure F4.2-1). These sites are locations at which early exploratory drilling attempts were made. The sites include four wellsite locations, HS 44043, 44045, 44046 and 44047, drilled by Count Alfred Von Hammerstein in the early 1900's. The remaining site, HS 44044, also relates to an early 1900's well drilled by the Athabaska Oil and Asphalt Company. It does not appear that these sites were ever visited in the field and were simply recorded based on available historic literature.

Table F4.2-1 Previously Recorded Historical Resource Sites in the Local Study Area

	Site	Site Type	Location	Date Recorded
1	HfOu 1	Lithic Isolated Find	9-20-92-9-W4M	September 1995
2	HfOu 2	Lithic Isolated Find	14-28-91-9-W4M	September 1995
3	HS 44043	Historic Oil Well Locale	14-10-91-9-W4M	April 1974
4	HS 44044	Historic Oil Well Locale	S1/2-20-91-9-W4M	April 1974
5	HS 44045	Historic Oil Well Locale	03-06-92-9-W4M	April 1974
6	HS 44046	Historic Oil Well Locale	13-07-92-9-W4M	April 1974
7	HS 44047	Historic Oil Well Locale	15-19-92-9-W4M	April 1974

The strategy undertaken for the Project Millennium HRIA considers the relevant research issues that arise from previous studies in the region. Therefore, the study for the Project was designed to build on previous results to supplement current understanding of regional prehistory, especially in the area of site distribution patterns. A model was prepared prior to the field component in order to ascertain areas which exhibited high, moderate or low potential to contain historical resources. These areas were depicted graphically on a map and submitted to Alberta Community Development along with an application for a Permit to Excavate Historical Resources. Alberta Community Development concurred with our assessment of the resource potential in the area and all subsequent work has been conducted under Permit #97-123 issued to Grant Clarke of Golder Associates Ltd. A full report detailing the results of the HRIA is to be submitted to Alberta Community Development for final approval.



Sources: Suncor
Golder

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Project Millennium

PREVIOUSLY RECORDED
HISTORICAL RESOURCE
SITES IN THE LOCAL STUDY AREA

15 Apr. 1998	Figure F4.2-1	PRODUCED BY: JS REVIEWED BY:

/data14/suncor/local/9840/arcview/arky_oilwell.apr

F4.2.3 Traditional Resources

Several historic trails and beaver dams were also identified during Traditional Land Use investigations conducted for the Steepbank Project (Fort McKay 1996d) which are present in or extend through the Project Millennium HRIA study area. Several vegetation gathering sites, hunting and trapping locations were also noted. No cabins or graves were identified as present within the Project Millennium HRIA study area during this study.

F4.2.4 Palaeontological Resources

Palaeontological resource sensitivity in the vicinity of Project Millennium is shown in maps provided by the Tyrrell Museum of Palaeontology. "Low" potential is present along the east and west banks of the Athabasca River in Township 90 and 91, Range 9, West of the Fourth Meridian. "Probable" potential is identified in Sections 21, 28 and 33 of Township 91, Range 9, W4M and for much of the west half of Twp92-R9-W4M at the confluence of the Steepbank and Athabasca Rivers.

Project Millennium intersects these areas of sensitivity along the western boundary of the Project area. Portions of Sections 20 and 29-91-9-W4M of the Project area are within Low potential areas. Portions of Sections 21, 28 and 33-91-9-W4M and portions of Sections 4, 9, 16 and 21-92-9-W4M are located within areas of probable potential for palaeontological resources.

F4.3 HISTORICAL RESOURCES PROJECT IMPACT ASSESSMENT

F4.3.1 Introduction

Historical resource management is a two-stage process, involving an impact assessment and a mitigation stage. When a final HRIA report is accepted by Alberta Community Development (ACD), the first stage is considered complete for the area specified in the permit granted by ACD. HRIA reporting requirements include formulation of management recommendations for the area in question and the resources identified. These recommendations are reviewed by ACD and the remaining requirements of the act are established before issuance of a development approval. Generally, fulfilling these requirements is considered to have mitigated project impacts, thereby allowing development to proceed.

The purpose of the historical resources component of the Project Millennium EIA includes the completion of an historical resources overview and impact assessment. The second stage of the historical resources process, mitigation, would be a separate phase of investigation, if required by ACD.

The primary objective of any historical resources impact assessment is conservation of historical resources. This was completed for the Project Millennium assessment by conducting studies intended to address one key question.

F4.3.2 Key Question

HR-1: What impacts to historical resource sites, that warrant avoidance or further information recovery, will result from Project Millennium development activities?

To address this question an overview of baseline information and potential for historical resources in the study area were determined. Specific objectives of the overview included:

- gather and review preliminary data (secondary sources, previous research, general background material);
- identify gaps in existing data;
- identify past, current and future research problems and orientations;
- study historical resource potential through use of maps, satellite imagery and aerial photographs;

- plan the future research strategies, including the field component for the Project; and
- make recommendations for the impact assessment phase of the Project.

Once this overview was completed, it was submitted to Alberta Community Development as part of the application for Permit to Excavate Historical Resources. With Alberta Community Development acceptance of the proposal and the granting of a permit, the impact assessment was initiated. More specifically, the objectives outlined to further accomplish this task included:

- identify and inventory historical resources within the project area;
- evaluate the significance of the sites with respect to potential impacts;
- gather data pertaining to ongoing research; and
- make recommendations for the impact mitigation phase.

A mitigation phase was not completed as part of this Project. If required by ACD, Suncor will undertake the necessary work. During a mitigation stage, the objective is to reduce development impact on historical resource sites by gathering data which would otherwise be irretrievably lost.

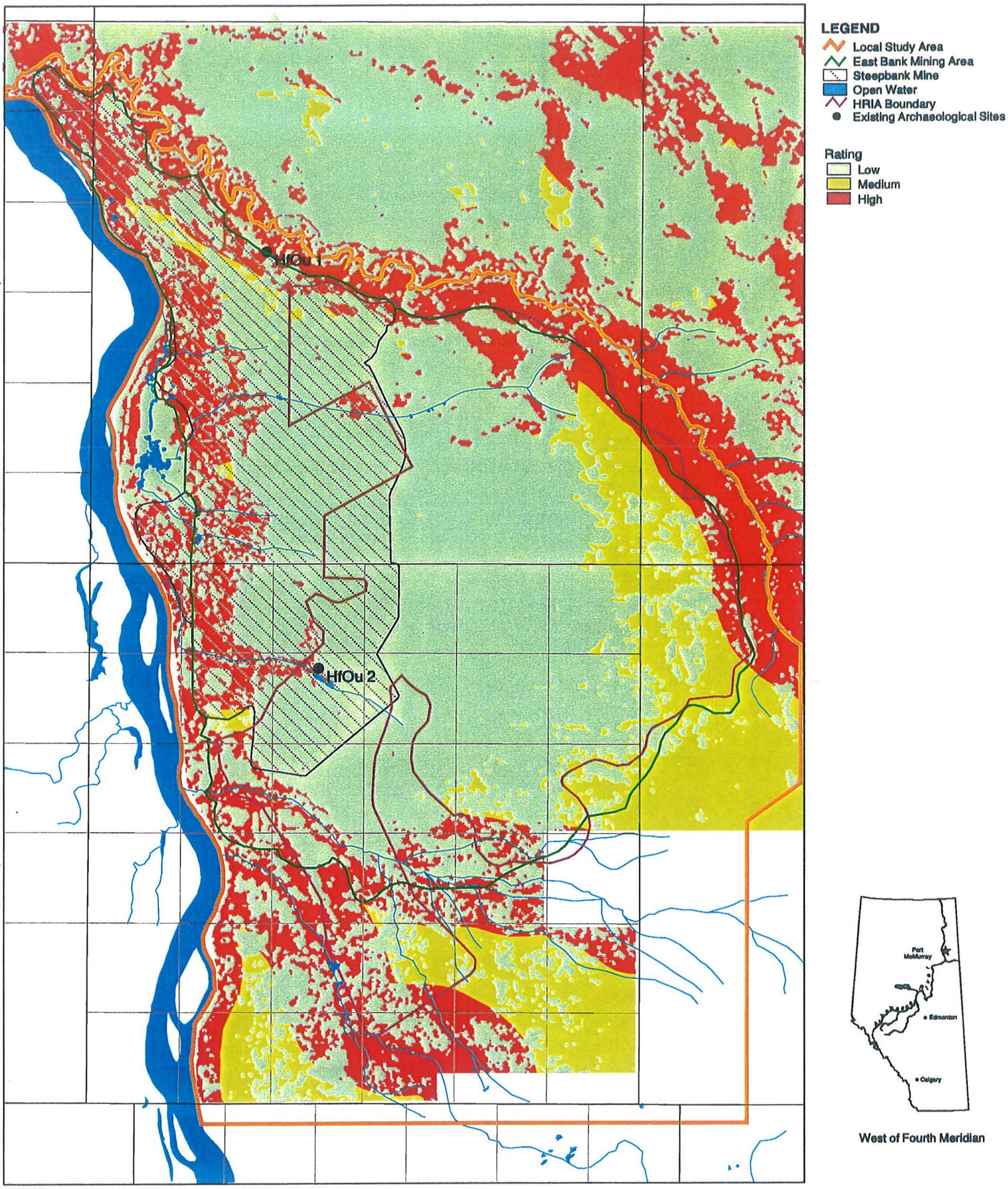
F4.3.3 Analysis of the Key Question

F4.3.3.1 Historical Resource Site Potential Model

Prior to the initiation of archaeological field work on Project Millennium, a predictive model was created to focus field time on areas which held the greatest potential for yielding historical resource sites (Figure F4.3-1). This map was based primarily on vegetation communities with open water as a secondary component. Potential was ranked as high, moderate or low depending on the proximity to water and the vegetation community present.

Due to the small number of sites identified in the LSA, no representative information regarding their environmental setting was available for use in the modelling. The two identified archaeological site locations in the LSA are situated in well drained terrain along the margins of active water courses. Both these factors were accommodated in the variables selected to structure the potential model.

As the model is based primarily on vegetation zones and distance to water, areas of high and moderate potential are often made up of small, unconnected polygons. These range in size from one or two hectares to area is comprised of a large, centrally located, uninterrupted area of low potential



SOURCES: Suncor
Golder
Klohn-Crippen

Based on vegetation and hydrology

Map Projection: UTM 12
Datum: NAD 83

LOCAL STUDY AREA
HISTORICAL RESOURCE
SITE POTENTIAL

15 Apr. 1998 | Figure F4.3-1 | PRODUCED BY: JS REVIEWED BY:

/data14/suncor/local/9840/arcview/site_potential.apr

(Figure F4.3-1). This area contains no navigable flowing water courses and is poorly drained.

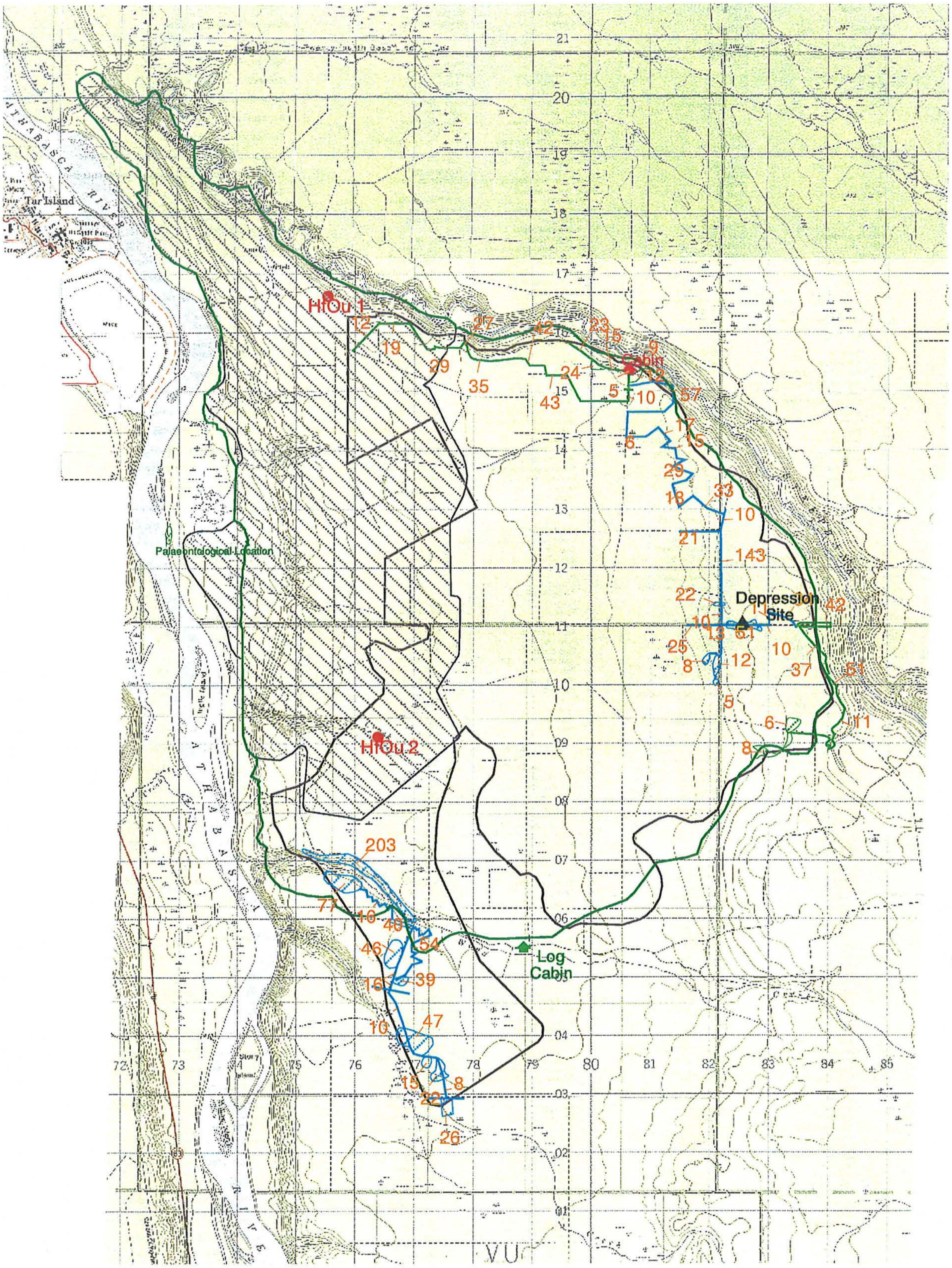
Areas of high and moderate potential were primarily distributed in two broad areas on opposite sides of the HRIA study area. The first area was concentrated in the north and eastern borders of the study area, along the Steepbank River. These areas include large expanses of aspen dominated woodlands with well drained soils and a close horizontal proximity to the Steepbank River. As the name implies, access to the Steepbank River from the upper terrace is often difficult. Areas of high potential may be located as much as 80 m above the river in some instances. Such a change in elevation may occur in a horizontal distance of less than 350 m in some locations. The second area of high and moderate potential is less continuous and is located in the southern part of the HRIA study area. These areas of potential are scattered thoughout the region along side and in between Wood and McLean creeks.

These areas, although less continuous than those along the Steepbank River, have, for the most part, a much lower vertical to horizontal ratio between the area and the water's edge. Based on this, and other less important factors, both sets of high potential areas were examined equally.

F4.3.3.2 Results of the Field Component

The field component of the historical resources impact assessment was completed by a crew of three to five archaeologists over a period of eight days in September of 1997. An aerial reconnaissance was completed on the first day of the field component to identify access points as well as to confirm the accuracy of the potential site map. Based on the map and the aerial reconnaissance, several transect locations were identified. These transects were refined once surveys commenced to reflect in-field observations.

Overall, the extensive foot traverses completed for this program were accompanied by a total of 1,629 shovel tests (Figure F4.3-2). Transects were designed to follow areas of high or moderate potential that had linear orientations, or to zig zag across irregular and wide shaped areas. Cut lines and winter roads, when present, were used as reference guides. Actual transects were completed away from these areas because the upper sediments were likely disturbed along the cut lines and roads. Judgementally placed shovel tests were approximately 50 x 50 cm in size and excavated to sterile subsoil. Grader piles along the edge of the road/cut lines and other areas of exposed subsurface materials were investigated where possible in an attempt to identify artifacts that may have been displaced. Pedestrian transects were accompanied by more intensive investigations in areas which, based on local microtopography or localized



LEGEND

- HRIA Boundary
- Steepbank Mine
- East Bank Mining Area
- Cabin
- Log Cabin
- Depression Site
- Recorded Sites
- Transect (3 Person)
- Transect (4 Person)
- Intensively Studied Areas (3 person)
- Intensively Studied Areas (4 person)
- 32 Number of Shovel Tests

West of Fourth Meridian

Sources: Suncor
Golder
NTS 1:50,000 Edition 3
Surveys and Mapping Branch, Department of Energy, Mines and Resources Branch, Alberta Transportation.

Scale 1:100,000

1000 0 1000 2000 3000

Metres

Map Projection: UTM 12
Datum: NAD 27

SUNCOR ENERGY

Project Millennium

1:100,000 SCALE
TOPOGRAPHIC MAP OF THE LOCAL STUDY AREA IDENTIFYING THE LOCATION OF THE PEDESTRIAN TRANSECTS AND SHOVEL TESTS

08 Apr. 1998 | Figure F4.3-2 | Produced by: J. Shaw Reviewed by:

components. These areas were typically subjected to the most rigorous shovel testing of the field program. Impacted areas, including bulldozed areas, graded roadways, tree throws and scarified sections of forestry cut blocks were also investigated. No evidence of the historic site HS 44044 was observed in the intensively investigated areas along the upper terrace on the south side of Wood Creek. It is likely that this drilling location was closer to the mouth of the creek, near the confluence with the Athabasca River, and not on the upper terrace. No attempt was made to locate site HS 44043, which is reported to be situated somewhere within LSD 14-10-91-09-W4M (Figure F4.3-1). Access is difficult to the area surrounding the potential site location, as it is is low lying and water saturated.

Information from the Steepbank Mine traditional land use study (Fort McKay 1996d) indicated that a few traditional trails and several beaver dams were present in the Project Millennium HRIA area. Shovel testing was completed in areas adjacent to three beaver dams along Wood Creek during the Project HRIA. None of these tests produced cultural materials. Attempts to investigate the trails also proved unproductive. Some of these trails are currently adjacent to or are now part of winter roads and seismic lines. One such trail is situated along the north shore of Wood Creek. Due to the sediment displacement and vegetation removal associated with the road, no evidence of the trail was noted. Extensive shovel testing in the area did not yield evidence of these trails or any historic artifacts.

Approximately 607 ha of land were investigated by transect and these more intensive assessments. As a result of the historical resources impact assessment, three distinct cultural sites with structures or features were identified, as well as other observations of cultural material of lesser importance. None of these sites are of sufficient age to be considered historical resources under the Alberta Historical Resources Act. These sites do, however, identify a small but important use of the area in recent times.

The identified sites likely represent a quite different land use pattern than that employed in prehistoric times. They were however, recorded in areas that were predicted in advance to exhibit high potential for archaeological sites. Two cabin locations and one site with a sparse scatter of historic period cultural material surrounding an excavated depression were observed. One of the cabin locations is located along a seismic line/winter road that is along one of the routes identified in the Steepbank traditional land use study as being part of the traditional trails system. One other scatter of historic refuse was noted in association with a well pad, in the SE quarter of Section 16-91-9-W4M. No features were observed in association with this material. Numerous materials were observed which may relate to the construction or dismantling of the well site or to trappers and hunters that stopped in the well pad clearing, which is situated just off a nearby cutline. As these sites were identified during the field component of the HRIA, details of each of the main sites are described below. These sites are important to the traditional land use of the area and are further discussed in Section F3.3.

Cabin 1

The log cabin is located along the north side of Wood Creek (Figure F4.3-2). The cabin is situated along the south side of a winter road that was identified during the Steepbank traditional land use investigations as being an old trail. The construction techniques employed in building the cabin and some of the materials used indicate that it is less than 50 years old. The cabin is located on trapline (#2453), as discussed in Section F3.3. The cabin appears to have been abandoned some years ago. The cabin is approximately 12 x 15 feet, with walls of approximately 6 feet in height. The cabin originally had a flat roof, with a single window present on the east side and one door. The glass in the window is intact and in good condition. The roof of the cabin is missing, although some of the supporting beams are still present. The logs have been cut with a wide bladed saw, most likely a chainsaw, confirming the relatively recent age of the cabin.

The window and door openings were completed by making cuts into the wall logs and chiseling out the necessary material. The window was set on both of the sides with 1 cm, machine planed planks. The window frame itself was roughly cut, but the glass was held in place with routered edging and small wire finishing nails.

One sanitary can was observed inside the cabin and two to three other cans were observed on the outside. A depression was present in the centre of the interior of the cabin, approximately 5 feet in diameter and 2 feet deep. The nature of this depression is unknown. Due to the recent nature of the cabin, no shovel tests were excavated at the site.

Cabin 2

A plywood cabin was observed on the top of the slope along the Steepbank River (Figure F4.3-2). It is located at the northern end of a large cut line, adjacent to a winter road which runs down to and then crosses the Steepbank River. This cabin is situated in Registered Fur Management area #2297, as discussed in Section F3.3. The cabin appears to be on skids and it is unlikely that this is its original location. The cabin is approximately 14 x 8 x 7.5 feet in size, with one door and two windows. The walls of the cabin are covered in thin plywood on both the inside and outside. The roof is only slightly peaked and has a small chimney for a wood stove. A kitchen chair with plastic back and seat was observed inside the cabin. A moderate amount of relatively recent refuse was observed in and around the cabin. This material included sanitary cans, metal, glass and wood fragments. Based on the artifacts and the construction material of the cabin, it is thought to be less than 30 years of age. Because of its comparatively recent age, no shovel tests were conducted. Shovel tests excavated nearby, however, were all negative.

Depression 1

A small scatter of historic artifacts and a cultural depression were observed on the north side of a cut line in the SW 1/4 of Section 6, Township 92, Range 8, W4M (Figure F4.3-2). A moderate sized depression is present, measuring approximately 16.4 x 10 feet in size and 2.5 feet deep. An associated mound of dirt measuring 13 x 8 feet across is situated directly to the north. Adjacent to these features are a 1 x 6 inch plank with a wire nail in it. A rectangular, heavy metal 'cover', with a machined hole cut in the top and a hand cut hole in the front. Presumably this specimen comes from a piece of heavy equipment. This site is also less than 50 years in age.

The site lies approximately nine km east southeast of Shipyard Lake, and roughly two km west of the Steepbank River. It is situated approximately 1 metre north of an east/west trending cutline on a semi-open, south facing knoll. The immediate site area contains birch and willow stands. The surrounding area is poplar and aspen with tamarack and black spruce to the south. A drainage is located approximately 100 m to the south.

Palaeontological Location

An outcrop along the Athabasca River was observed to contain palaeontological materials. The small shelf of an outcrop is approximately 50 m in length and 10 m wide at its widest point. The outcrop is part of the Moberly member of the Waterways Formation and is Upper Devonian in age. The Moberly Member has been characterized as being a fragmental limestone, limestone, argillaceous limestone and includes some shale (Carrigy and Kramers 1974). The Royal Tyrrell Museum of Palaeontology was informed of the observation and assisted in the identification of the materials from the photographs. The outcrop is located outside of the Project Millennium mine footprint, but inside the LSA. The materials included stromatoporoids, small brachiopod shells, nautiloids and other aquatic invertebrate fossils.

F4.3.3.3 Summary

Several cultural locations were observed during the conduct of this HRIA, but no historical resources were formally recorded with Alberta Community Development. These sites included two cabins, one site with a cultural depression, one historic debris scatter and a palaeontological outcrop. Although several trappers cabins were identified during the Steepbank traditional land use study, neither of the cabins observed during this HRIA were listed. Due to the recent nature of these cultural sites and the recording and photodocumentation that was completed during the course of the field work, no mitigation is recommended at these sites. The identification of the cultural sites is an important link to the recording and understanding of the land use practices within the LSA. As these sites are all less than 50 years old, they are not sufficient age to be regulated under the provisions of the Alberta Historical Resources Act.

The palaeontological locale is part of the Waterways Formation, an Upper Devonian bedrock formation that outcrops throughout the region. It is located outside of the development area and will not be directly affected by the Project. As there will be no impacts at the site, no mitigation is recommended.

It has been recommended to Alberta Community Development that Suncor be allowed to proceed with Project Millennium without further mitigation of the effects of construction on the historical resources in the proposed mine footprint.

F4.3.4 Residual Effects

As no mitigation is recommended for any of the sites identified during the HRIA, the residual effects of the project are considered to be minimal. The cultural materials identified are not of sufficient age to be considered historical resources and the palaeontological locale is located outside of the development area and will not be affected.

F4.4 HISTORICAL RESOURCES CUMULATIVE EFFECTS ASSESSMENT

F4.4.1 Introduction

The past few years have seen a resurgence of development activity in northeastern Alberta. Many of these projects include substantial land altering impacts. These have the potential to damage or even destroy cultural material and historical resource sites. Through the proper management of these resources our knowledge of these sites and their distribution is increased.

The cumulative effects of these activities on historical resources are difficult to assess. Large portions of the region have never been subject to any prior historical resources investigations. Actual abundance of historical resource sites are not known, making quantitative analyses almost impossible. Attempts have been made to understand the distribution of prehistoric and historic period sites in the region and their relation to the environment, but a lack of baseline data for much of the area increases the uncertainty of these analyses.

In an effort to quantify the cumulative effects of oil sands operations in northeastern Alberta, an assessment of historical resources potential was produced for the region affected by these developments. A Historical Resources Regional Study Area (HRRSA) was selected to incorporate all of the existing, approved and planned oil sand developments that are currently known, as well as, the known historical site distributions. This assessment is displayed by the production of a map using GIS Technology. The mapping of archaeological potential has been used successfully in the recent past (Dalla Bona 1994, 1995; Golder 1996h, 1997h, 1998f, 1998g; Kvamme 1992; Eldridge and Mackie 1993).

F4.4.2 Historical Resources Regional Study Area Map of Potential

The HRRSA extends from UTM grid line 440000E to 510000E and from 6270000N to 6370000N and is approximately 1,100,000 hectares (2,717,000 acres) in area. It includes all or portions of national registry (Borden) blocks HdOr, HeOr, HfOr, HgOr, HhOr, HiOr, HdOs, HeOs, HfOs, HgOs, HhOs, HiOs, HdOt, HeOt, HfOt, HgOt, HhOt, HiOt, HdOu, HeOu, HfOu, HgOu, HhOu, HiOu, HdOv, HeOv, HfOv, HgOv, HhOv, HiOv, HdOw, HeOw, HfOw, HgOw, HhOw, HiOw, HdOx, HeOx, HfOx, HgOx, HhOx and HiOx.

The distribution of historical resources depends not only on available resources, terrain and other environmental attributes, but is also dependent on human factors such as population densities, seasonal movement cycles, and other culture-based variables. The attempt at modelling potentially sensitive areas for historical resources, incorporated as many of the relevant variables as possible.

Ethnographic and archaeological studies indicate that the presence of archaeological sites is strongly associated with the natural water courses throughout the Boreal Forest. The people of the region not only spent the majority of their time along these waterways, but often these areas exhibit the highest potential for site preservation through sediment deposition. The riparian zones along the creeks and rivers also contain some of the best habitat and resource diversity in the region. People used waterways as transportation corridors, food acquisition and gathering locations.

It is important to establish that the distribution of archaeological and, to a certain degree historical sites, are not fully represented in the archaeological record. A large proportion of the activities that have been carried out in the region in the past have not been preserved to the present day. Organic materials break down quickly in the soils of the forest and are rarely preserved. Many activities, such as the gathering of vegetation and snaring game do not leave materials behind in the archaeological record. Whenever possible, efforts were made to incorporate information such as ethnographic accounts, traditional land use information and archaeological experience into the establishment of the value rankings.

Each of the categories was ranked in accordance with current understandings of the movements of the local populations within the area, over the past 10,000 years. Additionally, the potential for preservation within the areas in question was also considered.

Criteria considered in the HRRSA model included:

- percent slope;
- aspect (facing direction);
- elevation;
- areas in the vicinity of known historic fur trade post locations;
- soils, including sediment type, topographical feature and dryness/ drainage properties of the sediments;
- vegetation;
- proximity to standing water; and
- proximity to flowing water.

Each of these categories was first developed into a separate GIS map layer. All of the variables on each map layer were then ranked independently as to their importance with respect to site location. The rankings were completed on a scale of zero to ten, using even integers as increments, with ten being the most important and zero having little or no importance.

It is acknowledged that the map layers used for the model are not equal in importance with respect to their association with site distribution. Factors such as the proximity to water are typically regarded as more important than others, including aspect and slope. Because of this, the categories have been given differential weighting to increase the perceived accuracy of the model as a reflection of past activities throughout the landscape. This was based on a scale of one to three, with a value of one representing low ranking categories, two for moderate and three represented highly significant categories. The map layers for proximity to standing water and proximity to flowing water were weighted as a three. Soils, fur trade post locations and vegetation were weighted as two and aspect, slope and elevation were weighted as one.

The weighting of map layers has been used successfully in previous modelling projects throughout the Boreal Forest (e.g., Dalla Bona 1994, 1995). Few published references provide examples of explicit testing of predictive models of this nature. One such test involved the application of a predictive site model to three separate field locations throughout northern Ontario (Dalla Bona 1995). The results of this test concluded that the model had variable success in predicting site locations. The best performance experienced was that 90% of the sites identified during the field investigations in one test location were situated within areas of high potential. Within a second test location, 75% of the sites recorded were within areas identified by the model as high potential and no sites were identified within the final test area (Dalla Bona 1995).

After each of the separate Project Millennium map sheets were created and the variables on each sheet ranked, all of the data were compiled onto one map. This map illustrates a gradation of potential based on the sum of all of the variables from each of the seven map layers. The sums for the HRRSA model ranged from 0 to 116. Scores were then normalized into three blocks of potential, where the sums representing low potential ranged from 0 to 38, moderate ranged from 39 to 77, and high ranged from 78 to 116. The map was then plotted to illustrate the combined potential for historical resources. No previous maps have been produced for this area at a regional scale.

When the areas were calculated, however, it was noted that low potential areas accounted for approximately 71% of the area, moderate potential for 28% and high potential accounted for slightly less than 1% of the total area. This is clearly not a true representation of archaeological potential throughout the area. It was decided that at least the upper five percent of the sums should be used to represent the high potential regions of the area. This was accomplished by including the upper four percent of the moderate potential in the range of data depicted as high potential on the map. No adjustments were made to the ranking or weighting schemes, nor were computer manipulations performed.

The resulting map (Figure F4.4-1) illustrates the potential for historical resources graphically, throughout the HRRSA.

All known sites were then plotted on the potential map to assess the accuracy of the rankings, given present data limitations (Figure F4.4-2). As much of the past historical resources research in the region has been driven by proposed developments, the distribution of historical resources reflects those areas which have been assessed more than the actual site distribution in the region. For this reason, specific site locational data were deliberately not used in the construction of the potential map and are only used for comparative purposes.

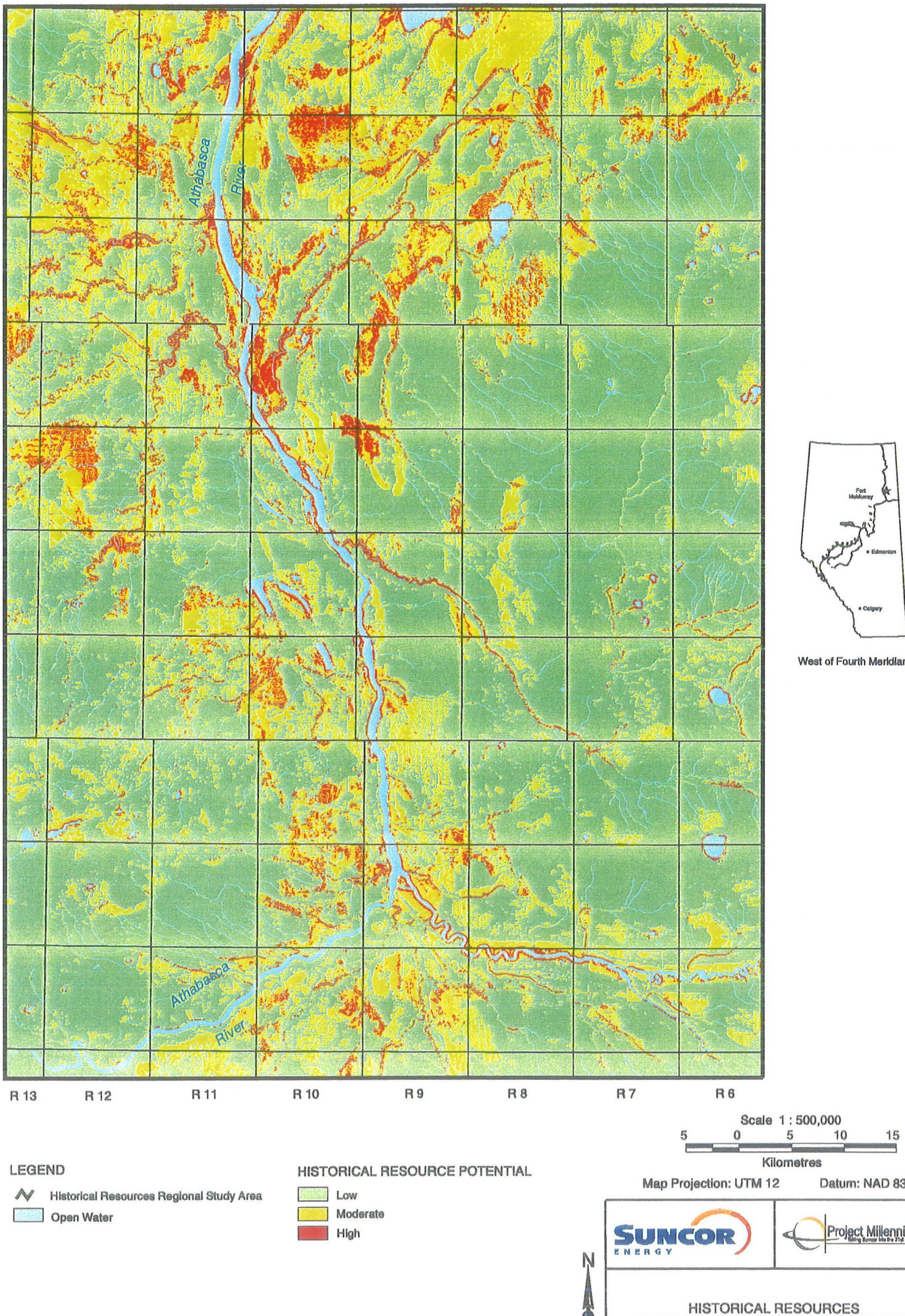
Some factors could not be rectified and incorporated prior to the completion of the model. Many of these limitations are not exclusive to this model, but are symptomatic of problems in all predictive models relating to historic resources in the north. These limitations include an incomplete and highly speculative understanding of the seasonal movements of the people of this area prior to approximately A.D. 1700. Before the arrival of furtraders in the area, very little second-hand information was recorded regarding the people of the area and their day to day lives.

Other limitations include the size of the area under consideration and the topographic information available at which the information was synthesized. Due to the large area considered, some small features will naturally be obscured. Slope is a good example of a category in which valuable information has been limited. Similarly, differences in elevation, which may be significant to site location decision making cannot be extracted from the map data.

These types of limitations must be expected in the production of large scale models. However, it is unlikely that they would significantly affect the predictive capability of a regional scale map. As the purpose of the map is to delineate the potential of the region, minor topographic variations that are lost in the mapping process, may not have significantly influenced location decisions on a regional scale.

F4.4.3 Discussion

The distribution of high, moderate and low potential areas throughout the HRRSA is illustrated in Figure F4.4-1. The areas identified by the model as high potential were arbitrarily set to identify the highest 5% of the land base as high potential areas.



SOURCE: Golder

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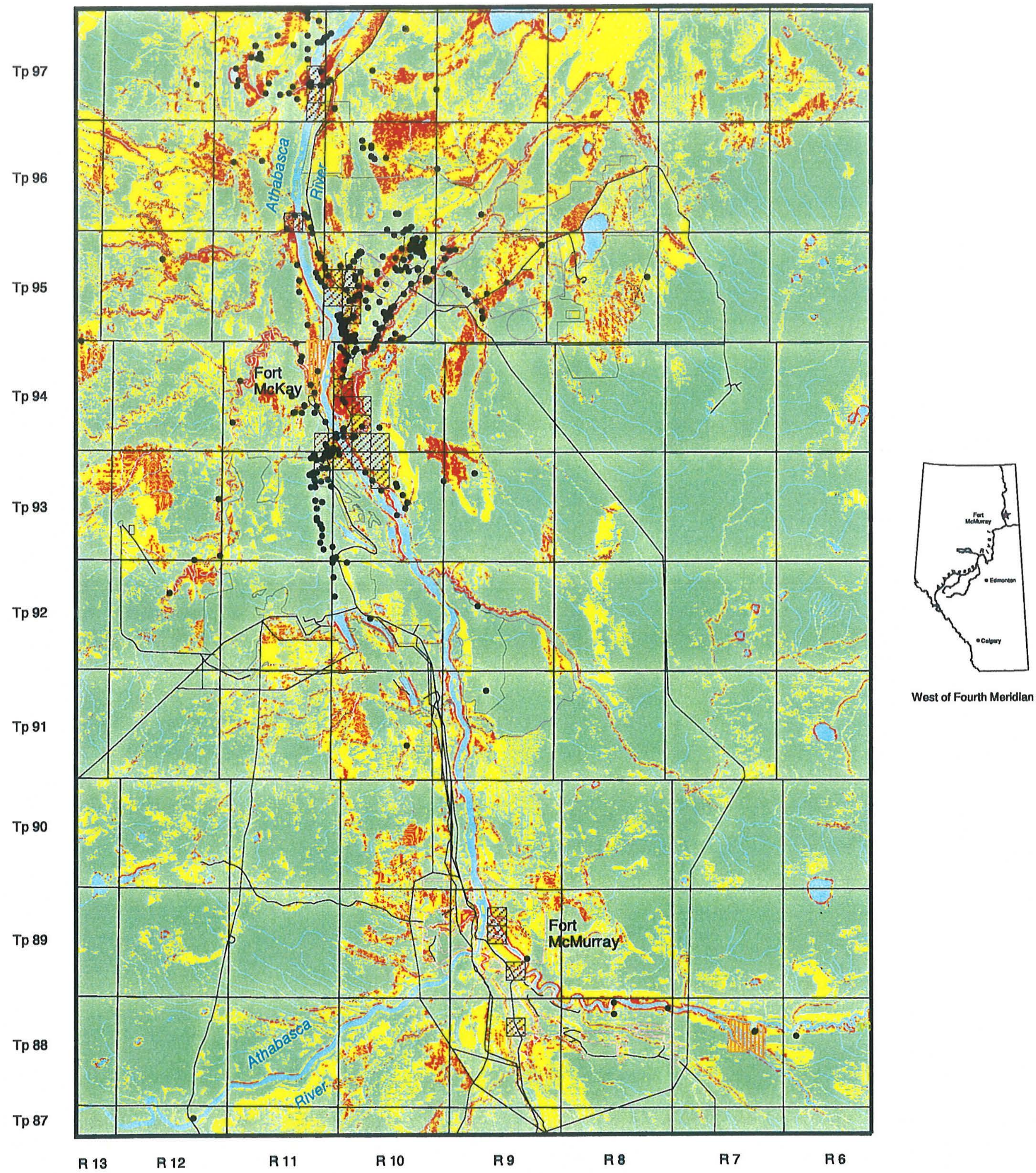
HISTORICAL RESOURCES
REGIONAL STUDY AREA POTENTIAL MAP

07 Apr. 1998

Figure F4.4-1

PRODUCED BY: M.K.
REVIEWED BY:

/data14/suncor/regional/9840/arcview/mktemp.apr



LEGEND
- Historical Resources Regional Study Area
- Linear Disturbances
- Open Water
- Forestry
- Existing Open Pit Mines
- Other Disturbances
- In-Situ
- Proposed Open Pit Mines
- Municipalities
- Indian Reserves
- Designated Historical Resources / Buffer Zones
- Historical Resource Sites

HISTORICAL RESOURCE POTENTIAL
- Low
- Moderate
- High

SOURCES: Suncor, Syncrude, Petro-Canada, Mobil, Al-Pac, Golder

Scale 1 : 500,000
5 0 5 10 15
Kilometres

Map Projection: UTM 12 Datum: NAD 83

N

SUNCOR ENERGY

Project Millennium

HISTORICAL RESOURCES
REGIONAL STUDY AREA POTENTIAL MAP
AND HISTORICAL RESOURCE SITE LOCATIONS

09 Apr. 1998 | Figure F4.4-2 | PRODUCED BY: M.K. REVIEWED BY:

/data14/suncor/regional/98...view/mktemp.apr

High potential areas are distributed throughout the HRRSA. As expected, the shores and terraces of the Athabasca, Clearwater, Steepbank, MacKay, Muskeg, Firebag, Ells and Tar rivers rank as high potential areas. Areas surrounding major standing waterbodies such as McClelland, Beaver, Ruth and Kearl lakes also rank highly. Other areas of high potential are present away from the main waterbodies. These zones of potential include tracts of land adjacent to lesser waterbodies, as well as, upland regions.

A number of distinct zones of high potential are observed away from waterways. These include areas south of Suncor/Lease 86/17 and Syncrude Mildred Lake to the southwest of Beaver and Ruth lakes. This area is situated between the Beaver and Ruth lakes/Athabasca River area and the Thickwood Hills, located further southwest. Moderate to High potential is also observed throughout the region between the Dover and MacKay rivers, west of the Syncrude Mildred Lake operation.

Concentrated areas of high potential are also situated throughout the north-central portion of the HRRSA. These include areas south and southwest of Kearl Lake, as well as a large area to the northeast of Saline Lake, near the headwaters of Jackpine Creek (formerly Hartley Creek). The Fort Hills also rank as having high potential for historical resources.

Areas in the eastern portion of the HRRSA tend to rank lower than those in the west and north. A slight increase in potential is observed in the buffered region along the North Steepbank River. Small areas of moderate potential are also depicted in the upland area between the North Steepbank and Steepbank rivers. The region to the south of the Thickwood Hills also ranks as relatively low potential for historical resources.

Low potential areas are also depicted in regions of existing disturbances such as Fort McMurray and Syncrude Mildred Lake. Suncor Lease 86/17, and other developments did not allow for accurate pre-disturbance information to be included in the model. These areas would likely have demonstrated higher potential had the information been available. This distinction becomes important when considering the distribution of known sites in the region.

A total of 352 archaeological sites have been recorded with precise location information within the HRRSA in Alberta Community Development's prehistoric sites records. The location of these sites have been overlaid on the map of potential site locations (Figure F4.4-2). Several additional sites have been recently identified or are currently under review by Alberta Community Development. Information relating to their type and location is not available at this time. If these sites were included in the analysis, in excess of 400 sites would be present in the HRRSA.

The majority of these sites are artifact scatters (n=114), followed by isolated finds (n=91). Both of these site types show an association with terrace landforms. Campsites (n=57) and workshops (n=24), common site types in the HRRSA, also tend to be associated with terrace features as well. Ridges also have a high incidence of sites. Common between these two landforms is the fact that they are well drained and the vegetation is typically fairly open, mixedwood communities.

In addition, 69 historic period sites have been recorded at the Historical Sites Service (Alberta Community Development). These sites include numerous wells and several ranger stations, lookout towers, fur trade posts, mounted police posts, missions, cabins and a historic steamboat. Locational information regarding the historic period sites is filed using the legal land classification system. Some of this information is available only to the section level of classification. UTM coordinates or other means of precisely locating these sites is not available. For this reason, these sites could not be plotted effectively in Figure F4.4-2.

Many of the historic period sites are located in or adjacent to other recent development areas including the townsites of Fort McMurray and Fort McKay. Others are situated along the banks of the Athabasca and Clearwater rivers. Site file searches completed at the Historic Sites Service in Edmonton revealed that most of the historic period sites recorded are in close proximity to the Athabasca, Clearwater or Christina rivers. The legal descriptions of some early oil exploration well locations, however, were recorded in areas that range up to 12 km from the Athabasca River. Even the majority of these sites lie within 10 km of the river. The most notable exception to this pattern of distribution is the Thickwood Hills lookout tower. This site is located in relative isolation from the typical patterning of historic sites. The site does, however lie within an area of moderate to high potential in Section 11-Twp90-R12-W4M.

Two of the sites are also recorded as archaeological sites and precise locational information. These two sites, as well as some other historic period archaeological sites, have been plotted in the site distribution illustrated in Figure F4.4-2. A total of 421 historical resources are currently on record within the HRRSA, with information regarding their location.

A total of 12 sections of land are listed on file with ACD as relating to significant or provincially registered sites. These sites include historic and prehistoric sites and are all located in close proximity to the Athabasca River. As these designations apply to an entire section of land, it is not possible to determine the nature of the potential for the exact site location.

The sections of land are, however, located in areas of generally high potential.

Fourteen 'Buffer Zones' are also present in the HRRSA. Buffer zones are areas designated by ACD in lands adjacent to designated sites. These sections may be subject to specific restrictions regarding surface access and are associated with high or moderate potential.

Part of the traditional seasonal movements of the people of the region included large spring aggregations. These multi-family gatherings took place annually and were held in centralized areas of plentiful food and easy access for all involved. Aggregation centres have been documented along the Saskatchewan River and are present approximately every 60 to 80 km. It was also noted that these sites are often in close proximity to fur trade post locations (Meyer and Thistle 1995, Wondrasek 1997). Because similar cultural groups were present on both the Athabasca and Saskatchewan rivers, the pattern is believed to extend along the length of these rivers, as well as possibly the Peace. At least two such areas are present within the confines of the HRRSA. These include the Cree Burn Lake site (HhOv 16), near Fort McKay and the confluence of the Clearwater and Athabasca rivers, at Fort McMurray. It is possible that additional aggregation sites are present that archaeological investigations have not yet identified. These sites, and any others that may be identified in the future, would be considered significant sites in the region.

A visual inspection of the site distribution indicates the accuracy of the potential model in depicting historical resource sensitivity within areas where HRIAs have been conducted. A distinct correlation can be seen between areas of high to moderate potential and the location of sites. One exception is again the site sites located in the "low potential" zone along the Beaver River in the Syncrude Mildred Lake development area where a lack of soils and vegetation baseline data has artificially lowered the potential of the local area. Such areas were not used in the numerical assessment of the model's accuracy.

A numerical analysis of the sites in the area was also performed. A total of 286 sites, from areas where the model is not affected by prior disturbance, were used in the analysis. Due to differences between the accuracy of site data and the model, nine sites were classified as being within lakes or rivers. These sites were manually adjusted to the closest shoreline. Of the total number of sites, 26.9% (n=77) are located in areas of high potential, 39.5% (n=113) are within moderate and 33.6% (n=96) are within low potential areas. In excess of 66.4% of the sites are located within high and moderate potential zones. It should be stressed again that these site locations are predominantly a reflection of the locations of previous HRIA investigations. The distribution of these sites include all of the biases involved in each of those programs.

At first glance the percentage of historical resources in high potential areas appears to be acceptable. A predictive model is referred to as successful if it predicts the location of 40% of the sites within 40% of the landbase, as would be expected by chance (Kvamme 1992). An analysis of sites per total area reveals that 5 to 1 ratio is present for sites to be located in a high potential area (Table F4.4-1).

Table F4.4-1 Relationship of Known Sites and Areas of High, Moderate and Low Potential in the HRRSA.

Potential	Number of Sites (in Undisturbed Lands)	Percent Total Sites	Potential in HRRSA (%)	Sites (%): Area of Potential (%)
High	77	26.9	5.4	5 : 1
Moderate	113	39.5	23.2	1.7 : 1
Low	96	33.6	71.3	0.5 : 1

Although the actual percentages show moderate predictive success, the model appears to depict the overall trend in historical resource potential within the region relatively well. The majority of the sites classified as being in low potential areas are roughly within 100 metres of high or moderate terrain. These sites may relate to areas which are of low regional potential, but exhibit high potential on a local scale. Previous research has confirmed the importance of local, microtopographic features with respect to the location of historical resources in the Muskeg River area of the HRRSA (Golder 1997h). Small knolls and ridges were very attractive features with respect to historical resource site locations. These features contained the majority of sites identified during the previous archaeological studies in this area, but are too small to be identified in a regional map of this scale. It is therefore important to use the map constructed for this study as a general indicator of regional potential in conjunction with detailed assessments of local terrain to get an accurate evaluation of the potential of specific development areas.

F4.4.4 Summary

This map of historical resource potential is the first attempt at a systematic, computer generated map of historical resource potential for this portion of northeastern Alberta. The map illustrates the ongoing effect of oil sands development within the HRRSA. As archaeological sites are a non-renewable resource, it is important that adequate historical resources assessment and mitigation programs be conducted prior to development. The HRIAs completed in advance of developments in the region have resulted in an accumulation of knowledge about the nature and distribution of the historical resources of the area. Further research in the region will be a necessary step in the refinement of the model used in this analysis to determine high potential areas.

Archaeological sites are predominantly distributed throughout areas of proposed, approved or existing developments. This is entirely a reflection of the concentration of historical resource impact assessments and not a reflection of actual site distribution. Historic period sites are primarily distributed along the Athabasca, Christina and Clearwater rivers. These sites typically are located within areas of current development or fall in and around areas depicted as high to moderate potential (Figure F4.4-2). Only a few sites, such as historic wells, may fall in areas classified as having low potential.

Ethnographic and archaeological information suggests that significant sites are to be expected within the HRRSA. These will include prehistoric sites, such as aggregation centres as well as historic period sites such as fur trade and Northwest Mounted Police posts. Aggregation centres have been identified along the Athabasca in the Fort McKay/Cree Burn Lake region and have been suggested as probable within the Fort McMurray area.

Impact assessment and mitigation programs conducted prior to oil sand development, as required under the Alberta Historical Resources Act, allows for the identification and documentation of these resources. As well as providing appropriate management of historical resources concerns associated with developments, the identification and recording of sites increases the knowledge of regional site distribution and will allow for refinements to be made to the regional potential model used in this analysis. The map indicates where sites are likely to be present, however, field work is necessary to identify actual site locations and to test its accuracy.

F4.4.5 Residual Effects

The residual negative effects of the developments within the HRRSA will impact those historical resources that remain after adequate historical resources management programs have been completed (as required for developments reviewed by Alberta Community Development). These residual effects are managed by Alberta Community Development through the completion of HRIAs and mitigation programs as required. These studies are designed to offset any negative residual effects through the avoidance of sites, conservation of important historical materials and through the increase of knowledge pertaining to the historical resources of the region. Through the completion of adequate historical resource management programs, Alberta Community Development considers these impacts acceptable.

F4.5 HISTORICAL RESOURCES CONCLUSION

In September of 1997, Golder completed a Historical Resources Impact Assessment (HRIA) on behalf of Suncor on lands proposed for development in association with the development of Project Millennium. All work completed for this Project was conducted under Historical Resources Permit #97-123, issued by Alberta Community Development. Prior to the field investigation the local study area (LSA) was assessed to identify areas having high potential for historical resources. Approximately 607 ha of land were investigated, accompanied by a total of 1,629 shovel tests. Two previously recorded prehistoric sites, are located in the vicinity of the HRIA study area. They were both recorded during the HRIA completed for Suncor's Steepbank Mine.

No historical resource sites were recorded during the course of the Project Millennium HRIA. Three locations were observed at which cultural features or structures are present, but these sites do not qualify as historical resources under the Alberta Historical Resources Act. These locations include two with cabins and one with an excavated depression.

Five historical sites within the LSA were also identified during searches of files maintained by Alberta Community Development. These sites relate to early oil exploration in the Athabasca region, dating to approximately 1906-1909. No evidence of these sites was observed in the field during this HRIA.

One palaeontological location was also noted along the Athabasca River. This site is outside of the Project Millennium development area, but is within the LSA. The outcrop relates to the Moberly Member of the Waterways formation, which outcrops regularly along the Athabasca River and underlies the entire oil sands region. The area will not be affected by the development. The materials observed included Upper Devonian aged stromatoporoids, small brachiopod shells, nautiloid cephalopods, and fossils of other aquatic invertebrates.

As no known historical resources will be affected as part of Project Millennium, there is no predicted impact.

The cumulative effects of Project Millennium and other existing, approved and planned developments in the region are more difficult to address. The regional database concerning the distribution, quantity and significance of historical resources is incomplete. A model of historical resource potential was created as part of the Project Millennium HRIA in an effort to quantify and illustrate the cumulative effects of regional oil sands development. The analysis was inconclusive due to incomplete information.

G EIA IMPACT SUMMARY

G1 OVERVIEW OF THE EIA

This report summarizes the basis and results of the Environmental Impact Assessment (EIA) conducted for Suncor's Project Millennium (the Project). The EIA cumulatively assessed the impacts associated with the development, operation and closure of Project Millennium, in association with existing and approved regional developments. The EIA also addressed the cumulative effects associated with existing and approved developments, Project Millennium and planned (publicly disclosed) developments.

The impact predictions are presented in terms of direction, magnitude, duration, frequency, geographic extent, and reversibility. Seasonal variations are discussed where they were determined to be relevant to specific potential impacts. The EIA report discussed measures to prevent or mitigate impacts, proposed monitoring programs and reviewed the residual and cumulative impacts and their significance.

Volume 2 of the Project Millennium Application provides full details of the EIA, including the biophysical, human health, land use, historical resource and socio-economic baseline settings, impact assessment and cumulative effects assessments.

G1.1 Results of Assessment

The predicted biophysical and historical resource impacts identified for Project Millennium are acceptable. The predicted impacts will have no significant long-term effects on the environment, provided the recommended mitigation is undertaken. A table at the end of this section contains a summary of the mitigation measures and residual impacts identified for Project Millennium on completion of the EIA.

G1.2 Scope of the EIA

The Project Millennium EIA was completed in accordance with the March 8, 1998 Final Terms of Reference for Project Millennium. Therefore, this EIA was completed to:

- provide information on the environmental resources and resource uses that could be affected by Project Millennium;
- provide a sufficient base for the prediction of positive and negative impacts and the extent to which negative impacts may be mitigated by planning, project design, construction techniques, operational practices and reclamation techniques;
- quantify and assess impact significance where possible, including consideration of spatial temporal and cumulative aspects;

- discuss the sources of information used in the assessment, including a summary of previously conducted environmental assessments related to Suncor's operations;
- describe and rational the selection of key components and indicators to be examined in the EIA (based on a broadly-based examination of all ecosystem components and previous assessment work);
- discuss the consultative process which Suncor utilized in the selection of environmental components and indicators; and
- describe the following for each environmental parameter:
  - existing conditions, with comment on whether available data is sufficient to assess impacts and mitigative measures; consider environmental disturbances from previous activities that have become part of the baseline conditions,
  - the nature and significance of the environmental effects and impacts associated with the development activities,
  - where appropriate, how biodiversity is addressed in the assessment, considering fauna, habitat, ecosystems and landscapes,
  - present plans to minimize, mitigate or eliminate negative effects and impacts, with discussion of the key elements of such plans,
  - the residual impacts and their significance,
  - a plan to identify possible effects and impacts, monitor environmental impacts and manage environmental change to demonstrate the project is operating in an environmentally sound manner, and
  - a plan that addresses the adverse impacts associated with Project Millennium that may require joint resolution by government, industry and the community, with description of how this plan will be implemented and how it will incorporate the participation of government, industry and the community.

The following subsections summarize the basis and results of the biophysical, historical resources and socio-economic components of the EIA.

G1.3 Baseline Conditions

The EIA provides information on the environmental resources and resource use that could be affected by Project Millennium. The baseline conditions for the Project Millennium development area provide the foundation upon which biophysical and historical resources impacts were predicted. Detailed information on the biophysical and historical resources baseline conditions are described in the relevant sections of the EIA (Volume 2 of this application).

The EIA baseline conditions represent different components of the environment:

- Air Quality;

- Aquatics - including surface hydrology and hydrogeology, surface water quality, and fisheries and fish habitat;
- Terrestrial Resources - including soils and terrain, terrestrial vegetation and wetlands, ecological land classification and wildlife;
- Reclamation and Mine Closure;
- Human Health;
- Historical Resources;
- Traditional Land Use and Resource Use; and
- Socio-economics.

Included within this EIA is a review of the information available from the literature, previous oil sands EIA reports and environmental studies. Additional information from current oil sands operations, industry study groups, traditional knowledge and government sources was also used in the baseline. The final source of baseline information came from studies completed in 1997 as part of the Project Millennium EIA.

G1.4 Local and Regional Considerations

The information on baseline conditions collected for the EIA included considering local (Figure G1.1-1) and regional (Figure G1.1-2) study areas (LSA and RSA). The LSAs centered around the Project Millennium development area on Leases 97, 25 and 19, east of the Athabasca River. The LSAs included both the recently approved Suncor Steepbank Mine areas as well as areas proposed for development under Project Millennium. The RSA area extends from south of Fort McMurray, north toward Lake Athabasca.

G1.5 Impact Assessment

The impact assessments of environmental, historical resource and socio-economics were focused on issues identified by regulatory agencies, local communities and other oil sands development stakeholders. The impact assessments considered Project Millennium construction, operation and closure phases.

Cumulative impacts related to Project Millennium were assessed after considering the residual impacts associated with Project Millennium in combination with two development scenarios (Table G1.1-1).

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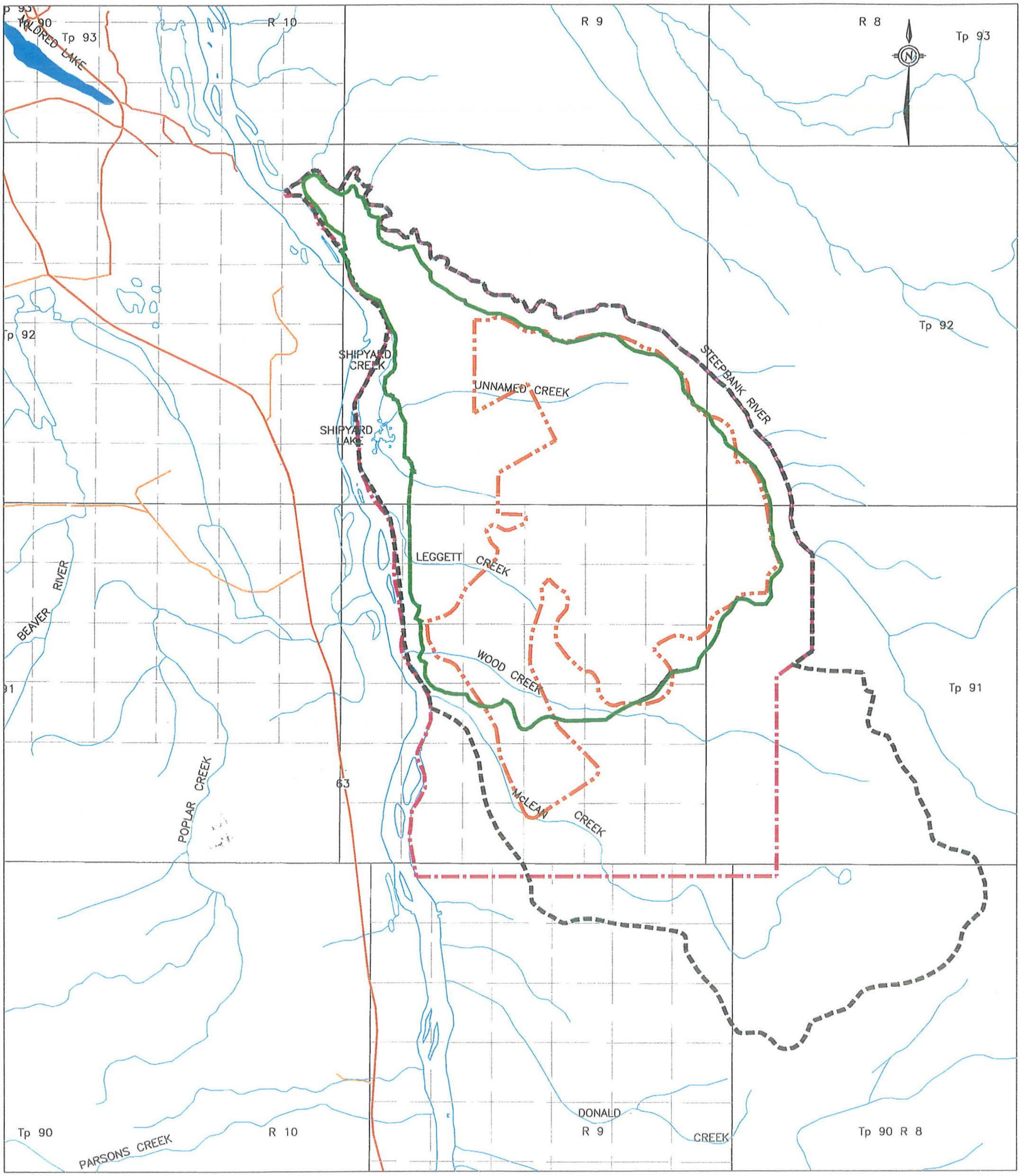


LEGEND

- EAST BANK MINING AREA
- LOCAL STUDY AREA FOR TERRESTRIAL AND HISTORICAL RESOURCES
- LOCAL STUDY AREA FOR AQUATICS
- HISTORICAL RESOURCES IMPACT ASSESSMENT STUDY BOUNDARY

NOTE:

TRADITIONAL LAND USE AND RESOURCE USE ARE A COMBINATION OF TERRESTRIAL AND AQUATICS LSAs

REFERENCE

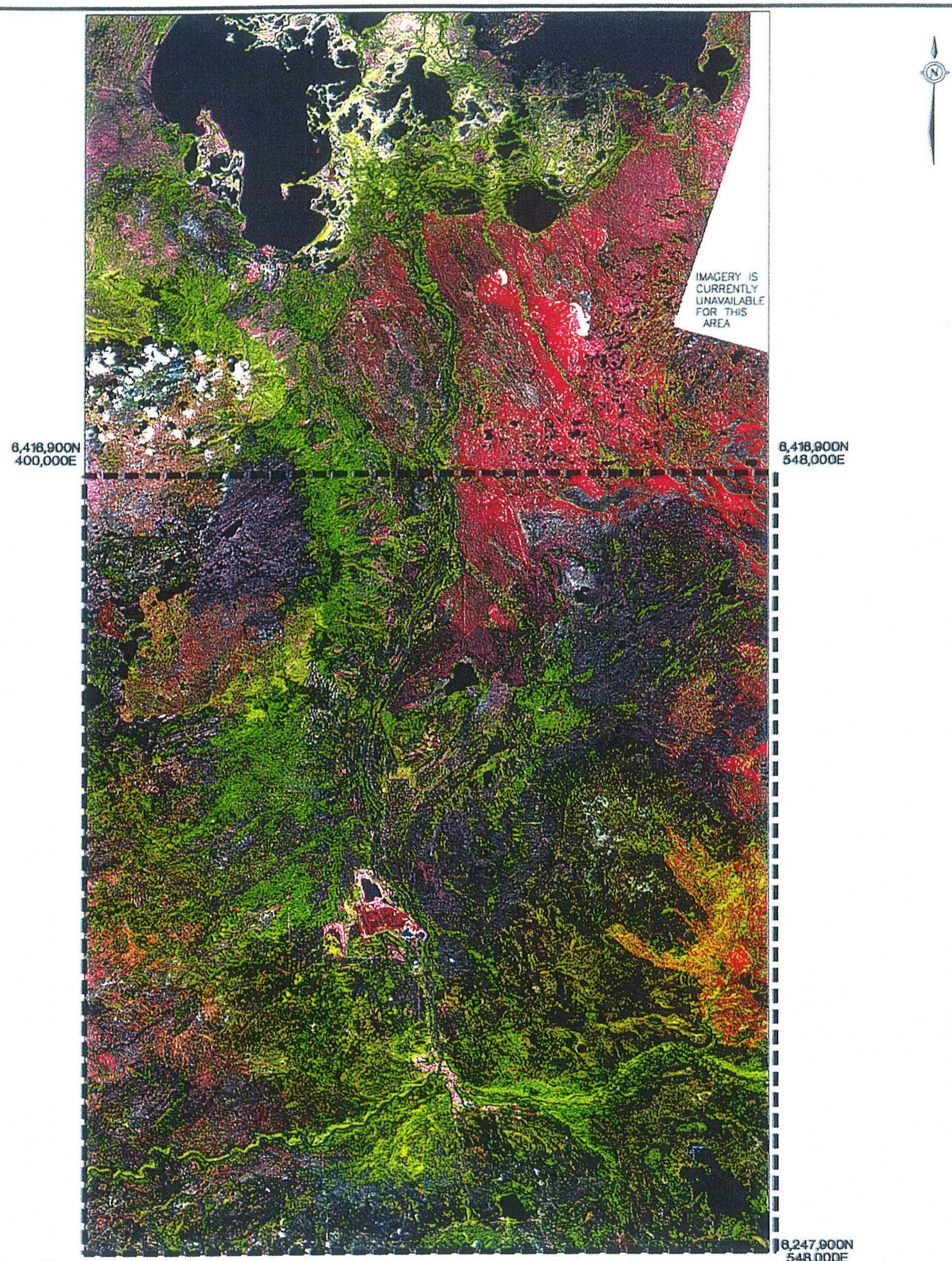
DIGITAL DATA SETS 74D AND 74E RESOURCE DATA DIVISION, ALBERTA ENVIRONMENTAL PROTECTION, 1997.
MINE PLAN SUPPLIED BY SUNCOR ENERGY, MAR 1998.
DATUM IS IN NAD83 UTM

0 1 2 3 4 5km
SCALE 1:150,000

SUNCOR ENERGY | Project Millennium Taking Suncor Into the 21st Century

PROJECT MILLENNIUM
LOCAL STUDY AREAS

06 Apr. 1998	Figure G1.1-1	DRAWN BY: CG/TM



LEGEND

REGIONAL STUDY AREA

0 10 20 30 40km

SCALE 1:1,250,000

SUNCOR ENERGY

Project Millennium
Taking Suncor Into the 21st Century

OIL SANDS REGIONAL STUDY AREA

05 Apr. 1998	Figure G1.1-2	DRAWN BY: TM

Table G1.1-1 Project Millennium Impact Assessment Scenarios

DEVELOPMENT	Baseline EXISTING + APPROVED DEVELOPMENTS	Impact Assessment EXISTING + APPROVED DEVELOPMENTS + SUNCOR PROJECT MILLENNIUM	Cumulative Effects Assessment EXISTING + APPROVED DEVELOPMENTS + SUNCOR PROJECT MILLENNIUM + PLANNED DEVELOPMENTS
	Suncor Lease 86/17	Suncor Lease 86/17	Suncor Lease 86/17
EXISTING	**Syncrude Mildred Lake**	Syncrude Mildred Lake	Syncrude Mildred Lake
	Suncor Steepbank Mine	Suncor Steepbank Mine	Suncor Steepbank Mine
	Northstar Energy	Northstar Energy	Northstar Energy
	SOLV-EX	SOLV-EX	SOLV-EX
	Municipalities	Municipalities	Municipalities
	Pulp mills for water quality	Pulp mills for water quality	Pulp mills for water quality
	Forestry	Forestry	Forestry
	Pipelines/roadways/others	Pipelines/roadways/others	Pipelines/roadways/others
APPROVED	**Suncor Steepbank Mine and Fixed Plant Expansion**	Suncor Steepbank Mine and Fixed Plant Expansion	Suncor Steepbank Mine and Fixed Plant Expansion
	Syncrude Mildred Lake Debottlenecking Phase 1/2	Syncrude Mildred Lake Debottlenecking Phase 1/2	Syncrude Mildred Lake Debottlenecking Phase 1/2
	Syncrude Aurora Mine	Syncrude Aurora Mine	Syncrude Aurora Mine
	Forestry	Forestry	Forestry
THE PROJECT		**Suncor Project Millennium - Upgrader and Mine**	Suncor Project Millennium - Upgrader and Mine
PLANNED			**Muskeg River Mine Project**
			Syncrude Project 21 Mildred Lake Upgrader Expansion
			Mobil Kearl Oil Sands Mine and Upgrader
			Shell Lease 13 East Mine
			Gulf Surmont - In-situ
			Petro-Canada MacKay River - In-situ
			JACOS Hangingstone - In-situ
			Fee Lot 2 Development
			Major pipelines, utility corridors and roadways
			Municipal Growth

The impact assessment scenarios included in the Project Millennium EIA included the following:

G1.5.1 Project Millennium Impact Assessment

The first scenario centers around the baseline conditions, which include the environmental and socio-economic conditions within the project region based on the existing and currently approved developments. The impacts associated with Project Millennium are considered in addition to the baseline conditions. Mitigation and monitoring programs are reviewed in detail under this scenario.

G1.5.2 Project Millennium Cumulative Effects Assessment

The second assessment scenario considers the potential impacts of Project Millennium as well as other oil sands developments that have advanced to the formal public disclosure stage or are known to be planned for the region. The cumulative effects assessment identifies and assesses likely environmental effects associated with Project Millennium and the planned developments on the existing and approved developments.

Consideration of mitigation and monitoring programs in the cumulative effects assessment is based on the programs employed by current operators as well as on such programs as proposed for Project Millennium. However, it is recognized that the operators of planned developments may propose and be subject to unique solutions and requirements, depending on circumstances specific to their developments.

G1.5.3 Impact Analyses Methodology

Impact analyses were performed for the key questions for each EIA component. The analyses address each link on the component linkage diagram. The impact analysis consists of four main steps:

- identification of activities that could contribute to environmental change;
- analysis of potential linkages;
- analysis and classification of impacts; and
- identification and description of mitigation measures and monitoring for potential residual impacts.

Validation of the link includes consideration of the mitigation measures. Mitigation, within the context of this EIA, is defined as follows: "the application of design, construction or scheduling principles to minimize or eliminate potential adverse impacts and, where possible, enhance environmental quality" (Sadar 1994). For certain activities, ongoing mitigation (e.g., operating practices changes) can minimize or eliminate physical or chemical stresses, thereby rendering invalid the link between Project Millennium activity and environmental changes.

If a link between a Project Millennium activity and an environmental change is considered valid, the key question under consideration is examined.

G1.5.4 Impact Description Criteria

Residual impacts for air, aquatics, terrestrial and human health components are classified using quantification criteria to determine environmental consequence. Each impact is first described in terms of the following criteria: direction, magnitude, geographic extent, duration, reversibility and frequency (including seasonal effects).

There will always be some uncertainty associated with the information and methods used in an EIA because of its predictive nature. The certainty with which an impact analysis can be completed depends on a number of factors including:

- understanding of natural/ecological processes at work now and in the future; and
- understanding of present and future properties of the KIR affected.

The level of uncertainty for an impact analysis will be discussed when there are questions about the factors reviewed above. Where the level of uncertainty makes a prediction of the impact problematic, a subjective assessment is made based on the available information, the applicability of information on surrogates and on professional opinion.

G1.5.5 Environmental Consequence and Significance

Environmental consequence is an overall property associated with an impact and is a function of direction, magnitude, duration, frequency, geographic extent, and reversibility.

The Canadian Environmental Assessment Act (CEAA) requires an assessment to determine if a proposed project is likely to result in significant adverse impacts after mitigation measures have been applied. Residual impacts that are of negligible or low environmental consequence are all considered to be not significant. Residual impacts that are of moderate or high environment consequence are further evaluated for significance. In addition to applying the "significance" definitions listed above, this evaluation considers: a) the probability of occurrence of the impacts; b) the probability that the magnitude of the impacts will be as predicted; and c) the effect of those impacts from a regional perspective. Based on this qualitative environmental risk assessment, the significance of the impact is then rated.

G2 COMPONENT-SPECIFIC RESULTS OF THE EIA

G2.1 Air Quality

G2.1.1 Introduction

Project Millennium has been designed to mitigate air quality impacts through:

- continuing use of the Flue Gas Desulphurization (FGD) plant to reduce SO_2 and particulate emissions associated with coke combustion;
- installation of a flare gas recovery project (scheduled for completion in 1999);
- meeting additional energy requirements for the Project by waste heat recovery from the Millennium Upgrader and by natural gas fired turbine generators with attached heat recovery steam generators;
- recompression of gases currently being continuously flared, for treatment and use in the planned flare gas recovery project;
- installation of two Claus sulphur recovery trains with a downstream tail gas treatment unit for the Millennium Upgrader;
- use of low-NO_x burners for new plant equipment;
- use of mine fleet vehicles with improved emission control technology;
- improvement in the quality of diesel fuels used for mine fleet vehicles;
- implementation of a site-wide NO_x management plan;
- tie-in of any new diluted bitumen and diluent tanks to the Vapour Recovery System;
- installation of a new larger vacuum column and upgrading of the overhead circuit in the Naphtha Recovery Unit (NRU) to handle the new rates with a minimum diluent recovery of 99.3%;
- modification of the diluent (e.g., narrower boiling range, and less benzene and light ends) for use in secondary extraction to improve recovery in the NRU and reduce volatile organic compound (VOC) emissions from diluent;
- watering of roads and active areas of the coke pile during warm weather periods to suppress dust;
- participating in a regional ground-level ozone modelling program;
- managing greenhouse gas emissions on a corporate basis through implementation of a seven-point plan; and
- maintaining its active role in the Regional Air Quality Coordinating Committee (RAQCC) to:
  - further understanding of the relationship between acid loading and environmental sensitivity, and

- use data collected by the enhanced air quality monitoring network to: protect human health, vegetation and wildlife; examine soil and water acidification; and minimize odours in the region over the long term.

The air quality impact assessment predicted the incremental effects of the Project on top of existing and approved oil sands operations. The assessment considered the issues, as addressed through the key question approach in Section B3 of the EIA. The issues and environmental consequences are summarized in Table G2.1-1.

Table G2.1-1 Air Quality Issues and Environmental Consequences

Issue	Environmental Consequence
Impacts of Project emissions on ambient air quality. Includes prediction of air quality concentrations for SO_2, NO_2, CO, PM, VOC and TRS.	Low to Moderate (depending on parameter)
Impacts of Project emissions on deposition of acid-forming compounds. Includes modelling of NO_x and SO_2 emissions.	Evaluated in Water Quality, Soils and Terrestrial Vegetation and Wetlands sections
Impacts of Project emissions on concentrations of ground level ozone	Undetermined
Noise from the Project	Negligible

G2.1.2 Impact Assessment

Ambient Air Quality Concentrations

The Project, in combination with existing and approved developments in the study area, will result in changes to ambient air quality concentrations as reviewed below for the compounds of interest.

Sulphur Dioxide (SO_2)

The ISC3BE model was used to predict SO_2 concentrations resulting from the Project. The model provides predicted maximum concentrations, areal extent of land above the Alberta Guideline, number of exceedances and the location of the high readings. In comparing the results to historical levels, there has been a substantial decrease in concentrations and emissions. The model results indicate:

- The predicted impacts of hourly SO_2 emissions and concentrations on the air quality are classified as moderate in magnitude, short-term in duration, moderate in frequency, regional in geographic extent and reversible. The environmental consequence of these impacts was rated as low.
- The predicted impacts of daily SO_2 emissions and concentrations on the air quality are classified as moderate in magnitude, short-term in duration, moderate in frequency, local in geographic extent and reversible. The environmental consequence of these impacts was rated as low.

- The predicted impacts of annual SO_2 emissions and concentrations on the air quality are classified as high in magnitude, mid-term in duration, high in frequency, local in geographic extent and reversible. The environmental consequence of these impacts was rated as moderate.

Impacts to the annual SO_2 concentrations were assigned a moderate environmental consequence. The maximum annual concentration plus the areal extent are all within existing operations. There are no exceedances projected outside of the development areas. Outside of the Suncor and Syncrude lease boundaries, the maximum annual concentrations are predicted to be approximately 20 $\mu g/m^3$ and therefore below the annual Alberta Guideline of 30 $\mu g/m^3$. The concentrations from the Project at Fort McKay are predicted to be between 5 and 10 $\mu g/m^3$, while those at Fort McMurray are predicted to be less than 5 $\mu g/m^3$. Viewed in this context, it is predicted that there would be no exceedances outside of the lease areas and that the concentrations in the rest of the RSA will be low. Hence the environmental risk is considered to be low and, therefore this impact is not significant.

Nitrogen Dioxide (NO_2)

The ISC3BE model was used to predict NO_2 concentrations resulting from the Project Millennium case. The model results indicate:

- The predicted impacts of hourly NO_2 concentrations on the air quality are classified as low in magnitude, short-term in duration, low in frequency, local in geographic extent and reversible. The environmental consequence of these impacts was rated as low.
- The predicted impacts of daily NO_2 concentrations on the air quality are classified as high in magnitude, short-term in duration, moderate in frequency, local in geographic extent and reversible. The environmental consequence of these impacts was rated as moderate.
- The predicted impacts of annual NO_2 concentrations on the air quality are classified as high in magnitude, mid-term in duration, high in frequency, local in geographic extent and reversible. The environmental consequence of these impacts was rated as moderate.

Impacts to the daily and annual NO_2 concentrations were assigned a moderate environmental consequence. The maximum daily concentration plus the areal extent are all within a small area within the existing operations. There are no exceedances projected outside of the development areas. Daily concentrations are predicted to be well below 100 $\mu g/m^3$ at Fort McKay and Fort McMurray. The maximum annual concentration plus the areal extent are also centered in the existing operational area but occupy a larger area. There are no exceedances predicted outside the development areas. Annual concentrations at both Fort McKay and Fort McMurray are predicted to be between 20 and 40 $\mu g/m^3$. Viewed in this context of low concentrations outside the mine pits, the environmental consequence of the NO_2 emissions is rated as being of no significance.

Carbon Monoxide (CO)

The ISC3BE model was used to predict CO concentrations resulting from the Project. The model results indicate:

- The predicted impacts of hourly CO emissions and concentrations on the air quality are classified as low in magnitude, short-term in duration, low in frequency, local in geographic extent and reversible. The environmental consequence of these impacts was rated as low.
- The predicted impacts of 8-hour CO emissions and concentrations on the air quality are classified as low in magnitude, short-term in duration, low in frequency, local in geographic extent and reversible. The environmental consequence of these impacts was rated as low.

Particulate Matter (PM)

The ISC3BE model was used to predict PM concentrations resulting from the Project Millennium case. The model results indicate:

- The predicted impacts of daily PM concentrations on the air quality are classified as moderate in magnitude, short-term in duration, moderate in frequency, local in geographic extent and reversible. The environmental consequence of these impacts was rated as low.
- The predicted impacts of annual PM concentrations on the air quality are classified as low in magnitude, short-term in duration, low in frequency, local in geographic extent and reversible. The environmental consequence of these impacts is negligible.

Volatile Organic Compounds (VOC)

The impacts related to VOC emissions are evaluated under the Human Health section of the EIA (Section F1).

Total Reduced Sulphur (TRS)

The ISC3BE model was used to predict TRS concentrations resulting from the Project. The model results indicate:

- The predicted impacts of hourly TRS concentrations on the air quality are classified as high in magnitude, short-term in duration, moderate in frequency, local in geographic extent and reversible. The environmental consequence of these impacts was rated as moderate.
- The predicted impacts of daily TRS concentrations on the air quality are classified as high in magnitude, short-term in duration, moderate in frequency, regional in geographic extent and reversible. The environmental consequence of these impacts was rated as moderate.

Impacts to the hourly and daily TRS concentrations were assigned a moderate environmental consequence based on the assumption that the TRS emissions will be increasing in proportion to the increasing VOC emissions from the ponds. This modelling assumption overestimates TRS because the TRS emission from the ponds are believed to be biogenic in nature. Therefore, it is more probable that there will be no significant increase in the TRS releases from the existing Baseline rates. Both Suncor and Syncrude have ongoing abatement programs in place. Over the past few years, there has been a decrease in the number of odor complaints from over 275 to less than 20 per year. The annual concentrations of H_2S at Fort McKay and Fort McMurray are predicted to be below the Alberta guideline. In fact, the model using the high emission rates predicts the daily concentration will not exceed the Alberta guideline outside the development areas. Viewed in the context of low concentrations outside the existing operational areas, the potential of no net increase in emission rates, and the decrease of off-site odour complaints, the impact of TRS emissions is not considered to be significant.

Acid-Forming Compounds (NO_x and SO_2)

The CALPUFF model was used for predicting the PAI resulting from the Project. The CALPUFF model is a good tool for estimating the PAI in the Oil Sands Region as it takes into account the chemical transformations of the emitted SO_2 and NO_x and predicts wet (rain and snow scavenged) and dry (via an effective dry deposition velocity) deposition of SO_2, SO_4^{2-} , NO, NO_2, NO_3^- and HNO_3. A background PAI of 0.1 keq/ha/y has been incorporated into the presented PAI numbers. This value was based on estimates of sulphur and nitrogen and base cation concentrations and depositions in the region surrounding the RSA. Comparisons of emissions and concentrations are discussed below:

- The predicted PAI exceeds the Alberta interim critical loading for sensitive soils (0.25 keq/ha/y) over an area of 861,263 ha (35.5% of the RSA). The areal extents where the PAI exceeds the critical loadings being considered for less sensitive soils are: 195,695 ha (8.1% of the RSA) above 0.50 keq/ha/y; and 9,598 ha (0.4% of the RSA) above 1.0 keq/ha/y.
- The maximum predicted PAI of 2.13 keq/ha/y occurs in the development area, in the immediate vicinity of the open pit mines.
- The maximum predicted sulphate deposition rate of 1.15 keq/ha/y is predicted to occur in the active plant area.
- The highest predicted deposition rate of nitrates (1.01 keq/ha/y) occurs in the development area, adjacent to the open pit mines.
- The maximum wet and dry deposition rates (including both the sulphate and nitrate species) are 0.78 and 1.81 keq/ha/y, respectively. These maximums occur in the vicinity of the active open pit mines.

No impact predictions and environmental consequences have been established for PAI in the air section as PAI is used as an input into the water quality, soils, and terrestrial vegetation and wetlands evaluations. These are presented in Sections C3.2, D2.2 and D3.2, respectively.

Ground Level Ozone

The impact of Project emissions on concentrations of ground level ozone was not evaluated as part of the EIA because of the known inaccuracy of the model (SMOG) previously used for oil sands developments. Suncor is participating in a joint industry and government working group to research and assess ground level ozone issues in the oil sands region. This project includes development of a new modelling framework for ground level ozone in the region. The initial results of this new model are expected in October 1998.

The magnitude of impacts associated the Project contribution to ground level ozone cannot be determined prior to completion of the new modelling program. Therefore, the environmental consequence was rated as undetermined.

Noise

Operation of an open pit oil sands mine and associated extraction and upgrading equipment produces noise. The impact of this noise on residents in surrounding communities was assessed with consideration of the location of Fort McKay, the nearest community, and the locations of other operations relative to the Project and to Fort McKay.

The relative distance of the Project from Fort McKay means that contributions to noise levels in Fort McKay from the Project are predicted to be negligible. Current contributions from Suncor operations will be modified once the mining operation on Lease 86/17 is closed down and replaced by Project Millennium operations (which are located further from Fort McKay).

The predicted impact of noise from Project Millennium is classified as negligible in magnitude, high in frequency and of regional geographic extent. The impact ceases upon closure. The relatively large distance from the Project to Fort McKay means the impacts of noise related to the Project are negligible. The environmental consequence was rated as negligible.

G2.1.3 Cumulative Effects Assessment

The air emissions from Project Millennium, combined with those from all of the approved and disclosed projects in the CEA region will result in changes in the ambient air quality and in the deposition of acid forming compounds. Compounds of interest are reviewed individually below.

Sulphur Dioxide (SO_2)

The ISC3BE model was used to predict the SO_2 concentrations resulting from the Project and CEA facilities. The predicted cumulative impacts of hourly, daily and annual SO_2 emissions and concentrations are very similar to Project Millennium. The hourly and daily SO_2 concentrations are considered to be reversible, of moderate magnitude, short term in duration, moderate in frequency and regional in geographic extent. The environmental consequence of these impacts is low.

The annual SO_2 concentrations were classified as having a high magnitude, moderate duration, high frequency, reversible effect and local in geographic extent. The resulting environmental consequence of these impacts is moderate.

The moderate environmental consequence assigned to the annual SO_2 concentrations was determined on areal extents and maximum concentrations which occur within the development areas of existing operations. There are no exceedances projected outside of the development areas. Outside of the Suncor and Syncrude lease boundaries the maximum annual concentrations are predicted to be below the annual Alberta Guideline of 30 $\mu g/m^3$. Viewed in this context, the environmental risk is considered to be low and, therefore, this impact is not significant.

Nitrogen Dioxide (NO_2)

The ISC3BE model was used to predict NO_2 concentrations resulting from the combined Project and CEA emission sources. The predicted hourly NO_2 concentrations are classified as having impacts on the air quality which are low in magnitude, short term in duration, low in frequency, local in geographic extent and reversible. The environmental consequence of these impacts is low.

The predicted daily NO_2 concentrations were classified as having air quality impacts which are described as high in magnitude, short term in duration, moderate in frequency, local in geographic extent and reversible. The environmental consequence of these impacts is moderate.

Impacts based on the predicted annual NO_2 concentrations are classified as high in magnitude, mid term in duration, high in frequency, local in geographic extent and reversible. The environmental consequence of these impacts is moderate.

Impacts to the daily and annual NO_2 concentrations were assigned a moderate environmental consequence. The maximum daily concentration plus the areal extent are confined to a small area within the existing operations. There are no exceedances projected outside of the development areas. The maximum annual concentration plus the areal extent are also centered in the existing operational area but occupy a larger area. There are no exceedances predicted outside the development areas. Viewed in this context, the environmental consequence of the NO_2 emissions is rated as low and, therefore, this impact is not significant.

Carbon Monoxide (CO)

The hourly and 8-hour CO concentrations resulting from the CEA emission sources were predicted using the ISC3BE dispersion model. The impacts of both the hourly and 8-hour CO concentrations are classified as having impacts that are low in magnitude, short term in duration, low in frequency, local in geographic extent and reversible. The resulting environmental consequence of these impacts is low.

Particulate Matter (PM)

The ISC3BE model was used to predict daily and annual PM concentrations resulting from the CEA emission sources. The predicted impacts of the daily concentrations are classified as moderate in magnitude, short term in duration, moderate in frequency, local in geographic extent and reversible. The predicted impacts of annual PM emissions and concentrations on the air quality are classified as low in magnitude, short term in duration, low in frequency, local in geographic extent and reversible. The environmental consequence of both these sets of impacts is low.

Volatile Organic Components (VOC)

The ISC3BE model was used to predict VOC concentrations resulting from the CEA case. No impact predictions and environmental consequences have been established for VOCs (and the speciated VOCs) in the air section as VOCs are an input into the health section (F1).

Total Reduced Sulphur (TRS)

The ISC3BE model was used to predict TRS concentrations resulting from the CEA case. The major source of TRS was assumed to be the Suncor ponds, with the TRS emissions increasing in proportion to the increase in VOCs. This may result in an overestimate of TRS emissions.

The predicted impacts of hourly TRS concentrations on the air quality are classified as high in magnitude, short term in duration, moderate in frequency, regional in geographic extent and reversible. The environmental consequence of these impacts is moderate.

The predicted impacts of daily TRS concentrations on the air quality are classified as high in magnitude, mid term in duration, high in frequency, local in geographic extent and reversible. The environmental consequence of these impacts is moderate.

Impacts to the hourly and daily TRS concentrations were assigned a moderate environmental consequence based on the assumption that the TRS emissions will be increasing in proportion to the increasing VOC emissions from the ponds. The assumption may have been conservative, as it may be just as likely that there will be no significant increase in the TRS releases from the existing Baseline rates. TRS emissions are principally a concern for causing odours, and both Suncor and Syncrude have ongoing abatement programs in place. Over the past few years, there has been a decrease in the number of odour complaints from over 275 to less than 20 per year. Viewed in the context of low concentrations outside the existing operational areas, the potential of no net increase in emission rates, and the nuisance nature of off-site odours, the environmental consequence of the TRS emissions is rated as low and, therefore, this impact is not significant.

Acid-Forming Compounds

The CALPUFF model was used for predicting the deposition of acid forming compounds (measured as PAI) resulting from the CEA emission sources. The CALPUFF model takes into account the chemical transformations of the emitted SO_2 and NO_x and predicts both wet and dry deposition of SO_2, SO_4^{2-}, NO, NO_2, NO_3^- and HNO_3. Comparisons of emissions and concentrations are discussed below:

- The predicted PAI exceeds the Alberta interim critical loading for sensitive soils (0.25 keq/ha/y) over an area of 1,417,300 ha (58.4% of the RSA). The areal extents where the PAI exceeds the critical loadings being considered for less sensitive soils are: 420,086 ha (17.3% of the RSA) above 0.50 keq/ha/y; and 20,430 ha (0.8% of the RSA) above 1.0 keq/ha/y.
- The maximum predicted PAI of 2.1 keq/ha/y occurs in the development area, in the immediate vicinity of the open pit mines.
- The maximum predicted sulphate deposition rate of 1.13 keq/ha/y is predicted to occur in the active plant area.
- The highest predicted nitrate deposition rate of 1.1 keq/ha/y is predicted to occur in the development area, adjacent to the open pit mines.

No impact predictions and environmental consequences have been established for PAI in the air section as PAI is used as an input into the water quality, soils and terrain, and terrestrial vegetation and wetlands evaluations. These are presented in Sections C3.2, D2.2 and D3.2, respectively.

G2.1.4 Monitoring

Air quality monitoring programs will include:

- continued routine source monitoring of approved major air emission sources on a continuous basis as well as smaller sources on a more limited basis (as per the operating approval requirements);
- continued participation in the Air Monitoring System operated by the Wood Buffalo Environmental Association;
- continued participation in the Terrestrial Environmental Effects Monitoring Committee to evaluate changes in vegetation and soils resulting from air emissions; and
- continued participation in the Alberta Oil Sands Community Exposure and Health Effects Assessment Program.

G2.2 Aquatics

G2.2.1 Surface Hydrology and Hydrogeology

Introduction

Project Millennium has been designed to mitigate to the extent possible, the impacts on surface hydrology and hydrogeology expected for an open pit mining operation. The Project includes design considerations to:

- divert natural surface waters from the mining operation area;
- dewater groundwater areas impacted by the mine operation, with diversion to the interception drainage system for discharge or containment in the process water recycle system;
- maintain flows to Shipyard Lake during the mining operations, with incorporation of a self-sustaining drainage stream to provide flows to this wetlands on Project closure; and
- re-establish self-sustaining surface hydrology systems on the closure landscape.

The surface hydrology and hydrogeology impact assessment predicted the incremental effects of the Project on top of existing and approved oil sands operations. The assessment considered the issues, as addressed through the key question approach in Section C2.2 of the EIA. The issues and environmental consequences are summarized in Table G2.2-1.

Table G2.2-1 Surface Hydrology and Hydrogeology Issues and Environmental Consequences

Issue	Environmental Consequence
Groundwater levels (volumes), flow patterns and quality	Low
Groundwater impacts to flow and water levels in receiving streams, lakes, ponds and wetlands	Low
Water balance for open water areas of lakes, ponds, wetlands and streams	Negligible to Low
Sediment yields from project area river and stream basins, sediment concentrations in receiving streams and the channel regime of receiving streams	Negligible
Sustainability of closure landscape drainage systems	Low

The results of the assessment are summarized below for hydrogeology (groundwater), surface hydrology and closure drainage systems.

Hydrogeology

The following activities have been evaluated with regard to their impacts on the direction of groundwater flow, the rate of groundwater discharge and the quality of groundwater:

- changes to current groundwater regimes, including:
  - dewatering of the surficial deposits up-gradient of the mine,
  - lowering of the hydraulic head in the bedrock aquifers during mining, and
  - placement of consolidated tailings (CT) in the pits to reclaim the mine;
- changes to groundwater quality, including:
  - seepage from Tailings Pond 8A, and
  - seepage from the end pit lake.

The groundwater from the surficial deposits is expected to be diverted to Shipyard Lake and the Athabasca River, via Unnamed Creek and McLean Creek. The rate of this groundwater discharge is less than 0.01% of the minimum monthly flow in the Athabasca River, 1% of the minimum monthly flow in the Steepbank River and less than 3% of the average monthly flow in Shipyard Lake. The magnitude of these impacts is low; duration is short-term; geographic extent is local and impacts are irreversible. Therefore, the environmental consequence is low.

The porewater from CT is expected to seep through the bedrock aquifers, and discharge to the Athabasca River, Steepbank River and Shipyard Lake. The quality of the CT porewater is very similar to the natural quality of groundwater in the bedrock aquifers. The CT contains essentially the same organic compounds as the groundwater, although at slightly higher concentrations. Seepage from Pond 8A will be collected during operations and used in process. In the Far Future, following decommissioning and reclamation of the pond, seepage from this sand and overburden area will be about 10 L/s to the Athabasca River and end pit lake. In terms of groundwater flow, the magnitude of the changes is low. The frequency is high, while the geographic extent is local and irreversible. Therefore, the environmental consequence is low. In terms of groundwater quality, the magnitude for the impact is low; duration is long-term; geographic extent is local and the impacts are irreversible. Therefore, the environmental consequence is low.

Hydrology

Annual flows in Unnamed Creek downstream of the interception drainage system will increase. Flood peaks and the timing of flood flows are not expected to change. With the mitigation measures in place, there will be negligible environmental consequence to the water balance or levels of the Shipyard Lake wetlands.

Leggett Creek and Wood Creek will be eliminated in the development area and flows reduced to nil. The impact on both creeks is considered to be high in magnitude, local in extent and long-term. Other impacts of these changes to the creeks are discussed in Section C4, Fisheries and Fish Habitat.

Annual and flood flows in McLean Creek downstream of the interception drainage system will increase. The timing of flood flows is not expected to change. The impact on McLean Creek is considered to be high in magnitude, local in extent and short-term. The impact on Athabasca River is negligible. Other impacts of these effects are discussed in Section C4, Fisheries and Fish Habitat.

The mitigation measures employed in Project Millennium will control the sediment released from the east bank mine area to levels compatible with the receiving watercourses.

The change in mean annual flow to the Athabasca River for various times in the mine life cycle from both surface water and groundwater sources by basin and year is negligible to low. The maximum change in flow is less than 0.02 % throughout the life of the Project.

Low flows from surface water in the local study area are estimated to be zero for all periods greater than the 1 in 10 year drought. Groundwater discharges will likely remain at baseline levels.

These flow and sediment impacts are low in magnitude, local in geographic extent, long-term and irreversible. Therefore, the environmental consequence is negligible. The overall impacts due to changes in surface hydrology and hydrogeology are not significant.

Closure Drainage Systems

There is uncertainty on the ultimate success of the various reclamation and closure activities integral to re-establishment of the groundwaters and surface hydrology. This uncertainty means there is a low rather than negligible environmental consequence associated with the expected level of sustainability for closure landscape drainage systems. The planned monitoring programs on groundwater and surface water systems, as well as studies to verify designs for reclamation drainage systems will reduce the scientific uncertainty.

Monitoring

Suncor will continue operational monitoring programs to confirm predicted impacts to groundwater and surface water systems. These programs will monitor groundwater levels and quality, as well as flows and quality in surface drainage systems.

The riparian wetlands, Shipyard Lake, will be monitored throughout the operations of the Project to ensure that adequate supplies of water are maintained. The reclamation surface drainage systems will ensure that a self-sustaining system for provision of these waters is established as part of the Project closure plan.

G2.2.2 Surface Water Quality

Project Millennium has been designed to mitigate water quality impacts through:

- use of an interceptor ditch around the tailings pond to capture seepages;
- operating sedimentation ponds to polish muskeg dewatering flows (and equilibrate temperatures);
- directing CT surface flows exclusively into the end pit lake (EPL);
- developing wetlands systems to provide retention and bioremediation of process-affected waters; and
- initially directing the release of EPL water to the Athabasca River, rather than to McLean Creek.

In addition to the above features, existing discharges from the plant upgrader will be reduced by at least 50% to the Athabasca River by the year 2000.

The water quality impact assessment predicted the incremental effects of the Project on top of existing and approved oil sands operations. The assessment considered the issues, as addressed through the key question approach in Section C3.2 of the EIA. The issues and environmental consequences are summarized in Table G2.2-2.

Table G2.2-2 Water Quality Issues and Environmental Consequences

Issue	Environmental Consequence
Toxicity and water quality in the Athabasca River, McLean Creek and the Shipyard Lake wetlands	Low to Moderate
Thermal regime of McLean Creek and the Shipyard Lake wetlands	Negligible to Low
Dissolved oxygen levels in McLean Creek and the Shipyard Lake wetlands	Negligible
Accumulation of polycyclic aromatic hydrocarbons (PAHs) in sediments in the Athabasca River	Low
Toxicity in the EPL water prior to it flowing to the Athabasca River	Low
Water quality resulting from acidifying emissions	Low

Impact Assessment

Maintenance of Water Quality Guidelines

The Project, in combination with existing and approved developments in the study area, will not cause exceedances of acute or chronic toxicity guidelines for aquatic life. A number of metals exceed water quality guidelines in the Athabasca River naturally and the Project would not contribute an appreciable, additional load of these metals. These metals are not considered to be of concern, because they are largely associated with suspended particulate matter and are thus not in a bioavailable form.

Exceedance of the human health water quality guideline for benzo(a)anthracene may occur in the Athabasca River downstream of the Muskeg River due to the incremental contribution of the Project and approved, but not yet developed oil sands operations in the Muskeg River basin. This exceedance is primarily related to the initial discharges from EPLs. It is expected that continued examination of this issue will demonstrate that this hydrophobic compound will precipitate out or be bioremediated in EPLs and wetlands before reaching any receiving streams. Follow-up human health risk analysis rejected this compound as being of concern to wildlife and human health.

A similar pattern of background exceedances for metals occurs in McLean Creek, which receives muskeg dewatering flows during operation. No other mine related flows reach the creek during operation. McLean Creek will not be impacted by reclamation seepages. The exceedances projected are due solely to natural Basal and surficial aquifer waters and muskeg drainage waters. No acute or chronic toxicity will occur. The EPL discharge would only be directed to McLean Creek once it was of acceptable quality. Finally, McLean Creek is an intermittent stream that has no flow in the winter and will occasionally dry up in the summer. Viewed in this context, it is arguable whether the Project could decrease the current integrity of McLean Creek, regardless of the conclusions of conservative water quality modelling. This impact would be of moderate environmental consequence. However, the environmental risk to McLean Creek posed by the Project is considered to be low and, therefore, this effect is not considered significant.

Although limited baseline water chemistry data are available for the Shipyard Lake wetlands, worst-case projections can be made. These wetlands will be largely protected from the influence of Project-related flows by directing reclamation landscape flows to the EPL during periods of CT flux. Other than natural flows, the only mine-related flows that would reach this waterbody would be from muskeg dewatering. Therefore, the residual impact has been classified as of low environmental consequence.

Thermal Regime

Temperature changes in McLean Creek and Shipyard Lake, as a result of changing flow regimes, would remain within acceptable ranges. Uncertainty regarding the conservative analysis for McLean Creek indicates that temperature monitoring should be conducted in this stream under baseline conditions and during the life of the Project. A lower frequency of temperature monitoring will also be carried out in Shipyard Lake to verify impact predictions. If monitoring indicates a potential problem, the temperature of muskeg drainage waters entering small streams would be equilibrated with the receiving stream temperature by increasing the retention times of sedimentation ponds.

The residual impact of thermal regime impacts has been classified as negligible to low environmental consequence because of the negligible or low magnitude of the potential impacts.

Dissolved Oxygen

Dissolved oxygen impacts from muskeg drainage waters are not expected to occur. Suncor will follow expected regulatory requirements to develop a monitoring program. If monitoring of dissolved oxygen levels indicates a potential problem, oxygen levels would be controlled in muskeg drainage waters. The magnitude of impacts associated with dissolved oxygen is negligible. Therefore, the environmental consequence is negligible

Polycyclic Aromatic Hydrocarbons (PAHs)

Concentrations of the benzo(a)anthracene group were conservatively predicted to exceed the human health water quality guideline in the Athabasca River, downstream of the confluence of the Muskeg River. This is due to the incremental contribution of the Project and approved, but not yet developed oil sands operations in the Muskeg River basin. The accumulation of PAHs in sediments and their subsequent transport in the Athabasca River is not expected to increase because of limited available pathways for PAHs to be released from the Project area. It is anticipated that continuing examination of this issue will demonstrate that this exceedance would not occur because hydrophobic compounds will precipitate out, or be bioremediated in EPLs and wetlands before reaching receiving streams. In any case, conservative health risk analyses rejected this compound as being of concern to wildlife and human health.

The predicted impact of PAH releases is classified as negligible in magnitude, high in frequency and of regional geographic extent. Therefore, the environmental consequence is low.

End Pit Lake

Strategic design and management of the EPL will enable acute and chronic toxicity guidelines to be achieved before the outflow reaches the receiving stream. If continued wetlands monitoring and research demonstrates that remediation is as effective as currently indicated, Suncor will apply to AEP to redirect the outflow to McLean Creek. Notwithstanding the ability to strategically design and manage the EPL, Suncor recognizes there are a number of potential issues that require resolution and further evaluation. Suncor is committed to participate in research to ensure that the EPL meets regulatory and stakeholder end-use goals. Suncor is also committed to exploring alternatives to the EPL. Since these are issues facing all oil sands operators, they are best addressed in a coordinated effort.

Predicted impacts of the EPL water quality are classified as low in magnitude and local in geographic extent. The environmental consequence of these impacts is low because of the uncertainties associated with the EPL.

Acidification

Acidification of waterbodies as a result of air emissions is unlikely, though questions remain about possible spring pH depression in rivers and acidification of a small number of sensitive lakes in the RSA. The Fort McMurray oil sands area is subject to a higher than background rate of sulphate deposition, which has not been attributed to specific sources. However, despite the higher deposition rate, there is no evidence of anthropogenic acidification of lakes in this area, or in the province of Alberta.

There are no acid-sensitive lakes in the Aquatics LSA, and to date, fewer than ten lakes have been designated acid-sensitive within the RSA. These lakes are located just east of the oil sands area and to the northwest, in the Birch Mountains uplands.

Running waters may be sensitive to acidification during the spring, when runoff from rapid snow-melt may quickly reach streams by travelling over frozen ground. Based on its water chemistry and large dilution capacity, the Athabasca River is not sensitive to spring acid pulses, but there are a number of known acid-sensitive rivers in the RSA. The Firebag, Steepbank and Muskeg rivers have been designated as acid-sensitive. Since some relatively large tributaries of the Athabasca River are susceptible to spring acid pulses, small streams in the region are also potentially acid-sensitive.

Predicted Potential Acid Input associated with Project Millennium and existing and approved oil sands operations exceeds the interim critical load of 0.25 keq/ha/y for highly sensitive environments in an approximately 90 x 150 km area. Since most lakes in the region are not sensitive to acidification, it is unlikely that oil sands operations would cause large-scale acidification in surface waters. However, modelling suggests that the potential exists for acidification of a small number of lakes in the RSA. Additionally, even in the absence of a large number of acid-sensitive lakes in the RSA, long-term effects of acid deposition remain a concern in the oil sands area.

In summary, acid deposition from oil sands operations is not expected to cause large-scale acidification of lakes in the RSA, but sensitive lakes may be at risk. Changes in the occurrence and severity of spring pH depression in rivers cannot be evaluated using the available information, but also cannot be ruled out.

The impact of acidification of lakes is classified as low in magnitude, long-term in duration and regional in geographic extent. The environmental consequence of the impact is low because of the reversibility and uncertainty of the potential impacts.

Monitoring

Monitoring programs will include:

- participation in the Regional Aquatic Monitoring Program (RAMP);

- evaluation of the potential for muskeg drainage waters to cause declines in dissolved oxygen levels in receiving streams and sedimentation ponds;
- monitoring of thermal regimes for McLean Creek and Shipyard Lake;
- monitoring, on an intensive, short-term basis during the critical snowmelt period to evaluate the sensitivity of selected rivers and streams to spring acid pulses; and
- monitoring the end pit lake, once established, for PAHs and other constituents.

G2.2.3 Fisheries and Fish Habitat

Introduction

Project Millennium has been designed to mitigate fisheries and fish habitat impacts through:

- avoidance of habitat impacts in the Athabasca River;
- avoidance of impacts in the Steepbank River (minimal disturbance of watershed, 100 m setback from the escarpment, mitigation to prevent sedimentation);
- recycling of all process-affected waters throughout construction and operation of the Project;
- using water retention structures to regulate flows and control sediment in muskeg drainage and other water diversions;
- implementing measures to minimize water quality impacts (as detailed in Section C3.3;
- using tailings release waters and other process-affected water for operational waters, to reduce raw water withdrawal from the Athabasca River;
- distributing muskeg drainage and overburden dewatering evenly throughout the life of the mine to avoid a large increase in flows to receiving streams;
- developing a sustainable closure landscape and drainage systems by:
  - vegetating reclaimed surfaces to minimize surface erosion,
  - building drainage networks and regime channels to minimize gully and channel erosion,
  - constructing wetlands and lakes to reduce flood peak discharges and sediment loadings to receiving streams; and
- developing wetlands systems on the reclaimed CT deposit areas, the reclaimed tailings pond area as well as in conjunction with reclamation drainage systems to provide retention and bioremediation of operational and reclamation waters.

Design features for preventing or minimizing sediment loading, changes in dissolved oxygen, water temperature fluctuations and water quality changes will minimize effects on fisheries and fish habitat. Effects on critical sports fish habitat will be avoided by setting Project Millennium facilities back at least 100 m from the Athabasca and Steepbank rivers.

The fisheries and fish habitat impact assessment predicted the incremental effects of the Project on top of existing and approved oil sands operations. The assessment considered the issues, as addressed through the key question approach in Section C4.2 of the EIA. The issues and environmental consequences are summarized in Table G2.2-3.

Table G2.2-3 Fisheries and Fish Habitat Issues and Environmental Consequences

Issue	Environmental Consequence
Fish habitat	Negligible
Levels of acute or chronic toxicity to fish	Negligible
Fish abundance	Negligible
Fish tissue quality	Negligible
Aquatic ecosystems in reclamation streams, wetlands and the end pit lake	Undetermined

Impact Assessment

Fish Habitat

No effects on fish or fish habitat in the Steepbank River are expected from Project Millennium. The Project occupies a very small portion of the Steepbank River watershed and will not affect the hydrology of this river. Overburden dumps and Pit 1 are located just south of the Steepbank River. However, erosion protection will be put in place to prevent sedimentation and the area will be reclaimed rapidly. There will be a minimum 100 m setback of all mining activities from the Steepbank River escarpment.

Fish habitat in the Athabasca River will not be affected by Project Millennium. Very small changes in flow will occur in the Athabasca River, which are not expected to influence fish habitat. All project facilities located near the Athabasca River will be placed above the 1-in-100 year floodline. As well, erosion protection will be put in place to prevent sediment from entering the river.

No impacts on northern pike and forage fish habitat in Shipyard Lake are predicted. Suncor will monitor water quality and quantity in Shipyard Lake and adjust the inflows to the lake to maintain fish habitat.

McLean Creek will receive increased flows from diversion of the upper catchment of Wood Creek, as well as waters from muskeg and overburden dewatering operations. However, mitigation such as water retention structures and creek stabilization procedures will be incorporated into the project design to prevent impacts to fish habitat in this creek. Hence, no impacts on forage fish or Arctic grayling habitat in McLean Creek are expected to result from the Project. Suncor will monitor habitat in McLean Creek and implement additional mitigation if necessary.

Two small Athabasca River tributaries, Leggett and Wood creeks, will be lost due to Project Millennium. This will result in about 1.2 ha of fish habitat loss since the lower portions of these creeks (below the escarpment) are used by fish from the Athabasca River. The habitat in these creeks is used by forage fish, juvenile mountain whitefish and possibly Arctic grayling. Suncor is committed to a fish habitat compensation program. Fish habitat lost will be replaced and monitored to ensure that the "no net loss" objective is achieved.

Therefore, the environmental consequences of impacts of the Project on fish habitat was assessed as negligible because of no net loss of fish habitat.

Acute and Chronic Effects on Fish

Water quality modelling indicates that no toxic effects on fish or other aquatic organisms will result from Project Millennium because modelled concentrations of acute and chronic toxicity are less than guidelines for the protection of aquatic life. These results are based on recent laboratory testing of CT water toxicity, which included different levels of the aquatic food chain: bacteria, algae, invertebrates and fish. These tests have provided information on growth and survival of fish exposed to CT water. Other aspects of CT effects on fish health (e.g., disease resistance, embryo survival) have not been examined. However, it is assumed that the acute and chronic toxicity tests are adequate predictors of effects on fish health parameters. This assumption was shown to be valid for TID seepage waters, which have comparable characteristics. Suncor plans to conduct further studies on the effect of CT water on fish health to confirm this assumption. The studies will be conducted in Fort McMurray, and will include exposure of fish to concentrations of CT water that are representative of concentrations predicted to occur in the local study area.

Therefore, the environmental consequences of residual impacts of the Project on acute or chronic toxicity was assessed as negligible.

Fish Abundance

The Project is not predicted to have any impact on fish habitat or on increased acute or chronic toxicity to fish, thus it will not have any impact on fish abundance. Therefore, the environmental consequences of the Project on fish abundance is negligible.

Fish Flavour

People living in the oil sands region have expressed concern that Project Millennium will negatively affect (i.e., taint) the flavour of fish from the Athabasca and Steepbank rivers. Suncor has conducted studies on various waters from their operation to determine if they cause tainting in fish. Wastewater treatment system effluent and seepage from Tar Island Dyke (TID) were tested along with Athabasca River water from upstream of Suncor. The tests showed that TID seepage and

Athabasca River water did not cause tainting (Golder 1996f). Waters from the wastewater treatment system were tested twice with varying results. The first test showed upgrading wastewaters could cause tainting at a concentration of 0.5% (HydroQual 1996b). However, a second study indicated that the upgrader wastewater did not cause tainting (HydroQual 1996b). The difference in the results of these two studies is likely due to variability in the quality of the wastewaters. As part of Project Millennium, Suncor plans to reduce, by at least 50%, the amount of wastewaters released to the Athabasca River. Hence, any potential for tainting from the wastewater treatment system waters would be reduced by Project Millennium.

Since the levels of tainting compounds in CT water are similar to those in TID water, it is unlikely that CT water from the Project would cause tainting in fish. However, to confirm this prediction and to address concerns voiced by aboriginal people and Fort McMurray residents, Suncor will conduct a tainting study of CT water in conjunction with the planned fish health study. The tainting study will be conducted in Fort McMurray with a taste panel consisting of people from the region.

Therefore, the environmental consequences of residual impacts of the Project on fish tissue quality is predicted to be negligible because any impacts are negligible in magnitude.

Chemicals in Fish Tissue

Fish exposed to oil sands waters in the laboratory, as well as wild fish captured from the Athabasca River near Suncor showed very limited uptake of organic chemicals such as polycyclic aromatic hydrocarbons (PAHs). Very few heavy metals were detectable in fish flesh. Mercury was present in low levels in fish exposed to oil sands waters but not in levels higher than those in fish from the Athabasca River. These studies show that the potential for bioaccumulation of chemicals in fish is low. It is unlikely that the Project will result in direct effects on fish or cause exceedances of guidelines for human consumption of fish.

No studies have been conducted on the potential for chemicals from CT water to accumulate in fish. Levels of PAHs and metals in CT water are similar to those found in TID water, which has already been tested. However, since fish tissue quality is an issue that directly relates to people's use of this resource from the local study area, Suncor is committed to follow-up studies to confirm this prediction. Bioaccumulation studies on CT water will also be conducted in conjunction with the fish health studies.

Chemical levels in fish from the Athabasca River will also be monitored by Suncor. This will likely be done in cooperation with other oil sands operators as part of the oil sands Regional Aquatics Monitoring Program (RAMP).

The residual impacts of the Project on chemicals in fish tissue was assessed as negligible in magnitude. Therefore, the environmental consequence is rated as negligible.

Reclamation Streams, Wetlands and End Pit Lake

The end pit lake and reclamation drainage system will be designed to evolve into a productive, self-sustaining ecosystem. A 20% littoral zone, consisting of shallow wetlands and shoreline areas, will be incorporated in the end pit lake to enhance productivity and provide fish habitat. Several constructed wetlands will also provide aquatic habitat. As discussed in water quality, the end pit lake will be managed so that once it is filled, it is non-toxic to aquatic life. Research conducted to date indicates that it is likely that the reclamation drainage systems will support aquatic ecosystems.

Suncor recognizes that there are a number of issues that will need to be addressed to demonstrate long-term ecological viability of the end pit lake and reclamation streams. For example, potential for tainting, bioaccumulation and effects on fish health would have to be addressed prior to fish being introduced to the lake. Suncor is committed to participate in research to ensure that the end pit lake meets regulatory and stakeholder end land use goals. Suncor is also committed to exploring alternatives to the end pit lake. Since these issues are common to all oil sands operators, Suncor will cooperate with other companies to address them.

The end pit lake is likely to support a viable aquatic ecosystem. However, because of uncertainties about the design and functioning of this system, the impact is rated as uncertain.

Monitoring

The Fisheries and Fish Habitat impact assessment was based on mitigation inherent in the Project Millennium design. Negligible impacts are expected on fisheries and fish habitat. However, there are some uncertainties. Suncor will address these uncertainties by further studies or monitoring as appropriate. Follow-up studies and monitoring include:

- survey of Arctic grayling spawning for Wood and McLean creeks to determine fish utilization of these creeks;
- evaluation of compensation options, and habitat design and construction to determine viable options for habitat compensation;
- monitoring of existing and created/enhanced habitat to ensure that mitigation is working and no net loss objective is achieved;
- monitoring of benthic invertebrates in conjunction with water quality monitoring, to assess the effects on aquatic resources from the end pit lake discharge.
- completion of a fish health laboratory study on CT water using trophic level toxicity testing and chemical analyses of CT water to confirm:
  - prediction of no acute or chronic effects on fish,
  - determine links between acute and chronic effects and other fish health parameters,
  - confirm assumption of a link used in impact assessment, and

- confirm prediction of no bioaccumulation in fish tissue;

- monitoring of fish health, including fish tissue chemical residue analyses, as part of RAMP; to include walleye, goldeye, longnose sucker and lake whitefish in the Athabasca River and longnose sucker in the Steepbank River; and
- development of a plan to confirm end pit lake ecosystem viability once the design for the lake is finalized.

G2.2.4 Aquatics Cumulative Effects Assessment

Sub-key questions were developed to address the overall question of whether impacts to the Athabasca River will result from changes in hydrogeology, surface water hydrology, surface water quality, fisheries and fish habitat associated with Project Millennium and the combined developments. The following brief summaries characterize the effects of existing, approved and planned developments on aquatics in the RSA.

Surface Hydrology and Hydrogeology

The change in flow to the Athabasca River from both surface water and groundwater sources for various times in the Project life cycle, by basin and year is less than 0.03% of the mean annual flow in Athabasca River. Low flows from surface water in the LSA are estimated to be zero for all periods less frequent than the 1 in 10 year drought.

Water Quality

Combined developments will not cause exceedances of acute or chronic toxicity guidelines for aquatic life. A number of metals exceed water quality guidelines in the Athabasca River naturally and the combined developments would not contribute an appreciable, additional load of these metals. These metals are not considered to be of concern, because they are largely associated with suspended particulate matter and are thus not in a bioavailable form.

Based on the weight of evidence provided in the Water Quality impact assessment on PAHs, it is unlikely that PAHs released from combined oil sands developments will result in substantial accumulation in sediments of surface waters.

Analysis of potential waterbody acidification presented in the impact assessment also applies to the CEA. The difference between air quality model results for the CEA and those presented in the impact assessment consists of an increase in the area of exceedance of the Critical Load under the CEA (from 90 x 150 km to 120 x 170 km).

Fish and Fish Habitat

Since no effects on fish habitat in the Athabasca River are expected in relation to Project Millennium no further analysis of cumulative effects is required for Athabasca River fish habitat.

As described in Section C4.2.5, approximately 1.2 ha of fish habitat in the lower reaches of Wood and Leggett creeks will be lost as a result of Project Millennium. However, Suncor will mitigate habitat loss in these creeks by creating new habitat or enhancing existing habitat. The quality and quantity of habitat created/enhanced will be determined in consultation with the Department of Fisheries and Oceans to ensure that the "no net loss" objective is achieved. Habitat creation/enhancement will occur at the same time as habitat loss so that there will be no net loss of fish habitat at any given time. Therefore, since Project Millennium will not result in any net loss of fish habitat, no cumulative effects on fish habitat will result from Project Millennium and no further analysis is required.

Conclusions relative to fish abundance are as follows:

- No cumulative impacts on fish habitat are expected in relation to Project Millennium since habitat impacts from the Project will be mitigated.
- No acute and chronic effects on fish are expected from Project Millennium and the combined developments.
- Change in fishing pressure on a regional basis is not expected to impact fish abundance. Regulation of angling is within the jurisdiction of Fisheries Management Division of AEP. It is assumed that decreases in fish abundance would be prevented by appropriate enforcement of legislation.

Based on existing data from field and laboratory analyses, sufficient bioaccumulation of chemicals to cause direct effects on fish health or to cause exceedances of guidelines for human consumption is not expected to occur. Flavour impairment (i.e., tainting) is also not expected. No impacts on fish tissue quality are expected.

G2.3 Terrestrial Resources

The terrestrial resources section of the Project Millennium EIA includes consideration of soils and terrain, terrestrial vegetation and wetlands, ecological land classification units, and wildlife.

G2.3.1 Soils and Terrain

Introduction

The development of Project Millennium will involve complete removal of the soils and overburden. Therefore, almost all of the soil resources and landforms (i.e., terrain units) within the development footprint will be altered. At closure, terrain and soil will be replaced by a reconfigured landscape covered with a reclamation soil mix. The closure soil and terrain units will not be identical to their pre-development counterparts, rather they will be reconstructed to provide a variety of macro- and micro-environments designed to enhance the potential success of the end land use objectives outlined in Section E of Volume I of the application. This will be achieved by incorporating more varied relief than in the initial landscape and including a greater variety of subsurface materials in the landforms. The results of these alterations include more diversity in slopes and aspects, and a wider range of drainage classes.

The soils and terrain impact assessment predicted the incremental effects of the Project on top of existing and approved oil sands operations. The assessment considered the issues, as addressed through the key question approach in Section D2.2 of the EIA. The issues and environmental consequences are summarized in Table G2.3-1.

Table G2.3-1 Soils and Terrain Issues and Environmental Consequences

Issue	Environmental Consequence
Quantity of soils and terrain units	Low
Quality of soils and terrain units (i.e., land capability)	Negligible
Acidification of soils	Undetermined

Impact Assessment

Quantity of Soils and Terrain Units

Organic soils of the McLelland and Muskeg series comprise just over half the area of the local study area (LSA). For the remainder (i.e., the mineral soils), the largest unit is the Kinosis series at roughly 20%. Terrain units reflect a similar pattern, which is to be anticipated since they are based on the parent materials of the soils. Combined bog and fen units make up just over 50% of the LSA, with the morainal/till unit accounting for roughly another 20%.

The removal of soils and terrain and reconstruction of landforms and soils will result in a return of the area to a condition similar to, but altered from pre-development conditions. Because the existing soils and terrain units cannot be replaced, except by reclamation landforms and soils, the impact must be rated as moderate to high. However, because the potential diversity of the reclamation terrain is equal to or greater than what existed pre-development, the environmental consequence was assessed as low to moderate. The same applies to the soil units removed and replaced with reconstructed soils. These impacts were assessed as being of low to moderate environmental consequence. Because of the demonstrated success of reclamation in the oil sands areas, the impacts were rated as not significant.

Quality of Soils and Terrain Units (Land Capability)

Land capability ratings show a similar pattern to the soils and terrain as they are a product of the combined properties of the two. Over half the LSA is rated as non-productive (Class 5) for commercial forestry, while moderately productive lands account for another quarter of the area. Within the disturbance footprint, roughly 60% of the area is rated Class 5, while Classes 2, 3 and 4 range about 12% each.

The reclamation soils and terrain are predicted to result in a significant increase in land capability ratings for the development area. The net result is an increase in land capabilities of at least low capability of approximately 5,681 ha. There will be an elimination of some 5,380 ha of class 5, non-productive land capability areas.

The impacts of the Project on soils and terrain quality is rated as positive in direction. There are no residual impacts and therefore a positive environmental consequence.

Acidification of Soils

The Project operations, in conjunction with existing and approved operations that generate air emissions leading to acidification potentials have been modelled to identify areas where acidifying emissions may contribute potential acid input (PAI). The modelling results indicate that the existing and Project emissions have the potential to exceed the interim critical load of 0.25 keq/ha/y for highly sensitive environments in an approximately 90 x 150 km area.

The current soil sensitivity rating system is still conceptual in nature. Field verification of soil sensitivities has not been completed.

The uncertainties associated with the soil sensitivity ratings, as well as the fact that the PAI results are generated by model simulations leads to a high level of scientific uncertainty about the predicted impact of acidifying emissions on regional soils. Therefore, the environmental consequences for the impact of acidifying emissions on soils has been rated as undetermined. However, this rating is qualified through recognition that if the modelling results are representative of actual field conditions, and if there are sensitive soils within the influence area, then these soils have the potential to be impacted.

Monitoring

Monitoring programs will include:

- continuation of Suncor's routine program of monitoring: soil salvage and handling procedures, soil reconstruction activities and development of reclamation soils;
- evaluation of the development of soil capability characteristics, using the land capability guidelines; and

- monitoring of soil acidification through linkage with the environmental effects monitoring program under RAQCC.

G2.3.2 Terrestrial Vegetation and Wetlands

Introduction

Development of an open pit oil sands mine results in the removal of vegetation and wetlands in the immediate area of the development footprint. The primary mitigation for this action is the development and implementation of a comprehensive conservation and reclamation plan as part of mine closure.

Knowledge on the terrestrial vegetation and wetlands communities native to the development area has been documented through an extensive field assessment prior to development. This assessment, coupled with the knowledge on the landforms, soils, and groundwater and surface hydrological systems that will be included in the closure plan allows prediction of the replacement terrestrial vegetation and wetlands communities.

At closure, thirteen community types have been selected for establishment on the reclaimed landscapes of the Project. These communities include:

- Blueberry Pj-Aw (b1)
- Blueberry Aw(Bw) (b2)
- Blueberry Aw-Sw (b3)
- Low-bush cranberry Aw (d1)
- Low-bush cranberry Aw-Sw (d2)
- Low-bush cranberry Sw (d3)
- Dogwood Pb-Aw (e1)
- Dogwood Pb-Sw (e2)
- Dogwood Sw (e3)
- Deciduous Swamp (SONS)
- Shrubland
- Constructed Wetlands
- Open Water

The terrestrial vegetation and wetlands impact assessment predicted the incremental effects of Project Millennium on top of existing and approved oil sands operations. The assessment considered the issues, as addressed through the key question approach in Section D3.2 of the EIA. The issues and environmental consequences are summarized in Table G2.3-2.

Table G2.3-2 Terrestrial Vegetation and Wetlands Issues and Environmental Consequences

Environmental Issues	Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence
Key Indicator Resources							
old-growth forests	negative	high	local	life of project	reversible	occurs once during life of mine	high
riparian shrub complexes	negative	low	local	life of project	reversible	occurs once during life of project	low
plant communities of economic importance (aspen-white spruce forest)	positive	high	local	life of project	reversible	occurs once during life of mine	negligible
rare/endangered plants or communities (high rare plant potential habitat)	negative	moderate	low	life of project	reversible	occurs once during life of mine	low
traditional use plants	negative	low	local	life of project	reversible	occurs once during life of mine	low
Acidifying Emissions							
Concentrations of SO_2 on vegetation	negative	undetermined	regional	life of project	reversible	occurs over life of project	undetermined
Concentrations of NO_X on vegetation	negative	undetermined	regional	life of project	reversible	occurs over life of project	undetermined
Acidification on vegetation	negative	undetermined	regional	life of project	reversible	occurs over life of project	undetermined
Diversity Indicators							
Patch Number							
Terrestrial Vegetation	negative	moderate	local	life of project	reversible	occurs once during life of project	moderate
Wetlands	negative	high	local	life of project	irreversible	occurs once during life of mine	high
Patch Size							
Terrestrial Vegetation	negative	low*	local	life of project	reversible	occurs once during life of project	low
Wetlands	negative	high	local	life of project	irreversible	occurs once during life of mine	high

* Patch size will both increase and decrease following reclamation.

Impact Assessment

The Project will result in the clearing of 9,281 ha or 57% of the LSA. Baseline information for the LSA, indicates that 36% of community types identified represent terrestrial ecosite phases, while 62% represent wetlands. During construction and operation, 46% of terrestrial ecosite phases and 65% of wetlands community types will be lost in the development area.

Reclaimed landscapes will result in the addition of 7,239 ha of terrestrial ecosite phases and loss of 5,387 ha of wetlands community types in the LSA. Thus, upon closure, relative to pre-development, terrestrial ecosite phases will increase by 28% and wetlands communities will decrease by 34% within the LSA. An end pit lake of approximately 935 ha will account for 6% of the area Hence, a dominantly wetlands community area will be converted to a dominantly upland mixedwood forest area.

Key Indicator Resources

The only key indicator resource assessed as having both a high magnitude and negative direction is old growth forests. An assessment of old growth forests within the LSA is considered to have a high environmental consequence based on the rating system used.

In summary, the overall impact of the east bank mining area development on "old-growth" forest is negative in direction and high in magnitude, given that 21% of the old-growth forest communities will be cleared by the project. However this assessment must be tempered by the following:

- the net increase of old growth forest impact over the approved Steepbank Mine area is only 9 ha or 2% of the old growth forest within the LSA;
- the creation of more upland conditions after closure will ultimately allow for substantially greater old growth forest in the far future; and
- the loss of old growth forest (92 ha) is low in terms of the total amount in the RSA.

Based on the above-noted factors, the loss of old growth forests due to development of the east bank mining area, and particularly the loss due to Project Millennium development, is not considered to be significant.

Terrestrial Vegetation and Wetlands Community Changes

Within the uplands (terrestrial) ecosite phases, the greatest impacts occur within the: lichen Pj (a1); Labrador tea-mesic Pj-Sb (c1); and Labrador tea-subhygric Sb-Pj (g1) ecosite phases, where 3 ha or 100% of the ecosite phases within the LSA will be cleared. The blueberry ecosite, will experience a loss of 279 ha or 77% of the blueberry ecosite within the LSA. The low-bush cranberry ecosites will experience a loss of 2,230 ha or 46% within the LSA. In addition, the dogwood ecosites will experience a loss of 16% or 63 ha within the LSA.

Reclamation of the development area will result in the development of a much greater area of uplands terrestrial vegetation. The residual impact of the development on terrestrial vegetation is therefore positive in direction and high in magnitude.

Non-patterned, wooded fens (FTNN/FFNN), the dominant wetlands types in the LSA, collectively occupy 43% or 6,976 ha. The Project will remove 71% or 4,943 ha of non-patterned, wooded fens, representing a loss of 30% of the LSA. Similarly, 76% of all non-patterned shrubby fens will be directly lost to Project development. Wooded swamps (STNN/SFNN) and shrubby deciduous (SONS) swamps represent 14% or 2,207 ha of the LSA. Clearing of these swamps will result in a loss of 54% (1,190 ha). Wooded bogs without internal lawns (BTNN/BFNN) represent less than 1% or 46 ha of the LSA and will not be affected by the Project. Graminoid (MONG) and shrubby (MONS) marshes represent 2% or 318 ha of the LSA. Losses due to the Project, will affect 13% or 14 ha of graminoid marshes (MONG) and 8% or 18 ha of shrubby marshes (MONS) within the LSA. Shallow open water (WONN) represent less than 1% or 15 ha of the LSA. Mine development will affect 53% or 8 ha of the shallow open water areas in the LSA.

Wetlands are the dominant community types lost to the development because they occupy 62% of the LSA. The Project will remove 6,502 ha or 65% of wetlands. Reclamation and closure of the development area will result in return of some wetlands types, with 12% of the development area returned to wetlands. The net impact to the LSA is that 34% of the area wetlands will be lost. This is a high magnitude, irreversible residual impact. The environmental consequences are high. However, the wetlands areas lost to development are common throughout the region and are unlikely to have a high magnitude impact on wetlands in the region. Therefore, the loss of wetlands has been assessed as not significant on a regional basis.

The replacement of the wetlands areas by uplands areas with higher forest capability can be viewed as directionally positive. Some wetlands areas as well as shallow open water areas and lakes will be replaced as part of the closure plan. The residual impacts of the changes to terrestrial and wetlands vegetation communities has been rated as low in environmental consequence. There is a moderate degree of uncertainty associated with this rating as the effectiveness of some of the reclamation practices is yet unproved.

Impacts of Air Emissions and Water Release on Vegetation

Airborne emissions from oil sands developments can have both short and long-term effects on vegetation vigour and health. Short-term exposure effects are usually restricted to a localized area and can include chlorosis or necrosis of plant tissues which can decrease growth rates or eventually result in plant mortality. Long-term effects can occur over a much larger area and may result from the accumulation of contaminants in plant issues, either by direct absorption into plant tissues from the air, or indirectly through deposition into the soil and into the roots. Once incorporated in the plant tissues, the chemicals can alter internal biochemical processes and consequently can reduce productivity, vigour or health. Other chemicals (and dust) may be adsorbed onto the surface of the plant tissues, reducing respiration and reception of radiation or photosynthesis. These processes may again reduce plant vigour and productivity.

Studies on the impacts of air emissions in the oil sands area to vegetation have included specific research on effects to forest vegetation from sulphur dioxide. Recently, efforts to characterize effects of air emissions on regional vegetation have been initiated. The environmental effects monitoring program component of the Regional Airshed Monitoring Plan for the Wood Buffalo Zone (BOVAR 1996d), of which Suncor is a member, included selection of sites to complete studies on soils and vegetation sampling. The first sets of results for this study focus around site characterizations for aspen and jack pine plots.

Although monitoring of the effects of air emissions is proceeding, the lack of current data on the potential effects of air emissions on regional vegetation means that the assessment of residual impacts is currently undetermined.

Water-borne pollutant releases can also result in changes to vegetation productivity, vigour and health. Water emissions may include the release of light to heavy hydrocarbons during Project development. These chemicals, once released into water systems and soils can affect plant health and vigour once they are adsorbed onto the plant tissues.

Suncor has completed a number of studies to assess the impacts of process-affected waters on terrestrial and aquatic plants (as detailed in section E of Volume 1 of the Application). The results to date indicate that impacts are of low magnitude. However, the research to assess the impacts of waters associated with the consolidated tailing (CT) materials has just been initiated, with few results available. Therefore, continuing research is recommended.

Diversity of Terrestrial Vegetation and Wetlands

In summary, the impact of Project Millennium on terrestrial vegetation and wetlands diversity using the indices of patch number and patch size provides only one component of the assessment. Further assessment is provided in the ELC Section (D4.2). However, patch number can be demonstrated to decrease for both terrestrial and wetlands patches following mine closure. The overall impact on the terrestrial patches can be described as moderate in magnitude based on percentages of change from baseline conditions while for wetlands it is high (Table D3.2-27). The geographic extent is local while the direction of the impact will extend throughout the life of the Project. While the patch number for terrestrial ecosite phases can be increased through reclamation design and methods, the number of wetlands patches will not return to baseline conditions and is therefore classified as an irreversible impact. The environmental consequence is considered high for wetlands, however the number of wetlands patches in the RSA indicates that the impact is not significant.

The overall change in patch size is negative for both terrestrial ecosite phases and wetlands, however the magnitude is low for terrestrial patches given that there will be both an increase and decrease in patch size as reclamation proceeds. Flexibility in reclamation planning and design allows for the size of reclaimed terrestrial ecosite phases to adjust with the sequential phases of development and reclamation. This flexibility is much less in the case of wetlands reclamation since fens cannot be reclaimed and therefore the magnitude of the impact is higher. The geographical extent is local for both terrestrial ecosite phases and wetlands, reversible for terrestrial and irreversible for wetlands (Table D3.2-27). The potentially high environmental consequence associated with the reduction of wetlands diversity is tempered by the fact that unique wetlands will not be removed and that there is a large quantity and diversity of wetlands on a regional scale. Therefore, the environmental impact due to reduction of wetland diversity in the closure landscape is not considered to be significant.

Monitoring

Monitoring programs to verify impact predictions or to allow resolution of undetermined impacts will include:

- continuation of Suncor's routine program of monitoring reclamation areas, including both terrestrial and aquatic sites;
- continuation of monitoring of the impacts of CT waters on terrestrial and aquatic vegetation;
- development of a field-scale CT reclamation demonstration in 2000, following completion of preliminary design studies (three year program initiated in 1997); and
- participation in efforts to monitor the potential impacts of oil sands development air emissions on regional vegetation, as part of Suncor's participation in RAQCC and its environmental effects monitoring program.

G2.3.3 Ecological Land Classification

Introduction

Project Millennium has been designed to mitigate macroterrain, component ELC units and biodiversity impacts through these reclamation planning that will result in the creation of new macroterrain units and component ELC units. These reclamation landforms or macroterrain units include the following:

- reclaimed tailings settling pond (248 ha);
- tailing sand dykes (520 ha);
- CT backfilled mine cells (3,278 ha);
- above ground overburden disposal areas (573 ha);
- other overburden areas including dykes (2,117 ha);

- reclaimed reclamation material storage areas (437 ha);
- end pit lake including lake, littoral zone, and the intralake wetland (883 ha); and
- unmined developed areas (943 ha).

These engineered landforms will be amended with topsoil and revegetated through seeding of native plant species and ecosystem transplanting as required to approximate reclaimed ecosite phase. Over time these new component ELC units will gradually re-establish and will approximate pre-development conditions (species, richness, patch size, shape, diversity and function).

The ecological land classification assessment predicted the incremental effects of the Project on top of existing and approved oil sands operations. The assessment considered the issues, as addressed through the key question approach in Section D4.2 of the EIA. The issues and environmental consequences are summarized in Table G2.3-3.

Table G2.3-3 Ecological Land Classification Issues and Environmental Consequences

Issue	Environmental Consequence
Physical changes to macroterrain units	Low to Moderate
Potential changes to biodiversity	Low

Impact Assessment

Ecological Land Classification Units

The five macroterrain units identified in the LSA are Athabasca Floodplain, Athabasca Escarpment, Steepbank Escarpment, Steepbank Organic Plain, and the Steepbank Upland. Project development will result in a 5 % loss to the Athabasca Floodplain, a 68% loss to the Athabasca Escarpment, a 37 % loss to the Steepbank Escarpment, a 67 % loss to the Steepbank Organic Plain and a 39% loss to the Steepbank Upland. Some component ELC units associated with these macroterrain units will be permanently lost as a result of project development. However, the majority of these units represent a relatively small proportion of the associated macroterrain units.

The Ecological Land Classification impact assessment was based on mitigation inherent in the Project Millennium closure plan design. That is, the impact assessment included residual impacts after mitigation was applied. Low to high impacts are expected for the macroterrain units. All impacts are long-term and irreversible. The re-establishment of new reclamation macroterrain units means the environmental consequences of the residual impacts are rated as low to moderate. The moderate impact to some macroterrain units, while certain for the LSA, is of lower regional impact. Therefore, the residual impact has been rated as not significant.

ELC Diversity (Biodiversity)

There will be changes to biodiversity as a result of project development. The assessment focus on changes to richness, diversity, rare plant habitat loss, old growth forest loss, patch size and patch shape. There were some changes to richness, diversity, patch size and patch shape as a result of the Project. There will be some losses to "unique" ELC units within the Athabasca Floodplain, Athabasca Escarpment and Steepbank Escarpment, which were assessed primarily on rare plant habitat and old growth forest associations.

Moderate impacts to biodiversity are expected for all macroterrain units. However, there are uncertainties associated with predicting changes to biodiversity. The residual impact of the changes in ELC units is of low to moderate magnitude, of local geographic extent and reversible. The environmental consequence of the residual impacts was assessed as low.

Monitoring

Suncor will address these uncertainties by further studies or monitoring as appropriate for the key question. In addition, Suncor will integrate adaptive management strategies in their reclamation planning and will continue to work with the Oil Sands Terrestrial Vegetation and Wetlands Reclamation Committees.

G2.3.4 Wildlife

Introduction

Project Millennium has been designed to mitigate impacts to wildlife habitat, movement corridors, abundance and diversity by the measures described below:

- locating the development away from important habitat (e.g., minimum of 100 m from the Steepbank and Athabasca rivers);
- minimizing the footprint of development (e.g., restricting dump size, use of common access and utility corridors);
- completion of most clearing and construction activities during the winter when wildlife are typically not in breeding season;
- leaving movement corridors around the development area;
- progressively reclaiming the development area;
- manage landfill areas such that wastes (including food wastes) is covered on a daily basis;
- implement a nuisance wildlife program in cooperation with AEP, Wildlife Management Division.
- use of bird deterrence devices, such as human effigies and propane-fueled cannons, particularly during spring and fall migration periods;
- maintain vegetation free shoreline in tailings pond areas;

- participate in the Oil Sands Bird Protection Committee to discuss mitigation results and strategies; and
- measures to protect wildlife health through reduction in air and water emissions, as listed in Sections B4 and C3.3.

Mitigation for habitat lost due to changes in surface hydrology will primarily be through reclamation. Mine dewatering will cease at closure. This will allow the groundwater table to return to pre-development levels. As well, an end pit lake and numerous small wetlands are proposed for closure. This will have a net positive effect on wildlife.

The wildlife impact assessment predicted the incremental effects of the Project on top of existing and approved oil sands operations. The assessment considered the issues, as addressed through the key question approach in Section D5.2 of the EIA. The issues and environmental consequences are summarized in Table G2.3-4.

Table G2.3-4 Wildlife Issues and Environmental Consequences

Issue	Environmental Consequence
Wildlife habitats and movement	Low
Wildlife abundance and diversity	Low
Wildlife health during operations	Low
Wildlife health for closure	Low

Impact Assessment

The wildlife habitat, wildlife abundance, wildlife diversity and wildlife health impact assessments predicted the incremental effects of the Project on top of existing and approved oil sands developments. This was done quantitatively for changes in habitat and changes in potential wildlife diversity using Habitat Suitability Index (HSI) modelling and qualitatively for wildlife abundance using professional judgment. Wildlife health was assessed quantitatively using risk assessment techniques.

Changes in wildlife habitat and movement were addressed by examining the effects of site clearing, changes in hydrology, barriers to movement, sensory disturbances and reclamation practices. Changes in wildlife abundance and diversity were addressed by examining site clearing, sensory disturbance, changes in access leading to increases in hunting and poaching, removal of nuisance wildlife, increased vehicle-wildlife collisions and interactions of wildlife with infrastructure.

Habitat Changes

Habitat loss due to site clearing was predicted to have the greatest impact on wildlife. The magnitude of this impact is high for most of the KIR species. However, this impact is reversible, and it is expected that wildlife habitat will be progressively reclaimed during closure. Habitat loss due to changes in hydrology, barriers to movement and sensory disturbance were also predicted to have an effect on wildlife. Changes in hydrology were determined to be low in magnitude because most wildlife habitat will be lost through site clearing. Barriers to movement will have the greatest impact on the larger, more mobile wildlife species (e.g., moose, bear, and fisher). Sensory disturbance affecting habitat use will affect some wildlife species, particularly during the breeding seasons or when species are overwintering and may be energetically stressed.

Progressive reclamation practices will result in gains in wildlife habitat. This impact is expected to be positive for all of the KIR species. The magnitude of this impact is expected to be high.

The residual impact of the Project on wildlife habitat and movement was rated as low in environmental consequence. This is based on the predicted effectiveness of the reclamation and closure plans in replacing ecosystems. The preliminary indications of the effectiveness of the reclamation activities shows that wildlife species readily use the areas. Some uncertainty exists because some of the selected KIRs for wildlife frequent mature ecosystems, which have not had time to develop on oil sands reclamation areas.

Wildlife Abundance and Diversity

Abundance and diversity of wildlife species will be affected to some degree by site clearing, sensory disturbance, removal of problem or nuisance wildlife, wildlife-vehicle collisions and interactions with infrastructure. Site clearing will result in a loss of wildlife abundance, particularly of smaller, less mobile species (e.g., red-backed voles, snowshoe hares). Site clearing will also reduce wildlife diversity and the potential for diversity. Sensory disturbance may affect all of the KIR species, especially during reproductive periods or periods of energetic stress. Removal of problem wildlife will be a concern for beavers and black bears, however the magnitude of this impact will probably be low. Wildlife-vehicle collisions are expected to occur to some extent on Highway 63 from Fort McMurray to the Suncor turn-off, as a result of increased traffic levels. The magnitude of this impact is expected to be low on the highway and negligible on-site where reduced habitat and reduced speed limits will reduce the probability of collisions. Interactions with infrastructure (e.g., tailings pond, power lines, towers) will mainly affect bird species. The magnitude of this impact is expected to be low.

Most impacts related to change in wildlife abundance and diversity will result from site clearing or direct removal of vegetation communities. Wildlife species with small home ranges or limited mobility, or wildlife species with young will be most affected. As clearing is anticipated to take place during the winter months, most of the bird species will not be affected. As well, some of the larger, more mobile species (e.g., moose, bear, fisher) will most likely move out of the area. This impact was determined to be of low environmental consequence.

Changes in wildlife abundance and diversity attributed to sensory disturbance, removal of nuisance wildlife, increased wildlife-vehicle collisions and interactions with infrastructure were all determined to be of negligible to low environmental consequence.

Wildlife Health - Operations

Chemical concentrations in the water of the Athabasca River, McLean Creek and Shipyard Lake as a result of the Project are predicted to be safe for consumption by wildlife during the operational phase of the Project. The levels of Project-related chemicals in fish and aquatic invertebrates are also predicted to be safe for ingestion by wildlife during the operational phase. Direct inhalation of chemicals by wildlife is considered to be a minor exposure pathway in comparison to exposures through the food chain, and therefore was not evaluated. Rather, this pathway was indirectly evaluated via deposition of airborne chemicals onto plants and soils, followed by ingestion of these plants by wildlife. Based on the available data, chemical concentrations in vegetation are predicted to be safe for consumption by wildlife during the operational phase. Thus, impacts to wildlife health were predicted to be negligible for the chemicals evaluated during the operational phase. However, there is some uncertainty associated with the toxicity of naphthenic acids to wildlife, and therefore the environmental consequence of the residual impact is classified as low. Further studies are being conducted by Suncor to help resolve the uncertainty associated with naphthenic acids.

Wildlife Health - Closure

The potential for impacts to wildlife health as a result of exposure to chemical concentrations predicted for Shipyard Lake, McLean Creek, Athabasca River and EPL at closure and in the far future. The levels of substances in these waterbodies, with the exception of the EPL, at closure and in the far future were not predicted to result in impacts to wildlife health. There is some uncertainty associated with consumption of water from the EPL for a period of time between closure and far future. The risk assessment predicted marginal and inconsequential wildlife health risks for exposure to molybdenum in EPL water. Monitoring of the EPL will be conducted to establish if access to this waterbody by wildlife should be restricted, and whether mitigation will be needed to reduce exposures.

An evaluation of the potential for impacts to wildlife health as a result of exposures to chemicals on the reclaimed landscape, including exposure to ponded surface water/streams, soils and vegetation. Animals were assumed to forage within the LSA (including reclaimed areas and natural areas) in the far future, ingesting water, terrestrial plants, aquatic plants, terrestrial invertebrates and/or aquatic invertebrates, as determined by their foraging preferences. For ruffed grouse, mallards, deer mice, beavers and snowshoe hare, the magnitude of impact and resulting environmental consequence was determined to be negligible. For the moose, although average exposures on the reclaimed landscape were determined to result in negligible impacts to moose populations, maximum exposures to aquatic plants on the reclaimed landscape may lead to potential health risks for a small proportion of the population. Therefore, the environmental consequence was classified as low, rather than negligible. It should be noted that these risk estimates have been conservatively modelled assuming the home range of a moose is confined to the LSA, despite the fact that the home range of a moose would extend beyond this range. If the modelling procedures allowed moose to forage outside the

LSA in undisturbed areas, the risk estimates would be lower. The scientific uncertainty associated with this prediction is moderate, based on the limited available data for chemical concentrations in aquatic plants growing on reclaimed landscapes.

Monitoring

Monitoring is required to assess the affects of habitat change on wildlife including an evaluation of the use of designed wildlife corridors by wildlife. Monitoring of vegetation (and hence wildlife habitat) will also be required, and is discussed in Section D3.2.

Monitoring of wildlife numbers will be undertaken on reclaimed lands. As many wildlife species depend on mid to late forest seral stages, monitoring of these species numbers will not be useful, at least not in the short-term. Rather, monitoring for wildlife in the short-term should be based on whether the reclaimed area has been successfully set on a successional pathway that will eventually result in good habitat for the wildlife species of interest.

Monitoring of success of mitigation of impacts to wildlife interacting with tailing ponds will continue. Oswell, Suncor will continue further research to determine the potential for toxicity of naphthenic acids to wildlife.

G2.3.5 Terrestrial Cumulative Effects Assessment

Introduction

This CEA evaluated the potential effects of Project Millennium plus existing, approved and planned developments on the terrestrial resources including soils, terrain, vegetation, wetlands and wildlife, in the Regional Study Area (RSA). It is difficult to quantify cumulative effects with certainty due to the multitude of variables associated with various developments, including the phased nature of various developments such as oil sands mining. As well, reclamation practices may reduce various impacts by returning resources to equivalent capabilities, often resulting in enhancement of the land. For these reasons, a conservative approach was taken for the CEA, under the assumption that all developments occurred concurrently over the entire project area.

Soils and Terrain

The construction and operation phases of the combined developments will cause a loss of 3.2% of the natural soil and terrain units in the RSA. Reclamation of the developed areas and existing disturbed areas with reconfigured terrain units covered by a reclamation soil mixture will achieve positive impacts by increasing the diversity of terrain units. The impacts associated with this are estimated to be: negative in direction, low in magnitude, regional in extent, of long-term duration, irreversible and low in frequency. The environmental consequence is rated as low.

As a result of alterations in the quantity and distribution of soil and terrain units between the pre-development and closure landscapes, changes in land capability will be produced. These are estimated to be: positive in direction, low in magnitude, regional in extent and of long-term duration. The positive direction of change is the result of significant areas of non-productive Class 5 land being reclaimed to low capability Class 3. The environmental consequence is rated as low.

Operational activities of the developments will increase acidifying emissions released into the RSA air shed. The environmental consequence is rated as being undetermined because of the high level of uncertainty associated with soil acidification.

Terrestrial Vegetation and Wetlands

For the CEA, loss of terrestrial vegetation communities (16,129 ha or <1%) is predicted in the RSA. The Project contributes 5,644 ha to this loss. Reclamation will increase terrestrial vegetation by 306% to 49,444 ha or 2% of the RSA.

The residual impact on loss or alteration of terrestrial vegetation communities as low in magnitude, regional in geographic extent, long-term in duration and reversible. The environmental consequence is rated as low.

The total loss to wetlands from the combined developments is 33,661 ha or 1% of the RSA. The Project's contribution to this loss is 6,501 ha. Reclamation activities and reforestation will result in changes to the distribution of wetlands types in the RSA. Overall, wet open swamp will be reduced by 24%, but (blackspruce) marshes will increase by 595% in the RSA.

The residual impact to wetlands is low in magnitude, regional in geographic extent, and long-term in duration. Some impacts, such as those to bogs and fens, are not reversible, therefore the environmental consequence has been rated as low.

The impact of air emissions on vegetation health is undetermined. Additional data is required to assign an environmental consequence.

Ecological Land Classification Units

The CEA showed that 63,659 ha or 3% of ELC units in the RSA will be impacted by the combined developments. The Project contributes 5,644 or <1% of the loss in the RSA.

The impact on diversity to ELC units is negligible to low in magnitude, regional in geographic extent and long-term in duration. The environmental consequence in the RSA is rated as low.

Wildlife

During the construction phase of the oil sands developments, the combined developments will cause relatively small losses of wildlife habitat due to site clearing. These impacts are predicted to be negative in direction, low in magnitude, regional in geographic extent, long-term in duration and of varying frequency. The environmental consequence for the cumulative effects is low.

As well, minor changes in wildlife abundance and diversity are expected to occur as a result of site clearing, sensory disturbance, removal of nuisance wildlife, wildlife-traffic mortalities and wildlife interactions with infrastructure. These impacts represent a worst case scenario, as it is unlikely that all sites will be cleared to their maximum extent at the same time. The phased nature of site clearing and progressive reclamation will mitigate the cumulative effects of habitat loss. Eventual reclamation of all sites should result in equivalent habitat capability for wildlife within the region.

With the expectation of equivalent habitat capability, the residual impact to wildlife abundance and diversity is rated as being of low environmental consequence.

In the far future when equilibrium conditions have been established for all combined developments, a potential impact has been identified. The residual impact (i.e., affected population) is likely to be enhanced in the CEA, relative to the impact predicted for the Project, since there is a greater likelihood on a regional basis for this exposure pathway to be realized. However, the magnitude of exposure and associated health risks for a given individual animal should not be increased. The cumulative effects on wildlife health are predicted to be low in magnitude, regional in geographic extent, long-term in duration, reversible and of moderate to high frequency. The environmental consequence is rated as low.

G2.4 Mine Closure Assessment

Suncor has developed an integrated closure plan for its oil sands operations, including Lease 86/17, Steepbank Mine and Project Millennium. The reclamation planned as an integral component of Suncor's operation aims to return the developed areas to a capability equivalent to, or better than that which existed prior to development.

An assessment of the performance of the closure plan was completed. This assessment provided an analysis of predicted reclamation performance within the framework of meeting Suncor's corporate objectives and regulatory requirements. These goals and requirements have been evaluated in terms of a systematic assessment of twenty-two key issues. The results indicate that the closure landscape has a high probability of attaining the closure objectives and will support a stable geomorphological and ecological system which will be compatible with desired end land uses.

While there is currently a demonstration of successful reclamation in the existing operations on Lease 86/17, it is recognized that there are uncertainties related to certain aspects of this performance assessment. These uncertainties will be reduced during detailed design, by further research, or by ongoing monitoring activities that will provide continuing feedback into the iterative design process.

G2.5 Human Health Impacts

G2.5.1 Introduction

Project Millennium will release substances into the air and into the waters of the Athabasca River and Shipyard Lake while it is in operation between the years 2000 and 2033. After 2033, Suncor will close the development by completing reclamation and other closure activities. It is intended that the site will become a primarily forested area again, re-inhabited with native plants and animals. The human health impacts of the Environmental Impact Assessment (EIA) evaluated whether health effects would occur to people who live near the Project site, during the operational phase and after closure, when the area is fully reclaimed.

Project Millennium has been designed to mitigate human health impacts through:

- controlling air emissions and water discharges; and
- designing closure landscapes to ensure acceptable risk.

Issues

The human health assessment evaluated the effects of the Project by considering:

- The Project's potential environmental emissions in combination with existing and approved oil sands developments;
- Recreational exposure to Athabasca River and Shipyard Lake water (e.g., fishing, boating, swimming, hiking) and ingestion of fish during the operational phase;
- Inhalation of airborne chemicals during the operational phase of the Project;
- Ingestion of local plants and animals which may have been exposed to water and air emissions from the Project during the operational phase;
- Combined exposure to water, air, plants and animals during the operational phase;
- Exposure to chemical releases from the reclaimed landscape in the far future; and
- Cumulative effects associated with chemical releases from Project Millennium in combination with other existing, approved and planned developments in the area.

Special consideration was given to aboriginal lifestyles and health concerns voiced by the people of Fort McKay and Fort Chipewyan. The assessment recognizes that local people value being able to collect plants and animals from the land for traditional purposes. To evaluate this, blueberries, Labrador tea leaves and cattail root were collected and tested for levels of metals and other oil sands-related substances. In addition, small mammals were captured and tested for levels of metals. This information was used, together with information on the amount of local plants and animals people usually eat, to determine whether there is a chance for the health of aboriginal people to be impacted from eating foods from areas near the Project site.

In addition, during the consultation process it was recognized that several stakeholders were concerned with air quality issues. In response to these concerns, Suncor undertook a stack emission survey to gain further insight. Although some aspects of this undertaking are still in the analysis stage, some of the data (specifically volatile organic carbon emissions) was available in time for integration into the assessment. Results for other substances (i.e., particulates, PAHs and metals) will be available when the analysis is completed.

Methodology

The chance of health effects occurring to people is called a *health risk,* and the method of evaluating whether health risks will occur is called *risk assessment.* In order for a health risk to occur, people must first come in contact with (i.e., be exposed to) substances released from the Project.

The first step in the risk assessment was to determine three things:

- the substances that will be released from the Project;
- the people that might come in contact with the substances (for example, children, adults, the elderly); and
- the types of activities people may do that may cause them to come in contact with these substances (for example, food gathering, hunting, fishing, swimming).

The next step was to calculate the levels of substances people may come in contact with as a result of their activities. These levels were then compared to levels that are safe for people to be exposed to, without having health problems. These safe levels were derived from scientific studies and will protect even the most sensitive people (for example, the elderly, infants and young children). If the levels in the environment are less than safe levels, health problems should not occur. On the other hand, if levels in the environment were excessively higher than safe levels, the risk assessment would predict that health problems may occur.

G2.5.2 Impact Assessment

The residual impact classifications for each key question are summarized in Table G2.5-1.

Table G2.5-1 Summary of Residual Impact Classifications and Environmental Consequences

Key Question	Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence
HH-1	Negative	Low	Local	Long-Term	Reversible	Medium	Low
HH-2	Negative		Regional	Long-Term	Reversible	High	Low
HH-3	Negative		Local	Long-Term	Reversible	High	Low
HH-4	Negative		Local	Long-Term	Reversible	High	Low
HH-5 (far future)	Negative	Low	Local	Long-Term	Reversible	Medium	Low
HH-5 (EPL at closure)	Negative	Moderate	Local	Medium-Term	Reversible	Medium	Moderate
CHH-1	Negative		Regional	Long-Term	Reversible	High	Low

The above issues were framed and addressed through the key question approach in the EIA, and are summarized as follows:

HH-1: What impact will chemicals in operational water releases from Project Millennium have on human health?

The levels of substances in the water of the Athabasca River and Shipyard Lake as a result of the Project are predicted to be safe for occasional swimming and drinking during recreational activities. The levels of Project-related substances in fish are also predicted to be safe for eating. However, there is some uncertainty associated with the toxicity of naphthenic acids to people, and therefore the residual impact was classified as a low environmental consequence, rather than negligible. Further studies are being conducted to help resolve this uncertainty.

HH-2: What impact will chemicals in operational air emissions from Project Millennium have on human health?

The levels of substances in air are predicted to be safe for people living in the communities of Fort McKay, Fort Chipewyan and Fort McMurray. In addition, breathing air while outside in areas closer to the Project site (for example, while hunting, fishing, boating, gathering plants) is not predicted to result in health problems. Analysis of the recently conducted Suncor stack emissions survey is in progress to provide further resolution on this topic.

HH-3: What impact will consumption of local plants and game animals exposed to operational water releases and air emissions from Project Millennium have on human health?

The levels of substances in traditional plants and animals are predicted to be safe for eating by local aboriginal people, based on information on Fort McKay and Fort Chipewyan eating patterns and the levels of metals and other substances currently observed in local plants and animals. Analysis of the recently conducted Suncor stack emissions survey to predict future possible air deposition and resultant plant and game meat tissue quality is in progress to provide further resolution on this topic.

HH-4: What impact will the combined exposure to water, air, plants and game animals have on human health during the operational phase of Project Millennium?

Based on the previous analyses of HH-1, HH-2 and HH-3, the combined exposure to substances in water, air and traditional foods is not expected to result in health problems for local people. As noted previously, analyses of the recently conducted Suncor stack emission survey will provide further resolution of this topic.

HH-5: What impact will the release of chemicals in soils, plants and waters of the Project Millennium reclaimed landscape have on human health?

This assessment included an evaluation of a hunter/trapper who may live on the site after it has been cleaned up and returned to a forest. This hunter/trapper was assumed to consume local plants, game animals and water from the Athabasca River, Shipyard Lake or the end pit lake (EPL). The levels of substances in water from the Athabasca River and Shipyard Lake, in air and soils on the site, and in plants and animals harvested from the site, are not predicted to result in impacts to the health of hunters/trappers who live on the site for long periods of time. The levels of substances on the site after closure of the Project are also not predicted to result in health effects for people who occasionally use the Athabasca River or Shipyard Lake for recreational activities following closure of the Project.

A potential impact to human health was identified if people use the EPL for recreational activities at the start of the closure period. Although the environmental consequence of this impact is considered to be moderate (Table F1.5-1), it is not considered to be significant for the following reasons:

- there will be a Suncor monitoring presence at the end pit lake to establish whether the water quality is not acceptable; and
- the potential impact can be mitigated by restriction of access until the water quality is acceptable.

CHH-1: What impacts to human health will result from chemical exposure related to Project Millennium and the combined developments (cumulative effects)?

Based on the available data, air and water releases from Project Millennium, combined with releases from other developments in the area, are not predicted to result in health problems for people living in the oil sands area. Analysis of the recently conducted Suncor stack emissions survey is in progress to provide further resolution of this topic.

G2.5.3 Monitoring

The following are key areas of monitoring and research identified or discussed in the Human Health Assessment:

- continue to monitor the levels of substances in the water, air, soils, plants and animals that people may be exposed to, both while the Project is operating and after closure;
- monitoring of end pit lake water will be conducted, and, if necessary, human access to this water body will be restricted or future mitigation measures will be implemented to reduce or eliminate the impact.
- continue further research to determine the potential for toxicity of naphthenic acids and interpret the new information as it relates to this EIA; and
- continue to participate in regional studies related to ecological and human health, such as the Alberta Oil Sands Community Exposure and Health Effects Assessment Program, the Regional Aquatics Monitoring Program (RAMP) and the Wood Buffalo Environmental Association (WBEA).

G2.5.4 Suncor's Commitment to Protecting Human Health

Suncor is committed to protecting the health of people who live near the Project. To do this, Suncor will:

- continue to monitor the levels of substances in the water, air, soils, plants and animals that people may be exposed to, both while the Project is operating and after it has closed down;
- keep air and water emissions as low as possible to protect human health;
- clean up and revegetate the site after the Project has closed down to provide a safe area for people to use;
- continue further research to determine the potential for toxicity of naphthenic acids and interpret the new information as it relates to this EIA; and
- continue to participate in regional studies related to ecological and human health, such as the Alberta Oil Sands Community Exposure and Health Effects Assessment Program (AOSCEHEAP), the Regional Aquatics Monitoring Program (RAMP) and the Wood Buffalo Environmental Association (WBEA).

G2.6 Historical Resources

In September of 1997, Golder completed a Historical Resources Impact Assessment (HRIA) on behalf of Suncor on lands proposed for development in association with the development of Project Millennium. All work completed for this Project was conducted under Historical Resources Permit #97-123, issued by Alberta Community Development. Areas of investigation were guided by the production of an historical resources map of potential produced for the LSA. Approximately 1,500 acres of land were investigated, accompanied by a total of 1,629 shovel tests.

Two previously recorded prehistoric sites, HhOu 1 and 2, are located in the vicinity of the HRIA study area. These sites are both isolated find locations and were recorded during the HRIA completed for Suncor's Steepbank Mine.

No historical resource sites were recorded during the course of the Project Millennium HRIA. Three locations were observed at which cultural features or structures are present, but these sites do not qualify as historical resources under the Alberta Historical Resources Act. These locations include two with cabins and one with a cultural depression. One other scatter of recent refuse was observed associated with a well pad.

Five historical sites, HS 44043, 44044, 44045, 44046 and 44047 were also identified during site file searches within the LSA. These sites relate to early oil exploration in the Athabasca region, dating to approximately 1906-1909. References on the Historical Sites forms suggest that these sites were recorded from literature searches. No evidence of these sites was observed in the field during this HRIA.

One palaeontological location was also noted along the Athabasca River during the HRIA. This site is outside of the Project Millennium development area, but is within the LSA. The outcrop relates to the Moberly Member of the Waterways formation, which outcrops regularly along the Athabasca River and underlies the entire oil sands region. The area will not be affected by the development. The materials observed included Upper Devonian aged stromatoporoids, small brachiopod shells, nautiloid cephalopods, and fossils of other aquatic invertebrates.

The degree of concern for local negative effects pertaining to Project Millennium are negligible. The effects on cultural sites identified will be negative in direction, long-term in duration, local in geographic extent and irreversible. The scientific uncertainty is low, with a high likelihood of occurrence. The overall degree of concern is negligible. As no known historical resources will be affected as part of Project Millennium, the regional effect of the project is also negligible.

The cumulative effects of Project Millennium and other existing, approved and planned developments in the region are more difficult to address. The regional database concerning the distribution, quantity and significance of historical resources is, at best, incomplete. A model of historical resource potential was created as part of the Project Millennium HRIA in an effort to quantify and illustrate the cumulative effects of regional oil sand developments. The model indicates that the impacts will be moderate to low in severity, long-term and irreversible. They will be regional in extent, with a high degree of scientific uncertainty due to the lack of confirmed information for much of the region. The degree of concern and the likelihood of occurrence can not be addressed at this time due to the incomplete database. These will be addressable only after future impact assessments are completed.

G2.7 Traditional Land Use and Resource Use

Introduction

This section provides concluding remarks in relation to the objectives, methods and results of the Traditional Land Use and Resource Use components of the Project Millennium EIA. It reviews the environmental consequences of the Project on Traditional Land Use and Resource Use both locally and regionally. It also comments on the anticipated effects of the Project in combination with existing, approved and planned developments in the region.

Traditional Land Use

The objectives of this component of the EIA were to address a two key questions: "What impacts will development and closure of Project Millennium have on traditional land use practices?" and "What impacts will result from changes to traditional land use associated with Project Millennium and the combined developments?". With respect to traditional land use, methods adopted to consider these issues included:

- Review and consolidation of the extensive background information to establish a detailed understanding of traditional land use and resource use in the Project local and regional study areas.
- Preparation of a report by the Fort McKay community to provide specific information on resource and site distributions, harvest locations and traditional land use practices in both the local and regional study areas.
- Archival investigations to determine the potential of materials maintained at the Hudson Bay Company archives in defining a pattern of regional traditional land use over a much broader time frame than currently available.
- Quantitative analysis comparing the area identified by the Fort McKay Communities as traditional lands with those that would be affected by existing, approved and planned developments in combination with Project Millennium.

The information obtained in these studies provided a firm basis for concluding that the Aboriginal communities surrounding the development area continue to actively and extensively rely on the traditional land use practices involved in their "bush economy" to maintain their traditional way of life. These practices involve, hunting trapping, fishing, plant collection (for food, medicinal and other purposes) and a variety of social, ceremonial and recreational activities.

Many of these activities focus on highly productive riparian habitat in the vicinity of watercourses and in upland areas such as the Birch Hills. By comparison, use of the level interior plains, such as those where Project Millennium is situated, is relatively modest, reflecting the distribution and density of traditionally used resources. Registered trapline holders in the Project area were compensated under the Steepbank Mine development. Additionally, several resource harvest areas that reflect traditional use of the area associated with the trapline will be affected. These areas represent an area within which a wide variety of traditional practices were conducted (see Section F3.2). Although two traditional trails occur in the Project Millennium development area, these have been heavily modified by modern activities. No graves, cabins, or special places were reported to be present within the project area, however two relatively recent cabins were identified during historical resources investigations.

The short term effects of the expanded Steepbank Mine have been addressed by compensation to registered trapline owners for loss of their resource harvest areas. Medium term effects will be ameliorated by the staged nature of the development, which would provide a period of transition for both the traditional land users and the wildlife resources they harvest. The long term effects of the project will be addressed in closure and end land use planning that takes into account the potential of the landscape for sustainable traditional land use.

The effects of the Project on traditional land use practices would be considered low considering reported use patterns and the limited area to be affected by the project in comparison to the total traditional territory of the aboriginal communities. The environmental consequence of the Project on traditional land use is rated as Negligible. This rating is based on a low magnitude impact, which is local in area and reversible. The impact occurs once, although it will be long-term in duration.

Project Millennium, in culmination with existing, approved and planned developments in the region, would affect 12% of the traditional lands of the Fort McKay community.

In a quantitative sense, the direct effects of regional development on traditional land use practices would be considered to be moderate in magnitude, considering the portion of the traditional land use base that would be directly affected. The magnitude of indirect effects associated with increasing, sometimes competitive, land uses in the region is difficult to evaluate, but would probably be low as proposed population increases associated with the Project are small. Both these effects would be regional in geographic extent. Direct effects should be reversible with implementation of appropriate mitigation measures and closure planning. The indirect effects may also be reversible over the long term as developments cease operation and regional populations decrease. The likelihood of occurrence would be based on a variety of factors, including the economic viability of the oil sands and forestry resources and is considered to be moderate.

The degree of concern for loss of the traditional lifestyle in regional aboriginal communities that has been reported in studies conducted for projects in the region and other more general studies ranges from low through high. On-going consultation with each community will further clarify this situation. Suncor also supports the multi-stakeholder efforts currently underway and is committed to active participation in efforts to establish a regional strategy that balances development objectives with the concerns of resident communities.

Resource Use

The impact of Project Millennium on the non-traditional resource use was assessed through four key questions for the EIA. The questions addressed the impacts of Project Millennium on surface and mineral material extraction, agriculture, forestry and ESAs (including Special Places 2000 nominated sites). Two questions were used to assess impact on consumptive and non-consumptive effects on resource utilization were also assessed.

Project Millennium will impact sand and gravel resources because of the need for roads and infrastructure. To reduce impacts Suncor will use all available material on the mine footprint to minimize the impact on regional gravel resources. The agricultural potential for the LSA is very limited and, therefore, will not be impacted by the development. Forestry will be impacted on the LSA during the life of Project Millennium, but forestry potential will be regained after closure. Trees will be salvaged from areas impacted by development to reduce the loss of this resource. The Project impact on berry-picking, trapping, hunting and fishing is negligible because there will be no change in current access to, and use of the area. Essentially, there was no access to the area prior to development and this will continue during the lifetime of Project Millennium. After closure access to the area may improve because of the remaining mine infrastructure. Detailed description of impacts on vegetation (berries), wildlife (hunting and trapping) and fisheries are in the appropriate sections of the EIA. Trapping revenues will not be impacted because of a compensation agreement between the trappers and Suncor.

The Athabasca River-Tar Sands Reach ESA will be affected by Project development. However, this issue has previously been addressed as per the Fort McMurray-Athabasca Oil Sands Subregional Integrated Resource Plan (AEP 1996a). Because the issue was addressed in the Steepbank Mine EIA, and the resource plan guidelines will be followed during the development and operation of Project Millennium, there are no new impacts.

Non-consumptive resource use will not be negatively impacted by Project Millennium. Like berry-picking, hunting, fishing and trapping; the access to the area will not change. Because access is currently limited and will continue to be limited, the potential for non-consumptive resource use will not change. After closure the opportunity for non-consumptive resource use may improve because of improved access. Project Millennium may positively impact the potential for non-consumptive use by increasing the population and profile of the area; therefore increasing the number of visitors.

Cumulative effects were addressed by answering Key Question CRU-1. Cumulative effects were evaluated in a qualitative way because there were no major impacts as the result of Project Millennium. The results of the cumulative effects assessment is that Project Millennium will have a low impact on the land use in the RSA.

G2.8 Socio-Economics

Project Millennium creates significant employment, household income, and government fiscal benefits to the region, the province, and the country. It is a cornerstone project in the resurgent interest in developing the oil sands resources in northeastern Alberta.

The population growth induced by Project Millennium can be accommodated by the regional service providers. Indeed, the urban service area of Fort McMurray is already coping with population increases of similar magnitude in anticipation of a range of oil sands projects. The outlying communities, especially Fort McKay, which is located in close proximity to the Suncor plant, will likely experience a modest increase in population as well. This could create additional stress on their physical and service infrastructure.

Cumulatively, the region is preparing for a population increase of about one-third. This will create challenges for the municipality and the local and regional service providers. The current development phase of the oil sands industry is different from those in the past due to the scale of the total investment and the number of companies involved. This increases the need for regional cooperation between project proponents, the Regional Municipality of Wood Buffalo, and service providers. This cooperation is already emerging through the work of the Regional Infrastructure Working Group (RIWG) and the Athabasca Oil Sands Development Facilitation Committee (AOSDFC) and will need to be continued throughout the construction and operations phases of Project Millennium and the other proposed projects.

The main regional concerns include local employment, housing, education, social services, health services, emergency services and highway transportation. Sub-committees of the RIWG have been struck to develop resolution strategies. With respect to Project Millennium, Suncor has specific initiatives to ensure regional committees participate in the project to the fullest extent possible. One example is to target work force diversity consistent with regional demographics.

The challenges of growth notwithstanding, Project Millennium will have a positive socio-economic impact on the region and the project is desirable from the perspective of the region, the province, and the country.

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GLOSSARY

Abiotic Non-living factors that influence an ecosystem, such as climate, geology and soil characteristics.

Activity Area A limited portion of a site in which a specialized cultural function was carried out, such as hide scraping, tool manufacture, food preparation and other activities.

Acute Exposures Exposures occurring over a short period of time, usually at high concentrations.

Adverse Effect An undesirable or harmful effect to an organism (human, animal or plant), indicated by some result such as mortality, growth inhibition, reproductive abnormalities, altered food consumption, altered body and organ weights, altered enzyme concentrations, visible pathological changes or carcinogenic effects.

Age-to-maturity Most often refers to the age at which more than 50% of the individuals of a particular sex within a population reach sexual maturity. Age-to-maturity of individuals within the same population can vary considerably from the population median value. In fish species, males often reach sexual maturity at a younger age than female.

Airshed Describes the geographic area requiring unified management for achieving air pollution control.

Alkalinity A measure of water's capacity to neutralize an acid. It indicates the presence of carbonates, bicarbonates and hydroxides, and less significantly, borates, silicates, phosphates and organic substances. It is expressed as an equivalent of calcium carbonate. The composition of alkalinity is affected by pH, mineral composition, temperature and ionic strength. However, alkalinity is normally interpreted as a function of carbonates, bicarbonates and hydroxides. The sum of these three components is called total alkalinity.

Alluvium Sediment deposited in land environments by streams.

Ambient The conditions surrounding an organism or area.

AOSERP Alberta Oil Sands Environmental Research Program.

Aquifer A body of rock or soil that contains sufficient amounts of saturated permeable material to yield economic quantities of water to wells or springs.

Archaeology The scientific discipline responsible for studying the unwritten portion of man's historic and prehistoric past.

Armouring Channel erosion protection by covering with protection material.

Artifact	Any portable object modified or manufactured by man.
ASL	Above sea level.
Aspect	Compass orientation of a slope as an inclined element of the ground surface.
ASWQO	Alberta Surface Water Quality Objectives. Numerical concentrations or narrative statements established to support and protect the designated uses of water. These are minimum levels of quality, developed for Alberta watersheds, below which no waterbody is permitted to deteriorate. These objectives were established as minimum levels that would allow for the most sensitive use. These concentrations represent a goal to be achieved or surpassed.
Available Drawdown	The vertical distance that the equipotential surface of an aquifer can be lowered; in confined aquifers, this is to the top of the aquifer; in unconfined aquifers, this is to the bottom of the aquifer.
Background	An area not influenced by chemicals released from the site under evaluation.
Background Concentration (environmental)	The concentration of a chemical in a defined control area during a fixed period before, during or after data-gathering.
Backwater	Discrete, localized area exhibiting reverse flow direction and, generally lower stream velocity than main current; substrate similar to adjacent channel with more fines.
Baseline	A surveyed condition that serves as a reference point on which later surveys are coordinated or correlated.
Beaver River Sandstone	A light gray, medium to fine-grained quartz sandstone cemented in a silica matrix.
Bedrock	The body of rock which underlies gravel, soil or other superficial material.
Benthic Invertebrates	Invertebrate organisms living at, in or in association with the bottom (benthic) substrate of lakes, ponds and streams. Examples of benthic invertebrates include some aquatic insect species (such as caddisfly larvae) that spend at least part of their lifestages dwelling on bottom sediments in the river. These organisms play several important roles in the aquatic community. They are involved in the mineralization and recycling of organic matter produced in the open water above, or brought in from external sources, and they are important second and third links in the trophic sequence of aquatic communities. Many benthic invertebrates are major food sources for fish.

Bile	An alkaline secretion of the vertebrate liver. Bile, which is temporarily stored in the gall bladder, is composed of organic salts, excretion products and bile pigments. It primarily functions to emulsify fats in the small intestine.
Bioaccumulation	A general term meaning that an organism stores within its body a higher concentration of a substance than is found in the environment. This is not necessarily harmful. For example, freshwater fish must bioaccumulate salt to survive in intertidal waters. Many toxicants, such as arsenic, are not included among the dangerous bioaccumulative substances because they can be handled and excreted by aquatic organisms.
Bioavailability	The amount of chemical that enters the general circulation of the body following administration or exposure.
Bioconcentration	A process where there is a net accumulation of a chemical directly from an exposure medium into an organism.
Biodiversity	The variety of organisms and ecosystems that comprise both the communities of organisms within particular habitats and the physical conditions under which they live.
Biological Indicators	Any biological parameter used to indicate the response of individuals, populations or ecosystems to environmental stress. For example, growth is a biological indicator.
Biomarker	Biomarker refers to a chemical, physiological or pathological measurement of exposure or effect in an individual organism from the laboratory or the field. Examples include: contaminants in liver enzymes, bile and sex steroids.
Biome	A major community of plants and animals such as the boreal forest or tundra biome.
Biotic	The living organisms in an ecosystem.
Bitumen	A highly-viscous, tarry, black hydrocarbon material having an API gravity of about 9° (specific gravity about 1.0). It is a complex mixture of organic compounds. Carbon accounts for 80% to 85% of the elemental composition of bitumen, hydrogen - 10%, sulphur - 5%, and nitrogen, oxygen and trace elements the remainder.
BOD	The biochemical oxygen demand (BOD) determination is an imperical test in which standardized laboratory procedures are used to determine the relative oxygen requirements of wastewaters, effluents and polluted waters.
Bottom Sediments	Substrates that lie at the bottom of a body of water. For example, soft mud, silt, sand, gravel, rock and organic litter, that make up a river bottom.

Bottom-feeding Fish	Fish that feed on the substrates and/or organisms associated with the river bottom.
Cancer	A disease characterized by the rapid and uncontrolled growth of aberrant cells into malignant tumours.
Canopy	An overhanging cover, shelter or shade; the tallest layer of vegetation in an area.
Carcinogen	An agent that is reactive or toxic enough to act directly to cause cancer.
Carrying capacity	The maximum population size that can be supported by the available resources.
Centre Reject	A non bituminous baring material found within a central zone of the oil sand ore body.
Cervid	Of the family Cervidae, which includes elk, deer, moose, and caribou.
Chert	A fine-grained siliceous rock. Impure variety of chalcedony which is generally light-coloured.
Chronic Exposure	Exposures occurring over a relatively long duration of time (Health Canada considers periods of human exposure greater than three months to be chronic while the U.S. EPA only considers human exposures greater than seven years to be chronic).
Chronic Toxicity	The development of adverse effects after an extended exposure to relatively small quantities of a chemical.
Chronic Toxicity Unit (TU_c)	Measurement of long duration toxicity that produces an adverse effect on organisms.
Climax	The culminating stage in plant succession for a given site where the vegetation has reached a stable condition.
Cline	A gradual change in a feature across the distributional range of a species or population.
Closure	The point after shutdown of operations when regulatory certification is received and the area is returned to the Crown.
Community	Pertaining to plant or animal species living in close association or interacting as a unit.
Composite Tailings (CT)	A non-segregating mixture made by Syncrude Canada Ltd. of oil sands extraction tailings that consolidates relatively quickly in deposits. Composed of sand tailings, mature fine tailings and a chemical stabilizer (e.g., $CaSO_4$).
Concentration	Quantifiable amount of a chemical in environmental media.

Conceptual Model	A model developed at an early stage of the risk assessment process that describes a series of working hypotheses of how the chemicals of concern may affect potentially exposed populations. The model identifies the populations potentially at risk along with the relevant exposure pathways and scenarios.
Condition Factor	A measure of the relative "fitness" of an individual or population of fishes by examining the mathematical relationship between length and weight. The values calculated show the relationship between growth in length relative to growth in weight. In populations where increases in length are matched by increases in weight, the growth is said to be isometric. Allometric growth, the most common situation in wild populations, occurs when increases in either length or weight are disproportionate.
Conditioning Drums	Large, inclined cylindrical tumblers that rotate slowly, used for preparing (conditioning) oil sand for primary extraction by mixing it with hot water and steam.
Conductivity	A measure of a waterbody's capacity to conduct an electrical current. It is the reciprocal of resistance. This measurement provides the limnologist with an estimation of the total concentration of dissolved ionic matter in the water. It allows for a quick check of the alteration of total water quality due to the addition of pollutants to the water.
Confined Aquifer	An aquifer in which the potentiometric surface is above the top of the aquifer.
Conifers	White and black spruce, balsam fir, jack pine and tamarack.
Conservative Approach	Approach taken to incorporate protective assumptions to ensure that risks will not be underestimated.
Consolidated Tailings (CT)	Consolidated Tailings (CT) is a non-segregating mixture made by Suncor Energy Inc., Oil Sands of plant tailings which consolidates relatively quickly in tailings deposits. At Suncor, Consolidated Tailings are prepared by combining mature fine tails with thickened (cycloned) fresh sand tailings. This mixture is chemically stabilized (to prevent segregation of fine and coarse mineral solids) using gypsum ($CaSO_4$).
Consolidated Tailings Release Water	Water is expelled from Consolidated Tailings mixtures during the course of consolidation. The water is referred to as Consolidated Tailings (or CT) release water.
Consolidation	The gradual reduction in volume of a soil or semi-solid mass.
Contaminant Body Burdens	The total concentration of a contaminant found in either whole-body or individual tissue samples.

Contaminants	A general term referring to any chemical compound added to a receiving environment in excess of natural concentrations. The term includes chemicals or effects not generally regarded as "toxic," such as nutrients, colour and salts.
Control	A treatment in a toxicity test that duplicates all the conditions of exposure treatments but contains no test material. The control is used to determine basic test conditions in the absence of toxicity (e.g., health of test organisms, quality of dilution water).
Cratering	The act of creating depressions, or craters, in the snow when foraging for food. Usually done by elk or other ungulates.
Crop Tree Regeneration	The renewal of a forest or stand of trees by natural or artificial means, usually white spruce, jack pine or aspen.
Culture	The sum of man's non-biological behavioural traits: learned, patterned and adaptive.
CWQG	Canadian Water Quality Guidelines. Numerical concentrations or narrative statements recommended to support and maintain a designated water use in Canada. The guidelines contain recommendations for chemical, physical, radiological and biological parameters necessary to protect and enhance designated uses of water.
Cyclofeeder	A cyclofeeder is a vertical, open-topped cylindrical vessel with a conical bottom. The purpose of a cyclofeeder is to mix oil sand with warm water to form a slurry which can be pumped via a pipeline to Extraction. Warm water is introduced through horizontal ports situated at the bottom of the vertical portion to produce a vortex inside the vessel, into which incoming oil sands falls. The energy imparted to the oil sand forms a slurry, which is withdrawn at the bottom of the cone.
Darcy's Law	A law describing the rate of flow of water through porous media. (Named for Henry Darcy of Paris who formulated it in 1856 from extensive work on the flow of water through sand filter beds.)
DEM (Digital Elevation Model)	A three-dimensional grid representing the height of a landscape above a given datum.
Dendritic Drainage Pattern	A drainage pattern characterized by irregular branching in all directions with the tributaries joining with the main stream at all angles.
Deposit	Material left in a new position by a natural transporting agent such as water, wind, ice or gravity, or by the activity of man.
Depressurization	The process of reducing the pressure in an aquifer, by withdrawing water from it.

Depuration	Loss of accumulated chemical residues from an organism placed in clean water or clean solution.
Detection Limit (DL)	The lowest concentration at which individual measurement results for a specific analyte are statistically different from a blank (that may be zero) with a specified confidence level for a given method and representative matrix.
Deterministic	Risk approach using a single number from each parameter set in the risk calculation and producing a single value of risk.
Detoxification	To decrease the toxicity of a compound. Bacteria decrease the toxicity of resin and fatty acids in mill effluent by metabolizing or breaking down these compounds; enzymes like the EROD or P4501A proteins begin the process of breaking down and metabolizing many "oily" compounds by adding an oxygen atom.
Development Area	Any area altered to an unnatural state. This represents all land and water areas included within activities associated with development of the oil sands leases.
Diameter at Breast Height (DBH)	The diameter of a tree 1.5 m above the ground on the uphill side of the tree.
Discharge	In a stream or river, the volume of water that flows past a given point in a unit of time (i.e., m^3/s).
Disclimax	A type of climax community that is maintained by either continuous or intermittent disturbance to a severity that the natural climax vegetation is altered.
Disturbance (Historic)	A cultural deposit is said to be disturbed when the original sequence of deposition has been altered. Examples of agents of disturbance include erosion, plant or animal activity, cultivation and excavations.
Disturbance (Terrestrial)	A force that causes significant change in structure and/or composition of a habitat.
Disturbance coefficient	The effectiveness of the habitat within the disturbance zone of influence in fulfilling the requirements of a species.
Disturbance zone of influence	The maximum distance to which a disturbance (e.g., traffic noise) is felt by a species.
Diversity	The variety, distribution and abundance of different plant and animal communities and species within an area.
Dose	A measure of integral exposure. Examples include (1) the amount of chemical ingested, (2) the amount of a chemical taken up, and (3) the product of ambient exposure concentration and the duration of exposure.

Dose Rate	Dose per unit time, for example in mg/day, sometimes also called dosage. Dose rates are often expressed on a per-unit-body-weight basis, yielding units such as mg/kg body weight/day expressed as averages over some period, for example a lifetime.
Dose-Response	The quantitative relationship between exposure of an organism to a chemical and the extent of the adverse effect resulting from that exposure.
Drainage Basin	The total area that contributes water to a stream.
Dry Landscape Reclamation	A reclamation approach that involves dewatering or incorporation of fine tailings into a solid deposit capable of being reclaimed as a land surface or a wetland.
Ecological Land Classification	A means of classifying landscapes by integrating landforms, soils and vegetation components in a hierarchical manner.
Ecoregion	Ecological regions that have broad similarities with respect to soil, terrain and dominant vegetation.
Ecosection	Clearly-recognizable landforms such as river valleys and wetlands at a broad level of generalization.
Ecosite	Ecological units that develop under similar environmental influences (climate, moisture and nutrient regime). Ecosites are groups of one or more ecosite phases that occur within the same portion of the moisture/nutrient grid. Ecosite is a functional unit defined by the moisture and nutrient regime. It is not tied to specific landforms or plant communities, but is based on the combined interaction of biophysical factors that together dictate the availability of moisture and nutrients for plant growth.
Ecosite Phase	A subdivision of the ecosite based on the dominant tree species in the canopy. On some sites where the tree canopy is lacking, the tallest structural vegetation layer determines the ecosite phase.
Ecosystem	An integrated and stable association of living and non-living resources functioning within a defined physical location.
Edaphic	Referring to the soil. The influence of the soil on plant growth is referred to as an edaphic factor.
Edge	Where plant communities meet; and where plant communities meet a disturbance.
Effluent	Stream of water discharging from a source.
Environmental Impact Assessment	A review of the effects that a proposed development will have on the local and regional environment.

Environmental Media	One of the major categories of material found in the physical environment that surrounds or contacts organisms (e.g., surface water, groundwater, soil, food or air) and through which chemicals can move and reach the organism.
Ephemeral	A phenomenon or feature that last only a short time (i.e., an ephemeral stream is only present for short periods during the year).
EROD	Ethoxyresorufin-O-deethylase (EROD) are enzymes that can increase in concentration and activity following exposure of some organisms to chemicals such as polycyclic aromatic hydrocarbons. EROD measurement indirectly measures the presence of catalytical proteins that remove a CH_3CH_2-group from the substrate ethoxyresorufin.
Escarpment	A cliff or steep slope at the edge of an upland area. The steep face of a river valley.
Exposure	The contact reaction between a chemical and a biological system, or organism.
Exposure Assessment	The process of estimating the amount (concentration or dose) of a chemical that is taken up by a receptor from the environment.
Exposure Concentration	The concentration of a chemical in its transport or carrier medium at the point of contact.
Exposure Limit or Toxicity Reference Value	For a non-carcinogenic chemical, the maximum acceptable dose (per unit body weight and unit of time) of a chemical that a specified receptor can be exposed to, without the development of adverse effects. For a carcinogenic chemical, the maximum acceptable dose of a chemical to which a receptor can be exposed to, assuming a specified risk (e.g., 1 in 100 000). May be expressed as a Reference Dose (RfD) for non-carcinogenic (threshold-response) chemicals or as a Risk Specific Dose (RsD) for carcinogenic (non-threshold response) chemicals. Also referred to as a toxicity reference value.
Exposure Pathway or Route	The route by which a receptor comes into contact with a chemical or physical agent. Examples of exposure pathways include: the ingestion of water, food and soil; the inhalation of air and dust; and dermal absorption.
Exposure Ratio (ER) or Hazard Quotient (HQ)	A comparison between total exposure from all predicted routes of exposure and the exposure limits for chemicals of concern. This comparison is calculated by dividing the predicted exposure by the exposure limit. Also referred to as hazard quotient (HQ).
Exposure Scenario	A set of facts, assumptions and inferences about how exposure takes place, that helps the risk assessor evaluate, estimate and quantify exposures.

Fate
In the context of the study of contaminants, fate refers to the chemical form of a contaminant when it enters the environment and the compartment of the ecosystem in which that chemical is primarily concentrated (e.g., water or sediments). Fate also includes transport of the chemical within the ecosystem (via water, air or mobile biota) and the potential for food chain accumulation.

Fauna
An association of animals living in a particular place or at a particular time.

Fecundity
The most common measure of reproductive potential in fishes. It is the number of eggs in the ovary of a female fish. It is most commonly measured in gravid fish. Fecundity increases with the size of the female.

Filter-Feeders
Organisms that feed by straining small organisms or organic particles from the water column.

Filterable Residue
Materials in water that pass through a standard-size filter (often 0.45 μm). This is a measure of the "total dissolved solids" (TDS), i.e., chemicals that are dissolved in the water or that are in a particulate form smaller than the filter size. These chemicals are usually salts, such as sodium ions and potassium ions.

Fine Tailings
A suspension of fine silts, clays, residual bitumen and water that forms in the course of bitumen extraction from oil sands using the hot water extraction process. This material segregates from coarse sand tailings during placement in tailings ponds and accumulates in a layer (referred to as fine tailings) that dewaters very slowly. The top of the fine tailings deposit is typically about 85% water, 13% fine minerals and 2% bitumen by weight.

Fines
Silt and clay particles.

Fish Health Parameters
Parameters used to indicate the health of an individual fish. May include, for example, short-term response indicators such as changes in liver mixed function oxidase activity and the levels of plasma glucose, protein and lactic acid. Longer-term indicators include internal and external examination of exposed fish, changes in organ characteristics, hematocrit and hemoglobin levels. May also include challenge tests such as disease resistance and swimming stamina.

Fisheries Act
Federal legislation that protects fish habitat from being altered, disrupted or destroyed by chemical, physical or biological means. Destruction of the habitat could potentially undermine the economic, employment and other benefits that flow from Canada's fisheries resources (DFO 1986).

Floodplain
Land near rivers and lakes that may be inundated during seasonally high water levels (i.e., floods).

Flue Gas Desulphurization (FGD)	A process involving removal of a substantial portion of sulphur dioxide from the combustion gas (flue gas) formed from burning petroleum coke. Desulphurization is accomplished by contacting the combustion gases with a solution of limestone. Gypsum ($CaSO_4$) is formed as a byproduct of this process.
Fluvial	Relating to a stream or river.
Food Chain Transfer	A process by which materials accumulate in the tissues of lower trophic level organisms and are passed on to higher trophic level organisms by dietary uptake.
Forage Area	The area used by an organism for hunting or gathering food.
Forage Fish	Small fish that provide food for larger fish (e.g., longnose sucker, fathead minnow)
Forb	Broadleaved herb, as distinguished from grasses.
Forest	A collection of stands of trees that occur in similar space and time.
Forest Fragmentation	The change in the forest landscape, from extensive and continuous forests.
Forest Landscape	Forested or formerly forested land not currently developed for non-forest use.
Forest Succession	The orderly process of change in a forest as one plant community or stand condition is replaced by another, evolving toward the climax type of vegetation.
Fragmentation	The process of reducing size and connectivity of stands of trees that compose a forest.
Froth	Air-entrained bitumen with a froth-like appearance that is the product of the primary extraction step in the hot water extraction process.
Fugitive Emissions	Contaminants emitted from any source except those from stacks and vents. Typical sources include gaseous leakages from valves, flanges, drains, volatilization from ponds and lagoons, and open doors and windows. Typical particulate sources include bulk storage areas, open conveyors, construction areas or plant roads.
Genetic diversity	Describes the range of possible genetic characteristics found within a species and amongst different species (e.g., variations in hair colour, eye colour, and height in humans).
Geomorphic	Pertaining to natural evolution of surface soils and landscape over long periods.
Geomorphical Processes	The origin and distribution of landforms, with the emphasis on the nature of erosional processes.

Geomorphology	That branch of science which deals with the form of the earth, the general configurations of its surface and the changes that take place in the evolution of landforms.
GIS	Geographic Information System. Pertains to a type of computer software that is designed to develop, manage, analyze and display spatially-referenced data.
Glacial Till	Unsorted and unstratified glacial drift (generally unconsolidated) deposited directly by a glacier without subsequent reworking by water from the glacier. Consisting of a heterogeneous mixture of clay, silt, sand, gravel and boulders (i.e., drift) varying widely in size and shape.
Glaciolacustrine (or Glacio-Lacustrine)	Relating to the lakes that formed at the edge of glaciers as the glaciers receded. Glaciolacustrine sediments are commonly laminar deposits of fine sand, silt and clay.
Golder	Golder Associates Ltd.
Gonads	Organs responsible for producing haploid reproductive cells in multi-cellular cells in multi-cellular animals. In the male, these are the testes and in the female, the ovaries.
Groundtruth	Conductive site visits to confirm accuracy of remotely sensed information.
Groundwater	That part of the subsurface water that occurs beneath the water table, in soils and geologic formations that are fully saturated.
Groundwater Level	The level below which the rock and subsoil, to unknown depths, are saturated.
Groundwater Regime	Water below the land surface in a zone of saturation.
Groundwater Velocity	The speed at which groundwater advances through the ground. In this document, the term refers to the average linear velocity of the groundwater.
GSI	Gonad-Somatic Index. The proportion of reproductive tissue in the body of a fish. It is calculated by dividing the total gonad weight by the total body weight and multiplying the result by 100. It is used as an index of the proportion of growth allocated to reproductive tissues in relation to somatic growth.
Guild	A set of co-existing species that share a common resource.
Habitat	The place where an animal or plant naturally or normally lives and grows, for example, a stream habitat or a forest habitat.
Habitat alienation	The loss of habitat effectiveness as a result of sensory disturbances from human activities at disturbed sites.

Habitat effectiveness	Including the physical characteristics suitability of a habitat, the ability of a habitat to be used by wildlife. The effectiveness of a habitat can be decreased through visual, auditory, or olfactory disturbance even though the physical characteristics of the habitat remain unchanged.
Habitat fragmentation	Occurs when extensive, continuous tracts of habitat are reduced by habitat loss to dispersed and usually smaller patches of habitat. Generally reduces the total amount of available habitat and reduces remaining habitat into smaller, more isolated patches
Habitat generalist	Wildlife species that can survive and reproduce in a variety of habitat types (e.g., red-backed vole).
Habitat specialist	Wildlife species that is dependent on a few habitat types for survival and reproduction (e.g., Cape May warbler).
Habitat Suitability Index (HSI) model	Analytical tools for determining the relative potential of an area to support individuals or populations of a wildlife species. They are frequently used to quantify potential habitat losses and gains for wildlife as a result of various land use activities.
Habitat unit	Generally, used in HSI models. A habitat is ranked in regards to its suitability for a particular wildlife species. This ranking is then multiplied by the area (ha) of the particular habitat type to give the number of habitat units available to the wildlife species in question.
Hazard	A condition with the potential for causing an undesirable consequence.
Head	The energy, either kinetic or potential, possessed by each unit weight of a liquid, expressed as the vertical height through which a unit weight would have to fall to release the average energy possessed. It is used in various compound terms such as pressure head, velocity head and loss of head.
Herb	Tender plant, lacking woody stems, usually small or low; it may be annual or perennial, broadleaf (forb) or graminoid (grass).
Heterogeneity	Variation in the environment over space and time.
Histology/ Histological	The microscopic study of tissues.
Historical Resources Impact Assessment	A review of the effects that a proposed development will have on the local and regional historic and prehistoric heritage of an area.
Historical/Heritage Resources	Works of nature or of man, valued for their palaeontological, archaeological, prehistoric, historic, cultural, natural, scientific, or aesthetic interest.

Human Health Risk Assessment	The process of defining and quantifying risks and determining the acceptability of those risks to human life.
Hydraulic Conductivity	The permeability of soil or rock to water.
Hydraulic Gradient	A measure of the force of moving groundwater through soil or rock. It is measured as the rate of change in total head per unit distance of flow in a given direction. Hydraulic gradient is commonly shown as being dimensionless, since its units are m/m.
Hydraulic Head	The elevation, with respect to a specified reference level, at which water stands in a piezometer connected to the point in question in the soil. Its definition can be extended to soil above the water table if the piezometer is replaced by a tensiometer. The hydraulic head in systems under atmospheric pressure may be identified with a potential expressed in terms of the height of a water column. More specifically, it can be identified with the sum of gravitational and capillary potentials, and may be termed the hydraulic potential.
Hydraulic Structure	Any structure designed to handle water in any way. This includes retention, conveyance, control, regulation and dissipation of the energy of water.
Hydrocyclone	A device for separating out sand from extraction tailings slurry by imparting a rotating (cyclone) action to the slurry. Water, fine tailings and residual bitumen report to the overflow of the device. Sand flows out the bottom of the device in a dense slurry.
Hydrogeology	The study of the factors that deal with subsurface water (groundwater), and the related geologic aspects of surface water.
Hydrotransport	Refers to the transport of granular materials (e.g., oil sands ore or extraction tailings) by means of a water-based slurry in a pipeline.
ICP (Metals)	Inductively Coupled Plasma (Atomic Emission Spectroscopy). This analytical method is a U.S. EPA designated method (Method 6010). The method determines elements within samples of groundwater, aqueous samples, leachates, industrial wastes, soils, sludges, sediments and other solid wastes. Samples require chemical digestion before analysis.
Induction	Response to a biologically active compound — involves new or increased gene expression resulting in enhanced synthesis of a protein. Such induction is commonly determined by measuring increases in protein levels and/or increases in the corresponding enzyme activity. For example, induction of EROD would be determined by measuring increases in cytochrome P4501A protein levels and/or increases in EROD activity.
Inorganics	Pertaining to a compound that contains no carbon.

Integrated Resource Management	A coordinated approach to land and resource management, which encourages multiple-use practices.
Interspersion	The percentage of map units containing categories different from the map unit surrounding it.
Inversion	An atmospheric condition when temperatures increase with height above the ground. During inversion conditions the vertical mixing of emissions are restricted.
Isolated Find	The occurrence of a single artifact with no associated artifacts or features.
KIRs	Key indicator resources are the environmental attributes or components identified as a result of a social scoping exercise as having legal, scientific, cultural, economic or aesthetic value.
Landform	General term for the configuration of the ground surface as a factor in soil formation; it includes slope steepness and aspect as well as relief. Also, configurations of land surface taking distinctive forms and produced by natural processes (e.g., hill, valley, plateau).
LANDSAT	A specific satellite or series of satellites used for earth resource remote sensing. Satellite data can be converted to visual images for resource analysis and planning.
Landscape	A heterogeneous land area with interacting ecosystems.
Landscape Diversity	The size, shape and connectivity of different ecosystems across a large area.
Leaching	The removal, by water, of soluble matter from regolith or bedrock.
Lean Oil Sands	Oil bearing sands, which do not have a high enough saturation of oil to make extraction of them economically feasible.
Lesions	Pathological change in a body tissue.
Lethal	Causing death by direct action.
Linear corridor	Roads, seismic lines, pipelines and electrical transmission lines, or other long, narrow disturbances.
Lipid	One of a large variety of organic fats or fat-like compounds, including waxes, steroids, phospholipids and carotenes. Refers to substances that can be extracted from living matter using hydrocarbon solvents. They serve several functions in the body, such as energy storage and transport, cell membrane structure and chemical messengers.
Littoral Zone	The zone in a lake that is closest to the shore.

Loading Rates	The amount of deposition, determined by technical analysis, above which there is a specific deleterious ecological effect on a receptor.
LOAEL	Lowest Observed Adverse Effect Level. In toxicity testing it is the lowest concentration at which adverse effects on the measurement end point are observed.
LOEC	Lowest Observed Effect Concentration. The lowest concentration in a medium that causes an effect that is a statistically significant difference in effect compared to controls.
LOEL	Lowest Observed Effect Level. In toxicity testing it is the lowest concentration at which effects on the measurement end point are observed.
LSI	Liver Somatic Index. Ratio of liver versus total body weight. Expressed as a percentage of total body weight.
m^3/s	Cubic metres per second. The standard measure of water flow in rivers; i.e., the volume of water in cubic metres that passes a given point in one second.
Mature Fine Tailings (MFT)	These are fine tailings that have dewatered to a level of about 30% solids over a period of about three years after deposition. The rate of consolidation beyond this point is substantially reduced. Mature fine tailings behave like a viscous fluid.
Mature Forest	A forest greater than rotation age with moderate to high canopy closure; a multi-layered, multi-species canopy dominated by large overstory trees; some with broken tops and other decay; numerous large snags and accumulations of downed woody debris.
Mature Stand	A stand of trees for which the annual net rate of growth has peaked.
Media	The physical form of the environmental sample under study (e.g., soil, water, air).
Merchantable Forest	A forest area with potential to be harvested for protection of lumber/timber or wood pulp. Forests with a timber productivity rating of moderate to good.
Mesic	Pertaining to, or adapted to an area that has an intermediate supply of water; neither wet not dry.
Metabolism	Metabolism is the total of all enzymatic reactions occurring in the cell; a highly coordinated activity of interrelated enzyme systems exchanging matter and energy between the cell and the environment. Metabolism involves both the synthesis and breakdown (catabolism) of individual compounds.

Metabolites	Organisms alter or change compounds in various ways, such as removing parts of the original or parent compound, or in other cases adding new parts. Then, the parent compound has been metabolized and the newly converted compound is called a metabolite.
MFO	Mixed Function Oxidase. A term for reactions catalyzed by the Cytochrome P450 family of enzymes, occurring primarily in the liver. These reactions transform organic chemicals, often altering toxicity of the chemicals.
Microclimate	The temperature, precipitation and wind velocity in a restricted or localized area, site or habitat.
Microtox©	A toxicity test that includes an assay of light production by a strain of luminescent bacteria (*Photobacterium phosphoreum*).
Mineral Soil	Soils containing low levels of organic matter. Soils that have evolved on fluvial, glaciofluvial, lacustrine and morainal parent material.
Mixing Height	The depth of surface layer in which atmospheric mixing of emissions occurs.
Modelling	A simplified representation of a relationship or system of relationships. Modelling involves calculation techniques used to make quantitative estimates of an output parameter based on its relationship to input parameters. The input parameters influence the value of the output parameters.
Movement corridor	Travel way used by wildlife for daily, seasonal, annual and/or dispersal movements from one area or habitat to another.
Multilayered Canopy	Forest stands with two or more distinct tree layers in the canopy; also called multistoried stands.
Muskeg	A soil type comprised primarily of organic matter. Also known as bog peat.
Mycorrhizal	A fungi that forms a symbiotic relationship with plants, resulting in improved nutrient uptake by the plant.
NMHC	Non-Methane Hydrocarbons is a measure of the airborne hydrocarbons, less methane.
NOAEL	No observed adverse effect level. In toxicity testing, it is the highest concentration at which no adverse effects on the measurement end point are observed.
Node	Location along a river channel, lake inlet or lake outlet where flows, sediment yield and water quality have been quantified.

NOEC	No observed adverse effect concentration. The highest concentration in a medium that does not cause a statistically significant difference in effect as compared to controls.
NOEL	No observed effect level. In toxicity testing, it is the highest concentration at which no effects on the measurement end point are observed.
Non-Filterable Residue	Material in a water sample that does not pass through a standard size filter (often 0.45 mm). This is considered to represent "total suspended solids" (TSS), i.e., particulate matter suspended in the water column.
Noncarcinogen	A chemical that does not cause cancer and has a threshold concentration, below which adverse effects are unlikely.
NO_X	A measure of the oxides of nitrogen comprised of nitric oxide (NO) and nitrogen dioxide (NO_2).
Nutrients	Environmental substances (elements or compounds) such as nitrogen or phosphorus, which are necessary for the growth and development of plants and animals.
Oil Sands	A sand deposit containing a heavy hydrocarbon (bitumen) in the intergranular pore space of sands and fine grained particles. Typical oil sands comprise approximately 10 wt% bitumen, 85% coarse sand (>44μm) and a fines (<44μm) fraction, consisting of silts and clays.
Organic Soil	Soils containing high percentages of organic matter (fibric and humic inclusions).
Organics	Chemical compounds, naturally occurring or otherwise, which contain carbon, with the exception of carbon dioxide (CO_2) and carbonates (e.g., $CaCo_3$).
Overburden	The soil, sand, silt or clay that overlies bedrock. In mining terms, this includes all material that has to be removed to expose the ore.
Overstory	Those trees that form the upper canopy in a multi-layered forest.
Overwintering Habitat	Habitat used during the winter as a refuge and for feeding.
PAH(s)	Polycyclic Aromatic Hydrocarbon. A chemical byproduct of petroleum-related industry. Aromatics are considered to be highly toxic components of petroleum products. PAHs, many of which are potential carcinogens, are composed of at least two fused benzene rings. Toxicity increases along with molecular size and degree of alkylation of the aromatic nucleus.

PAI	The Potential Acid Input is a composite measure of acidification determined from the relative quantities of deposition from background and industrial emissions of sulphur, nitrogen and base cations.
Paleosol	A paleosol is a soil that was formed in the past. Paleosols are usually buried beneath a layer of sediments and are thus no longer being actively created by soil formation processes like organic decay.
PANH	Polycyclic Aromatic Nitrogen Heterocycle. See PAH.
PASH	Polycyclic Aromatic Sulphur Heterocycle.
Patch	This term is used to recognize that most ecosystems are not homogeneous, but rather exist as a group of patches or ecological islands that are recognizably different from the parts of the ecosystem that surround them but nevertheless interact with them.
Pathology	The science that deals with the cause and nature of disease or diseased tissues.
Peat	A material composed almost entirely of organic matter from the partial decomposition of plants growing in wet conditions.
Performance Assessment	Prediction of the future performance of a reclaimed lease to allow identification of potential adverse effects with respect to geotechnical, geomorphic and ecosystem sustainability.
Permit Holder	The director of an Historical Resource Impact Assessment. Responsible for the satisfactory completion of all field and laboratory work and author of the technical report.
Physiological	Related to function in cells, organs or entire organisms, in accordance with natural processes of life.
Pictograph	Aboriginally painted designs on natural rock surfaces. Red ochre is the most frequently used pigment.
Piezometer	A pipe in the ground in which the elevation of water level can be measured.
Piezometric Surface	If water level elevations in wells completed in an aquifer are plotted on a map and contoured, the resulting surface described by the contours is known as a potentiometric or piezometric surface.
Plant Community	An association of plants of various species found growing together.
PM_{10}	Airborne particulate matter with mean diameter less than 10 μm (microns) in diameter. This represents the fraction of airborne particles that can be inhaled into the upper respiratory tract.

$PM_{2.5}$	Airborne particulate matter with mean diameter less than 2.5 μm (microns) in diameter. This represents the fraction of airborne particles that can be inhaled deeply into the pulmonary tissue.
Polishing Pond	Pond where final sedimentation takes place before discharge.
Polygon	The spatial area delineated on a map to define one feature unit (e.g., one type of ecosite phase).
Population	A collection of individuals of the same species that potentially interbreed.
Porewater	Water between the grains of a soil or rock.
Problem Formulation	The initial step in a risk assessment that focuses the assessment on the chemicals, receptors and exposure pathways of greatest concern.
Productive Forest	Forests on lands with a capability rating of equal to or greater than 3, and stocked with trees to meet the stocking standards of a merchantable forest.
Propagules	Root fragments, seeds, and other plant materials which can develop into a plant under the right conditions.
QA/QC	Quality Assurance/Quality Control refers to a set of practices that ensure the quality of a product or a result. For example, "Good Laboratory Practice" is part of QA/QC in analytical laboratories and involves such things as proper instrument calibration, meticulous glassware cleaning and an accurate sample information system.
QA/QC Plan	Quality Assurance/Quality Control Plan.
Rearing Habitat	Habitat used by young fish for feeding and/or as a refuge from predators.
Receptor	The person or organism subjected to exposure to chemicals or physical agents.
Reclamation	The restoration of disturbed or wasteland to a state of useful capability. Reclamation is the initiation of the process that leads to a sustainable landscape (see definition), including the construction of stable landforms, drainage systems, wetlands, soil reconstruction, addition of nutrients and revegetation. This provides the basis for natural succession to mature ecosystems suitable for a variety of end uses.
Reclamation Certificate	A certificate issued by an Alberta Environmental Protection, Conservation, and Reclamation Inspector, signifying that the terms and conditions of a conservation and reclamation approval have been complied with.
Reclamation Unit	A unique combination of reclamation conditions, namely surface shape, sub-base material, cover material and initial vegetation.

Refugia	Areas of natural ecosystems within, or adjacent to, a development area from which plants or animals may move back into the development area, or to which animals may move from the development area.
Regeneration	The natural or artificial process of establishing young trees.
Rejects	Hard clusters of clays or lean oil sands that do not pass sizing screens in the extraction process and are rejected. Rejects contain residual bitumen and account for a portion of extraction recovery loss.
Relative Abundance	The proportional representation of a species in a sample or a community.
Remote Sensing	Measurement of some property of an object or surface by means other than direct contact; usually refers to the gathering of scientific information about the earth's surface from great heights and over broad areas, using instruments mounted on aircraft or satellites.
Replicate	Duplicate analyses of an individual sample. Replicate analyses are used for measuring precision in quality control.
Reproductive success	The production of healthy offspring which live to reproduce themselves.
RfD (Reference Dose)	The maximum recommended daily exposure for a non-carcinogenic chemical exhibiting a threshold (highly nonlinear) dose-response based on the NOAEL determined for the chemical from human and/or animals studies and the use of an appropriate uncertainty factor.
Richness	The number of species in a biological community (e.g., habitat).
Riffle Habitat	Shallow rapids where the water flows swiftly over completely or partially submerged materials to produce surface agitation.
Riparian Area	A geographic area containing an aquatic ecosystem and adjacent upland areas that directly affect it.
Risk	The likelihood or probability that the toxic effects associated with a chemical or physical agent will be produced in populations of individuals under their actual conditions of exposure. Risk is usually expressed as the probability of occurrence of an adverse effect, i.e., the expected ratio between the number of individuals that would experience an adverse effect at a given time and the total number of individuals exposed to the factor. Risk is expressed as a fraction without units and takes values from 0 (absolute certainty that there is no risk, which can never be shown) to 1.0, where there is absolute certainty that a risk will occur.

Risk Analysis	Quantification of predictions of magnitudes and probabilities of potential impacts on the health of people, wildlife and/or aquatic biota that might arise from exposure to chemicals originating from a study area.
Risk Assessment	Process that evaluates the probability of adverse effects that may occur, or are occurring on target organism(s) as a result of exposure to one or more stressors.
Risk Characterization	The process of evaluating the potential risk to a receptor based on comparison of the estimated exposure to the toxicity reference value.
Risk Management	The managerial, decision-making and active hazard control process used to deal with those environmental agents for which risk evaluation has indicated the risk is too high.
Risk-Based Concentration (RBC)	Concentration in environmental media below which health risks are not expected to occur.
Robust Landscape	Landscape with either an capability to self-correct after extreme events or one with hazard triggers reducing with time.
RsD (Risk Specific Dose)	The exposure limit determined for chemicals assumed to act as genotoxic, non-threshold carcinogens. An RsD is a function of carcinogenic potency (q_1^*) and defined acceptable risk (i.e., q_1^* , target level of risk); for example, the RsD for a lifetime cancer risk of one-in-one-million would equal q_1^*, 1×10^{-6}.
Run Habitat	Areas of swiftly flowing water, without surface waves, that approximate uniform flow and in which the slope of water surface is roughly parallel to the overall gradient of the stream reach.
Run-off	The portion of water from rain and snow which flows over land to streams, ponds or other surface water bodies. It is the portion of water from precipitation which does not infiltrate into the ground, or evaporate.
Run-on	Essentially the same as runoff, but referring to water that flows onto a property, or any piece of land of interest. Includes only those waters that have not been in contact with exposed oil sands, or with oil sands operational areas.
Runoff	The portion of water from rain and snow that flows over land to streams, ponds or other surface waterbodies. It is the portion of water from precipitation that does not infiltrate into the ground, or evaporate.
Sanitary Can	Specific design of metal can also known as an open topped can. Typically consists of a lapped or locked side seam and rolled or crimped lip. Invented in 1896.

Saturation Percentage	Percent water content where the soil is completely saturated with water.
Scale	Level of spatial resolution.
Screening	The process of filtering and removal of implausible or unlikely exposure pathways, chemicals or substances, or populations from the risk assessment process to focus the analysis on the chemicals, pathways and populations of greatest concern.
Secondary Extraction	In this step, bitumen froth from the primary extraction step is diluted with light hydrocarbon, and water and fine solids are removed by centrifuges in two stages.
Sediment Sampling	A field procedure relating to a method for determining the configuration of sediments.
Sedimentation	The process of subsidence and deposition of suspended matter carried by water, wastewater or other liquids, by gravity. It is usually accomplished by reducing the velocity of the liquid below the point at which it can transport the suspended material.
Sensory disturbance	Visual, auditory, or olfactory stimulus which creates a negative response in wildlife species.
Separation Cells	Large, cylindrical open-top vessels which are used as the primary extraction device in the hot water extraction process. Bitumen is recovered from the top of the vessel (as well as from a sidestream in a secondary circuit). Tailings are removed from the bottom.
Shell	Shell Canada Limited
Silviculture	The science and practice of controlling the establishment, composition and growth of the vegetation in forest stands. It includes the control or production of stand structures such as snags and down logs, in addition to live vegetation.
Site [Human Health]	The area determined to be significantly impacted after the iterative evaluations of the risk assessment. Can also be applied to political or legal boundaries.
Site [Historic]	Any location with detectable evidence of past human activity.
Slumps	Small shallow slope failure involving relocation of surficial soil on a slope without risk to the overall stability the facility.
Snag	Any standing dead, or partially-dead tree.
Snye	Discrete section on non-flowing water connected to a flowing channel only at its downstream end, generally formed in a side channel or behind a peninsula (bar).

Sodium Adsorption Ratio (SAR)	Concentrations of sodium, calcium and magnesium ions in a solution.
Soil Structure	The combination or arrangement of primary soil particles into secondary particles, units or peds.
Spawning Habitat	A particular type of area where a fish species chooses to reproduce. Preferred habitat (substrate, water flow, temperature) varies from species to species.
Species	A group of organisms that actually or potentially interbreed and are reproductively isolated from all other such groups; a taxonomic grouping of genetically and morphologically similar individuals; the category below genus.
Species abundance	The number of individuals of a particular species within a biological community (e.g., habitat).
Species Composition	A term that refers to the species found in the sampling area.
Species Distribution	Where the various species in an ecosystem are found at any given time. Species distribution varies with season.
Species Diversity	A description of a biological community that includes both the number of different species and their relative abundances. Provides a measure of the variation in number of species in a region. This variation depends partly on the variety of habitats and the variety of resources within habitats and, in part, on the degree of specialization to particular habitats and resources.
Species Richness	The number of different species occupying a given area.
Sport/Game Fish	Large fish caught for food or sport (e.g., northern pike, Arctic grayling).
Stability	A measure of the atmosphere's ability to disperse emissions. Stable atmospheric conditions create poorer dispersion of plumes and increased concentrations. Unstable conditions promote dispersion and result in lower concentrations.
Stand	An aggregation of trees occupying a specific area and sufficiently uniform in composition, age, arrangement and condition so that it is distinguishable from trees in adjoining areas.
Stand Age	The number of years since a stand experienced a stand-replacing disturbance event (e.g., fire, logging).
Stand Density	The number and size of trees on a forest site.
Standard Deviation (Sd)	A measure of the variability or spread of the measurements about the mean. It is calculated as the positive square root of the variance.

Stratigraphy	The succession and age of strata of rock and unconsolidated material. Also concerns the form, distribution, lithologic composition, fossil content and other properties of the strata.
Strip Mining	Mining method in which overburden is first removed from a seam of coal, or a sedimentary ore such as oil sands, allowing the coal or ore to be removed.
Structure (Stand Structure)	The various horizontal and vertical physical elements of the forest. The physical appearance of canopy and subcanopy trees and snags, shrub and herbaceous strata and downed woody material.
Subchronic toxicity	Adverse effects occurring as a result of the repeated daily exposure to a chemical for a short time. In Canada, human exposures lasting between two weeks and three months may be termed subchronic while in the U.S., human exposures lasting between two weeks and seven years may be termed subchronic.
Succession	A series of dynamic changes by which one group of organisms succeeds another through stages leading to a climax community.
Successional Stage	A stage or recognizable condition of a forest community that occurs during its development from bare ground to climax.
Suncor	Suncor Energy Inc., Oil Sands (also Suncor Inc., Oil Sands Group)
Surficial Aquifer	A surficial deposit containing water considered an aquifer.
Surficial Deposit	A geologic deposit (clay, silt or sand) that has been placed above bedrock. (See also "Overburden")
Suspended Sediments	Particles of matter suspended in the water. Measured as the oven dry weight of the solids, in mg/L, after filtration through a standard filter paper. Less than 25 mg/L would be considered clean water, while an extremely muddy river might have 200 mg/L of suspended sediments.
Sustainable Landscape	Ability of landscape (including landforms, drainage, water bodies and vegetation) to survive extreme events and natural cycles of change, without causing accelerated erosion and environmental impacts much more severe than that of the natural environment.
Syncrude	Syncrude Canada Ltd.
Tailings	A byproduct of oil sands extraction which are comprised of water, sands and clays, with minor amounts of residual bitumen.
Tailings Ponds	Man-made impoundment structures required to contain tailings. Tailings ponds are enclosed dykes made with tailings and/or overburden materials to stringent geotechnical standards.
TDS	Total dissolved solids.

Thalweg	The (imaginary) line connecting the lowest points along a streambed or valley. Within rivers, the deep channel area.
THC	Total Hydrocarbons include all airborne compounds containing only carbon and hydrogen.
TID	Tar Island Dyke.
Till	Sediments laid down by glaciers.
TOC	Total Organic Carbon. TOC is composed of both dissolved and particulate forms. TOC is often calculated as the difference between total carbon (TC) and total inorganic carbon (TIC). TOC has a direct relationship with both biochemical and chemical oxygen demands, and varies with the composition of organic matter present in the water. Organic matter in soils, aquatic vegetation and aquatic organisms are major sources of organic carbon.
Total Dissolved Solids (TDS)	The total concentration of all dissolved compounds solids found in a water sample. See filterable residue.
Toxic	A substance, dose or concentration that is harmful to a living organism.
Toxic Threshold	Almost all compounds (except genotoxic carcinogens) become toxic at some level with no evident harm or adverse effect below that level. Scientists refer to the level or concentration where they can first see evidence for an adverse effect on an organism as the toxic threshold. Genotoxic carcinogens exhibit some toxic potential at any level.
Toxicity	The inherent potential or capacity of a material to cause adverse effects in a living organism.
Toxicity Assessment	The process of determining the amount (concentration or dose) of a chemical to which a receptor may be exposed without the development of adverse effects.
Toxicity Reference Value (TRV)	For a non-carcinogenic chemical, the maximum acceptable dose (per unit body weight and unit of time) of a chemical to which a specified receptor can be exposed, without the development of adverse effects. For a carcinogenic chemical, the maximum acceptable dose of a chemical to which a receptor can be exposed, assuming a specified risk (e.g., 1 in 100,000). May be expressed as a Reference Dose (RfD) for non-carcinogenic (threshold-response) chemicals or as a Risk Specific Dose (RsD) for carcinogenic (non-threshold response) chemicals. Also referred to as exposure limit.
TSP	A measure of the total particulate matter suspended in the air. This represents all airborne particles with a mean diameter less than 30 μm (microns) in diameter.
TSS	Total suspended solids. See non-filterable residue.

U.S. EPA	U.S. Environmental Protection Agency.
Uncertainty	Imperfect knowledge concerning the present or future state of the system under consideration; a component of risk resulting from imperfect knowledge of the degree of hazard or of its spatial and temporal distribution.
Uncertainty Factor	A unitless numerical value that is applied to a reference toxicological value (i.e., NOAEL) to account for uncertainties in the experimental data used to derive the toxicological value (e.g., short testing period, lack of species diversity, small test group, etc.) and to increase the confidence in the safety of the exposure dose as it applies to species other than the test species (e.g., sensitive individuals in the human population). RfD equals the NOAEL divided by the uncertainty factor.
Unconfined Aquifer	An aquifer in which the water level is below the top of the aquifer.
Understory	Those trees or other vegetation in a forest stand below the main canopy level.
Upgraded Crude Oil	Often referred to as synthetic oil, upgraded crude oil is bitumen that has undergone alteration to improve its hydrogen-carbon balance to a lighter specific gravity product. At Suncor upgraded crude oil products may include: • Oil Sands A, a blend of low sulphur (hydrotreated) naphtha, kerosene and gas oil • Oil Sands Diesel, hydrotreated kerosene • Oil Sands E, a sour (higher sulphur) blend of coker distillate • Oil Sand Virgin, an uncracked vacuum tower product
Uptake	The process by which a chemical crosses an absorption barrier and is absorbed into the body.
Valued Ecosystem Component (VEC)	Components of an ecosystem (either plant, animal, or abiotic feature) considered valuable by various sectors of the public.
Vegetation Community	See "Plant Community".
VOC	Volatile Organic Compounds include aldehydes and all of the hydrocarbons except for ethane and methane. VOCs represent the airborne organic compounds likely to undergo or have a role in the chemical transformation of pollutants in the atmosphere.
Waste Area	The area where overburden materials are placed that are surplus to the need of the mine. Also referred to as a "waste dump".

Water Equivalent	As relating to snow; the depth of water that would result from melting.
Water Table	The shallowest saturated ground below ground level - technically, that surface of a body of unconfined groundwater in which the pressure is equal to atmospheric pressure.
Watershed	The entire surface drainage area that contributes water to a lake or river.
Wet Landscape Reclamation	A reclamation approach that involves a lake system, whereby contained fluid tailings are capped with a layer of water of sufficient depth to isolate fine tailings from direct contact with the surrounding environment.
Wetlands	Term for a broad group of wet habitats. Wetlands are transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. Wetlands include features that are permanently wet, or intermittently water-covered such as swamps, marshes, bogs, muskegs, potholes, swales, glades, slashes and overflow land of river valleys.
Worst-Case	A semi-quantitative term referring to the maximum possible exposure, dose or risk, that can conceivably occur, whether or not this exposure, dose, or risk actually occurs is observed in a specific population. It should refer to a hypothetical situation in which everything that can plausibly happen to maximize exposure, dose, or risk does happen. The worst-case may occur in a given population, but since it is usually a very unlikely set of circumstances in most cases, a worst-case estimate will be somewhat higher than what occurs in a specific population.
WSC	Water Survey of Canada
Xeric	Referring to habitats in which plant production is limited by availability of water.
YOY	Young of the year. Fish at age 0, within the first year after hatching.